Annex B2.5: INNS Assessment Report

Standard Gate two submission for London Water Recycling SRO

Notice – Position Statement

This document has been produced as the part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process allowing there to be control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions on behalf of customers to meet future drought resilience challenges.

This report forms part of suite of documents that make up the 'Gate 2 submission.' That submission details all the work undertaken by Thames Water in the ongoing development of the proposed SRO. The intention at this stage is to provide RAPID with an update on the concept design, feasibility, cost estimates and programme for the schemes, allowing decisions to be made on their progress.

Should a scheme be selected and confirmed in the Thames Water final Water Resources Management Plan (WRMP), in most cases it would need to enter a separate process to gain permission to build and run the final solution. That could be through either the Town and Country Planning Act 1990 or the Planning Act 2008 development consent order process. Both options require the designs to be fully appraised and, in most cases, an environmental statement to be produced. Where required that statement sets out the likely environmental impacts and what mitigation is required.

Community and stakeholder engagement is crucial to the development of the SROs. Some high-level activity has been undertaken to date. Much more detailed community engagement and formal consultation is required on all the schemes at the appropriate point. Before applying for permission Thames Water will need to demonstrate that they have presented information about the proposals to the community, gathered feedback and considered the views of stakeholders. We will have regard to that feedback and, where possible, make changes to the designs as a result.

The SROs are at a very early stage of development, despite some options having been considered for several years. The details set out in the Gate 2 documents are still at a formative stage.

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 2 Guidance and to comply with the regulatory process pursuant to Thames Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solutions presented in this document be taken forward, Thames Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

LONDON EFFLUENT REUSE SRO

Annex B.2.5. INNS Assessment Report

Report for: Thames Water Utilities Ltd

Ref. **4700399659**

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Ricardo ref. ED13591 Issue: 1.2 11/10/2022

Version Control

Version 1.0 – 25/07/2022		First Draft
Version 1.1 – 26/09/2022		Updates from Physical Environment Assessment Report Updates from Water Quality Assessment Report Incorporation of L2 Assurance Comments Incorporation of NAU Comments.
Version 1.2 – 06/10/2022		Second round of L2 Assurance Comments

Customer:
Thames Water Utilities Ltd

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4700399659

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APPENDICES

1 INTRODUCTION

This report is part of series of Environmental Assessment Reports (Annex B.2.) which catalogue the set of environmental assessments of the London Effluent Reuse Strategic Resource Option (SRO) through RAPID Gate 2: *Detailed feasibility, concept design and multi-solution decision making* and onward to RAPID Gate 3: *Developed design, finalised feasibility, pre-planning investigations and planning applications*. The reports set out the environmental assessments, which will in turn support regulatory assessment requirements proportionate to RAPID Gate 2 and onward to RAPID Gate 3. The scope and approach to the environmental evidence provided in these reports was set out in the Annex B.1. Gate 2 Scoping Report and consulted on with the National Appraisal Unit (NAU) in November 2021.

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This report forms part of suite of documents that make up the 'Gate 2 submission'. That submission details all the work undertaken by Thames Water (TWUL) in the ongoing development of the proposed SRO. The intention at this stage is to provide RAPID with an update on the concept design, feasibility, cost estimates and programme for the schemes, allowing decisions to be made on their progress.

Should a scheme be selected and confirmed in the TWUL final Water Resources Management Plan (WRMP), in most cases it would need to enter a separate process to gain permission to build and run the final solution. That could be through either the Town and Country Planning Act 1990 or the Planning Act 2008 development consent order process. Both options require the designs to be fully appraised and, in most cases, an environmental statement to be produced. Where required that statement sets out the likely environmental impacts and what mitigation is required.

Community and stakeholder engagement is crucial to the development of the SROs. Some high-level activity has been undertaken to date. Much more detailed community engagement and formal consultation is required on all the schemes at the appropriate point. Before applying for permission TWUL will need to demonstrate that they have presented information about the proposals to the community, gathered feedback and considered the views of stakeholders. We will have regard to that feedback and, where possible, make changes to the designs as a result.

The SROs are at a very early stage of development, despite some options having been considered for several years. The details set out in the Gate 2 documents are still at a formative stage.

Invasive non-native species (INNS) of flora and fauna are considered the second biggest threat after habitat loss and destruction to biodiversity worldwide and has been identified as one of the most serious and rapidly growing threats to biodiversity, ecosystem services and food, health and livelihood security[1]. The annual cost of INNS to Great Britain's economy was estimated in 2015 to be £1.7billion per year, of which around £5 million was attributed to water industry management of INNS[2]. New and existing INNS also pose a threat to achieving Water Framework Directive (WFD) objectives. The UKWIR project completed by Ricardo Energy & Environment (Ricardo)[3], provided further evidence of the implications of INNS to the water industry.

Subsequently, the Environment Agency (EA) in 2017, set out a position paper on the assessment of the risks of spreading INNS through existing water transfers. The position paper set out the scope, outcomes and timelines expected for the raw water transfer risk assessments, and options appraisal that water companies should deliver in Asset Management Plan (AMP) 7.

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[1] Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Sixth session Medellin, Colombia, 18–24 March 2018

[2] The Great Britain Non-native Species Secretariat (2015). The Great Britain Invasive Non-native Species Strategy, https://www.nonnativespecies.org/assets/Document-repository/gb-non-native-species-strategy-pb14324-5.pdf.

[3] UKWIR (2016). Invasive and Non-Native Species (INNS) Implications on The Water Industry. Report produced by Ricardo Energy & Environment. Report Number 16/DW/02/82. October 2016

As a result, INNS became a new "driver" within the 2019 Price Review (PR19). In previous price reviews, there was a limited scope for INNS work, justified within the biodiversity drivers. Having a separate driver recognised the increasing evidence and understanding of the risks posed by INNS. The guidance supporting this driver is explicit in stating that "*the most cost beneficial and least damaging way to manage invasive species is to prevent their arrival and spread*".[4]

This highlights the need to understand the *pathways* by which INNS can be transferred and hence be spread. Furthermore, the EA has identified raw water transfers (RWTs) as a subgroup of pathways that should have priority risk assessments (RAs) to assess the potential for INNS to spread[5]. It is noted that the London Effluent Reuse SRO is not a 'raw water' scheme but the principles of the EA PR19 INNS guidance have been adopted within this INNS assessment. As such, the PR19 INNS guidance indicates that all water companies will need to consider:

- Pathways of spread (understanding and reducing the risk from different pathways);
- Preventing spread (controlling, eradicating or managing INNS to prevent spread where this will contribute to WFD prevention of deterioration); and
- Action on INNS to achieve conservation objectives of Sites of Special Scientific Interest (SSSI) and sites protected under the Habitats Directive.

This has led to INNS being considered within the Water Industry National Environmental Programme and across the water industry (including TWUL) with a particular focus on investigating the risks of spreading INNS through the transfer options. All water companies with water transfers must include appraisal for mitigation, and company-wide biosecurity plans to reduce the risk of distributing INNS through existing activities and operations.

This report provides the assessment for the Gate 2 Invasive Non-Native Species (INNS) topic, which covers the components of the London Effluent Reuse SRO. The INNS assessment encompasses three approaches:

- An assessment of the potential changes in environmental parameters as a result of the operation of the London Effluent Reuse SRO components and the consequent impact on preferential physico-chemical conditions for INNS.
- A reach-based approach was adopted for this assessment, focused on the specific physical environmental parameters most likely to change as a result of the operation of the various components.
- A risk assessment adopting a heat map approach (high-level screening).
- A risk assessment adopting a pathway approach to quantify the risk of increased INNS distribution as a result of the operation of each SRO component utilising the EA's SRO Aquatic INNS Risk Assessment Tool (SAI-RAT).

The relevant section below provides a summary of the approach, the data used and the results of the two assessments.

1.1 LONDON EFFLUENT REUSE STRATEGIC RESOURCE OPTIONS

For Gate 2, the London Effluent Reuse SRO is set out as four source options and a range of sizes. Three of the options are in west London, utilising crude sewage or final effluent from Mogden sewage treatment works (STW) to a maximum total reduction of 200 Ml/d, with differing London effluent reuse scheme discharge locations in the freshwater River Thames. The fourth option is in east London, utilising final effluent from Beckton STW.

Full details of the conceptual design of the four schemes are provided in the Annex A. Conceptual Design Reports[6] (CDR). For assessment purposes no specific mitigation is allowed for unless included

[4] Environment Agency (2017). PR19 Driver Guidance, Driver Name: Invasive Non-Native Species (INNS)

[5] Environment Agency (2017). PR19 - Assessing the risks of spread of Invasive non-native species posed by existing water transfers - OFFICIAL

[6] Jacobs (2022) London Reuse Strategic Resource Option, Gate 2 Conceptual Design Reports (Annex A.).

as part of option design as set out in CDR (other than the Habitats Regulations Assessment (HRA) Stage 2 and Initial Environmental Appraisal (IEA)) which has regard for additional mitigation as per the ACWG methodology). A DRA intake would include appropriate fish screening and all new outfalls would include appropriate eel management measures. High level summaries of each option are provided below.

1.1.1 Mogden water recycling scheme

Final effluent from Mogden STW would be pumped in a new pipeline to a new reuse water recycling plant located at a site near Kempton water treatment works (WTW)) for advanced treatment via a new advanced water recycling plant (AWRP). Recycled water would be transferred in a new pipeline for discharge into the freshwater River Thames at a new outfall upstream of the existing Thames Water Walton intake. Additional abstraction for public water supply on a likely put-take basis would be through existing downstream intakes on the River Thames. AWRP wastewater and reverse osmosis (RO) concentrate would be conveyed back to Mogden STW inlet works via a return pipeline(s). There is an option that the AWRP wastewater could be discharged to the South Sewer for return to Mogden STW, but it is not possible to return the RO concentrate by this means. The option reduces the final effluent at the extant Mogden STW outfall to the estuarine Thames Tideway.

The Mogden water recycling scheme has been assessed for Gate 2 independently at 50 Ml/d, 100 Ml/d, 150 Ml/d and 200 Ml/d.

1.1.2 Mogden South Sewer scheme

Crude sewage would be diverted from the South Sewer of the sewerage catchment of Mogden STW. The South Sewer runs close to Kempton Park WTW, and the diverted sewage would be pumped to a new AWRP located at a site near Kempton WTW for advanced treatment. Recycled water would be transferred in a new pipeline for discharge into the freshwater River Thames at a new outfall upstream of the existing Thames Water Walton intake, potentially upstream of the Affinity Water Walton intake. Additional abstraction for public water supply on a likely put-take basis would be through existing downstream intakes on the River Thames. Waste streams from the AWRP would be conveyed by a new pipeline and treated at Mogden STW. The scheme reduces the final effluent at the extant Mogden STW outfall to the estuarine Thames Tideway.

During Gate 2, Thames Water took the decision to pause development of the Mogden South Sewer scheme due to limitations on available flow, cost of the scheme and regional modelling not selecting under any water resources planning horizon scenario. The Gate 1 concept design is therefore used in Gate 2, with the exception where scheme elements are shared with the Mogden effluent reuse scheme (certain conveyance routes, AWRP and discharge location) which have been further developed through Gate 2.

The Mogden South Sewer scheme has not been progressed through Gate 2 environmental assessments, and so a dedicated assessment section is not included within this report. However, due to the similarities with the 50 Ml/d Mogden water recycling scheme (AWRP, discharge location and volume), the outcomes of that assessment can be considered representative of a INNS assessment of a 50 Ml/d Mogden South Sewer scheme.

1.1.3 Teddington DRA scheme

Final effluent from Mogden STW would be subject to further treatment at a tertiary treatment plant (TTP) at Mogden STW. The treated water would be transferred in a new pipe-jacked tunnel for discharge into the freshwater River Thames at a new outfall upstream of the tidal limit at Teddington Weir. Additional abstraction for public water supply on a take-put basis would be through a new intake from the freshwater River Thames, upstream of the new outfall. Abstracted water would be pumped into the nearby Thames-Lee Tunnel (TLT) for transfer to Lockwood pumping station, part of Thames Water's Lee Valley reservoirs in North London.

The Teddington DRA scheme has been assessed for Gate 2 independently at 50 Ml/d, 75 Ml/d, 100 Ml/d and 150 Ml/d.

1.1.4 Beckton water recycling scheme

Final effluent from Beckton STW would be treated at a new AWRP within Beckton STW for advanced treatment. Recycled water would be conveyed via a new tunnel from the Beckton AWRP to Lockwood Pumping Station and then a TLT extension from Lockwood Pumping Station to a proposed new outfall located on a side channel of the freshwater River Lee Diversion, known as the Enfield Island Loop, upstream of the existing Thames Water Enfield intake to the King George V Reservoir. Additional abstraction for public water supply on a put/take basis would be through existing intakes in the lower Lee, to supplement the raw water supply to the Lee Valley reservoirs.

The Beckton water recycling scheme has been assessed for Gate 2 independently at 100 Ml/d, 200 Ml/d and 300 Ml/d.

1.2 INNS PREFERENCING ASSESSMENT

The INNS preferencing assessment considers the potential impact of changes in environmental parameters on the distribution of key INNS according to their known Physico-chemical preferences.

It is noted that the Environment Agency’s position statement advocates for the use of INNS “groups” and not individual species. However, for the purpose of the INNS preferencing assessment, where water resource activity may alter habitat favourability for specific INNS, the environmental requirements of individual species were considered.

The key references within Section 1.2.1 have been used to determine the following list of key INNS taxa, all identified during LRU monitoring in 2020 and 2021, that should be considered likely to be of most significance during the impact assessment.

It should be noted that many of the taxa listed here may be considered as well established in the wild in Britain and that the impact of some taxa (possibly those of intermediate risk in UKWIR (2016)[3]) may be limited.

Table 1-1 shows the key INNS taxa identified as of significance for this assessment. Table 1-2 show the optimal ranges of the key INNS species identified above for selected environmental parameters (For completeness, some additional non-native species considered as very well established or naturalised and of less significance in this context are also included in Table 1-2 in plain font). Note that their tolerance ranges will be wider than these optima, and data are also shown where available.

The key data sources used to determine the list of key INNS taxa are as follows (see ‘Reference’ column in Table 1-1 Key INNS Taxa of Potential Significance:

1. UK TAG high impact species. This list comprises a number of species from different habitat types, including 23 Freshwater, two Freshwater/Brackish and eight Riparian[7]
2. Final Top 10 INNS selected by the water companies 2015 (from Aldous et al, 2016[8]).
3. The highest-risk future alien invasive species in Great Britain (from Roy *et al*, 2014[9]).
4. Ranking of Ponto Caspian Species posing a threat to British freshwaters (from Gallardo & Aldridge, 2013[10]).

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[7] Environment Agency, 2019. Invasive non-native challenge. 2021 river basin management plans. https://consult.environment-agency.gov.uk/++preview++/environment-and-business/challenges-and-choices/user_uploads/inns-challenge-rbmp-2021-1.pdf

[8] Aldous, P., Aldridge, D., Fredenham, E., Nuttall, C. & Smithers, R., 2016. Invasive non-native species (INNS) implications on the water industry. UKWIR Report Ref No. 16/DW/02/82

[9] Roy, H., Peyton, J., Aldridge, D., Bantock, T., Blackburn, T., Britton, R., Clark, P., Cook, E., Dehnen-Schmutz, K., Dines, T., Dobson, M., Edwards, F., Harrower, C., Harvey, M., Minchin, D., Noble, D., Parrott, D., Pocock, M., Preston, C., Roy, S., Salisbury, A., Schönrogge, K., Sewell, J., Shaw, R., Stebbing, P., Stewart, A. & Walker, K., 2014. Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. Global Change Biology 20 (12), 3859–3871

[10] Gallardo, B. & Aldridge, D., 2013. Review of the ecological impact and invasion potential of Ponto Caspian invaders in Great Britain. Potential of Ponto Caspian invaders in Great Britain, Cambridge Environmental Consulting

Table 1-1 Key INNS Taxa of Potential Significance

Species	Name	Group	Reference
Dreissena rostriformis bugensis	Quagga mussel	Bivalve mollusc	1, 2, 3, 4
Dreissena polymorpha	Zebra mussel	Bivalve mollusc	1, 2
Corbicula fluminea	Asiatic clam	Bivalve mollusc	1, 2+
Dikerogammarus haemobaphes	Demon shrimp	Amphipod crustacean	1, 2, 4
Chelicorophium curvispinum	Caspian mud shrimp	Amphipod crustacean	4
Chelicorophium robustum		Amphipod crustacean	16
Hemimysis anomala	Bloody-red shrimp	Mysid crustacean	1, 4
Pacifastacus leniusculus	Signal crayfish	Decapod crustacean	1, 2, S9
Eriocheir sinensis	Chinese mitten crab	Decapod crustacean	1, S9
Hypania invalida	Bristle worm	Polychaete worm	4
Branchiura sowerbyi	Oligochaete worm	Oligochaete worm	*
Impatiens glandulifera	Himalayan balsam	Riparian plant	1, 2, S9
Hydrocotyle ranunculoides	Floating pennywort	Floating leaved plant	1, 2, S9
Elodea nuttallii	Nuttall's pondweed	Submerged plant	1, S9

S9 Species listed under Section 14, Schedule 9, Wildlife & Countryside Act 1981

*Potential risk probably low but not well understood.

+*C. fluminalis*

Note: The Killer shrimp, *Dikerogammarus villosus*, has not been found in the River Thames or adjacent water bodies to date. It is more generally restricted to still waters than *D. haemobaphes* but would otherwise have broadly similar physiological preferences to this related species.

Table 1-2 INNS Taxa with Reference to Their Optimal Range of Selected Environmental Parameters (Key taxa in bold)

Group	Taxon	DO (mg/l)	Salinity (ppt)	Cond (µS/cm)	Velocity (m/sec)	pH	Temp (°C)	Substrate	Nutrients	Misc Pollutants	Other
Bivalve mollusc	***Dreissena rostriformis bugensis***	8 - 10 mg/l Tolerant of 0.1 - 0.3 mg/l (lower than *D. polymorpha*)	< 1.5 ppt Tolerant of up to 5 ppt, possibly higher) During spawning <3 ppt	Requires a minimum Calcium concentration of ~ 12 mg/l	0.1 m/sec - Slow flowing rivers, canals and stillwaters for optimal feeding Feeding efficiency reduced at 0.2 m/s	Alkaline waters 7.4–9.6	20 ˚C Tolerant of 0 - 30 ˚C Spawning >10 - 12 ˚C	Both *Dreissena rostriformis bugensis* and *Dreissena polymorpha* prefer coarse substrate and artificial structure.	Can tolerate eutrophic & oligotrophic waterbodies	Can close shell for 2 weeks	Survives air exposure for up to 5 days. Can outcompete D. *polymorpha*
	Dreissena polymorpha	8 - 10 mg/l	Variable upper limit reported from 0.5 – 5 ppt Possibly tolerant of higher salinities	>110 µS/cm	As above but can avoid *Dreissena rostriformis bugensis* in faster flows. Settlement at <1.5 m/sec	Alkaline waters 7.4-8.5	17 - 25 ˚C Tolerant of 0 - 32 ˚C Spawning > 10-12 ˚C		Can tolerate eutrophic & oligotrophic waterbodies	Can close shell for 2 weeks	Survives air exposure for 3 weeks
	Corbicula fluminea	Low DO inhibits growth Common on oxygenated substrates	<5 ppt Tolerant of 5-14 ppt for up to 24hrs if acclimatised.		0 - 3 m/sec Thrives in still and flowing waters		2 - 34 ˚C Can tolerate 0 ˚C for weeks Spawns at ~15 ˚C	Burrowing, prefers sand to mud but not anoxic silt	Can tolerate eutrophic & oligotrophic waterbodies		Can survive out of water for prolonged periods

Group	Taxon	DO (mg/l)	Salinity (ppt)	Cond (µS/cm)	Velocity (m/sec)	pH	Temp (°C)	Substrate	Nutrients	Misc Pollutants	Other
Amphipod crustacean	***Dikerogammarus haemobaphes***		Tolerant up to 8 ppt	Recorded at between 471-529 µS/cm on the River Danube			<25 ˚C Tolerant up to 30 ˚C Species within the same genus typically spawn at >13 ˚C	Typically Inhabits large cobbles, boulders and artificial substrates and structures Also found within vegetation and within *D. polymorpha* colonies	Within the Danube tolerant of 22-26 ug/l Phosphorous		
	Chelicorophium curvispinum	9 - 10 mg/l	<6 ppt Tolerant of brackish waters		0.1-2 m/sec		20 ˚C	Highly adaptable			
	Chelicorophium robustum	9 - 10 mg/l	<6 ppt		0.1-2 m/sec		20 ˚C	Highly adaptable			
Mysid crustacean	***Hemimysis anomala***	>5 mg/l Tolerant of 4-11 mg/l	Tolerant of 0.1-18 ppt	Tolerant of 279-29200 µS/cm	<0.11 m/sec Tolerant of <0.35 m/sec	Tolerant of 6.35-8.65	9 - 20 ˚C Tolerant of 2 - 28 ˚C Spawns at >8 ˚C	Cobbles and coarse substrate if fish are present but finer fraction in darkness			
Decapod crustacean	***Pacifastacus leniusculus***	>6 mg/l	Adults tolerant up to 20 ppt Juveniles tolerant up to 7 ppt	>945 µS/cm	Broad tolerance	>6	Optimum growth 14-22 ˚C Tolerant of a wider temperature range Spawns at 6 - 13 ˚C	Found in a wide variety of substrate types, burrows in absence of refugia	Broad tolerance		Survives out of water for extended periods

Group	Taxon	DO (mg/l)	Salinity (ppt)	Cond (µS/cm)	Velocity (m/sec)	pH	Temp (°C)	Substrate	Nutrients	Misc Pollutants	Other
	Eriocheir sinensis	>2 mg/l	Mates & spawns in brackish/marine waters Juveniles/adults live in freshwater		Juvenile migration may slow in fast flow		Tolerant of 4-32 ˚C	Burrows into riverbanks and tidal margins			Migration to sea occurs in autumn
Polychaete worm	***Hypania invalida***	Observed at 6.5 mg/l	0-12 ppt	Observed at 443-586 µS/cm in the River Meuse			2-25 ˚C	Found in Mud/silt substrate but also within Dreissenid colonies			
Oligochaete worm	***Branchiura sowerbyi***						Warm rivers	Found in silt/mud substrate	Declines at low Phosphorous concentrations		
Riparian plant	***Impatiens glandulifera***										
Aquatic plants	***Hydrocotyle ranunculoides***		Limited tolerance to salinity		Found in slow flowing watercourses		Broad temperature range < 35 ˚C Tolerant below 0 ˚C		High nutrient concentrations are optimal for growth		
	Elodea nuttallii		Tolerant of salinity <14 ppt		Typically slow flowing rivers, canals and stillwaters	7.0 -9	10 - 20 ˚C		Broad tolerance to nutrient concentrations		Tolerant of high turbidity

Values show optimal range unless otherwise stated

1.2.1 Data Sources for Table 1.2

- CABI (Centre for Agriculture and Bioscience International) Invasive Species Compendium datasheets (https://www.cabi.org/isc).
- NNSS (GB non-native species secretariat) Information Portal (http://www.nonnativespecies.org/factsheet/index.cfm).
- NNSS Risk Assessment Summary Spreadsheets (http://www.nonnativespecies.org/index.cfm?pageid=143).
- ISSG (Invasive Species Specialist Group) Global Invasive Species Database. (http://www.iucngisd.org/gisd/)
- A study to assess the invasion risk of streams and rivers in Germany to determine a set of environmental variables that are most favourable for the establishment of non-native amphipods, isopods, gastropods and bivalves. The study looked at eight variables; chloride, ammonium, nitrate, oxygen, orthophosphate, distance to the next navigable waterway, and maximum and minimum temperature (Früh, D., Stoll, S. & Haase, P., 2012. Physico-chemical variables determining the invasion risk of freshwater habitats by alien molluscs and crustaceans. Ecology and Evolution 2012; 2(11): 2843–2853).
- A study to assess the sensitivity of native and alien freshwater bivalve species in Europe to climate-related environmental factors. Several alien bivalve species have become invasive, thereby impacting ecosystem functioning and services. These biodiversity changes can be attributed to deteriorated water quality, hydro-morphological alterations, and the overarching effect of global change. This study promotes a systematic assessment of the sensitivity of freshwater bivalve species occurring in European inland waters (Collas, F., Buijse, A., Hendriks, A., van der Velde, G., & Leuven, R., 2018. Sensitivity of native and alien freshwater bivalve species in Europe to climate-related environmental factors. Ecosphere 9(5): e02184. 10.1002/ecs2.2184).
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- *Hypania invalida* (Grube, 1960), a polychaete species new for the southern Baltic estuarine area: the Szczecin Lagoon and the River Odra mouth. Aquatic Invasions (2011) Volume 6, Issue 1: 39–46.
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- Information on the ecology of the oligochaete worm *Branchiura sowerbyi* in the Great Lakes. Liebig, J., Larson, J. & Fusaro, A., 2021. *Branchiura sowerbyi*: U.S. Geological Survey, Nonindigenous Aquatic Species Database, Gainesville, FL, and NOAA Great Lakes Aquatic Nonindigenous Species Information System, Ann Arbor, MI, https://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=1151, Revision Date: 9/12/2019, Access Date: 1/11/2021.
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- Literature review of alert Ponto Caspian Species posing a threat to British freshwaters. This includes some information on habitat preference, success in colonising new environments and environmental constraints. (Gallardo, B. & Aldridge, D., 2013. Review of the ecological impact and invasion potential of Ponto Caspian invaders in Great Britain. Potential of Ponto Caspian invaders in Great Britain, Cambridge Environmental Consulting).

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- Clark, P. F., Rainbow, P. S., Robbins, R. S., Smith, B., Yeomans, W. E., Thomas, M. and Dobson, G. 1998. The alien Chinese mitten crab, *Eriocheir sinensis* (Crustacea: Decapoda: Brachyura), in the Thames catchment. J. Mar. Biol. Ass. U.K., 78: 1215–1221.

2 BASELINE CONDITIONS

2.1 INTRODUCTION

The evidence base available for the INNS assessment is set out in the London Effluent Reuse SRO Gate 2 INNS Evidence Report. A summary of the baseline conditions present within each of the relevant river study reaches is presented below.

2.2 INVASIVE NON-NATIVE SPECIES

2.2.1 High Level Screening

The baseline data/evidence review considered INNS occurrence records stored within the NBN Atlas[11] covering a period of 20 years (1 January 2002 – 10 May 2022) as well as project specific monitoring data.

Following recommendations from the London Effluent Reuse Gate 1 INNS assessment, the INNS monitoring programme (see INNS Evidence Report) at 25 sites was extended into 2021 and 2022, to provide additional baseline information to inform the assessments. Surveys were conducted in Summer 2021, Spring 2022, and a final round of surveys are to be conducted in Summer 2022.

The purpose of the data review and project-specific monitoring was to build upon the Gate 1 baseline data review and establish which species are currently known to be present within the areas associated with the London Reuse scheme. Species records and monitoring data were assessed to identify which species are likely to be facilitated by a raw water transfer by becoming entrained and transported to new sites and/or the associated construction activities of the individual components. The data review encompassed all known INNS occurrence records within 500m of the scheme infrastructure as well as all INNS records within the wider catchments in which the scheme operates.

INNS species listed under; Schedule 9 of the Wildlife and Countryside Act, WFD UKTAG Aquatic Alien Species, EU Invasive and Alien Species Regulation, Wales Priority Species for Action, MSFD – UK priority species, WFD UKTAG alarm species, GB NNSS Alert species have been identified from the datasets for consideration.

A Kernel Density estimation algorithm was applied to the data captured during the NBN Atlas data review and project-specific monitoring using geographical imaging software (GIS). The algorithm provides a visual representation of INNS occurrence record densities, heatmaps were produced to summarise records within 500m of the scheme infrastructure and to summarise the INNS occurrence records for the operational catchments in which the scheme operates. This allows for the identification of regions with a higher density of recorded INNS occurrences based upon the number of records within a 250 m radius of each record. Though the heatmaps are able to show where a high number of occurrences have been recorded their accuracy in determining the actual density of INNS is dependent upon sampling effort, therefore the heatmaps only provide an indication of where INNS have been recorded and do not indicate actual INNS density.

2.2.2 Subject area overview

The results of the baseline/evidence review highlighted 42 INNS of interest recorded within 500m of the scheme since 2002. The ten most frequently recorded INNS are represented within Table 2-1 below, with the most commonly recorded species being New Zealand mudsnail (*Potamopyrgus antipodarum*) followed by Asian clam (*Corbicula fluminea*), Caspian mud shrimp (*Chelicorophium curvispinum*) and Zebra Mussel (*Dreissena polymorpha*). Further detail is provided on a reach buy reach basis within sections 2.2.3 to 2.2.5 below.

[11] https://nbnatlas.org/

Table 2-1 – The ten most frequently recorded INNS within 500m of the London Effluent Reuse schemes component reaches.

Common Name	Scientific Name	Occurrences
New Zealand Mudsnail	*Potamopyrgus antipodarum*	729
Asian Clam	*Corbicula fluminea*	352
Caspian Mud Shrimp	*Chelicorophium curvispinum*	317
Zebra Mussel	*Dreissena polymorpha*	270
Chinese Mitten Crab	*Eriocheir sinensis*	267
Demon Shrimp	*Dikerogammarus haemobaphes*	219
Ponto-Caspian Polycheate Worm	*Hypania invalida*	204
Floating Pennywort	*Hydrocotyle ranunculoides*	128
Himalayan Balsam	*Impatiens glandulifera*	113
Nuttall's Waterweed	*Elodea nuttallii*	104

It is noted that for many aquatic species and species that spread via seeds, plant fragments and eggs, a much wider study area is required as species could be transported by numerous pathways to the study area. Additionally, although the occurrence records provide an indication of the species which may be present, the data is dependent upon survey records and therefore is not a definitive record of INNS presence. Several prolific species have been recorded outside of the baseline/evidence period which are likely to remain present.

A high-level assessment of the River Thames River Basin District (RBD) revealed 76 species of interest which may pose a risk during the construction, operation or maintenance of London Effluent Reuse SRO components, shown below In Table 2-2. Of the species recorded within the Thames RBD several notable species were recorded which have not yet been recorded within reaches listed below. These include a number of aquatic invertebrate species such as Slipper Limpet (*Crepidula fornicata*), Soft-shell clam (*Mya arenaria*) and Red swamp crayfish (*Procambarus clarkii*) as well as numerous aquatic and terrestrial plant species including Cape Pondweed (*Aponogeton distachyos*) and Giant Knotweed (*Fallopia sachalinensis*).

Table 2-2 INNS recorded within the Thames RBD post 2001.

Common Name	Scientific Name	Occurrences
New Zealand Mudsnail	*Potamopyrgus antipodarum*	327
Himalayan Balsam	*Impatiens glandulifera*	266
Japanese Knotweed	*Fallopia japonica*	176
Cherry Laurel	*Prunus laurocerasus*	172
Signal Crayfish	*Pacifastacus leniusculus*	137
Butterfly Bush	*Buddleja davidii*	103
False Acacia	*Robinia pseudoacacia*	92
Spotted Touch-me-not	*Impatiens capensis*	90
Caspian Mud Shrimp	*Chelicorophium curvispinum*	75
Bladder Snail	*Physella acuta*	69
Least Duckweed	*Lemna minuta*	69
Nuttall's Waterweed	*Elodea nuttallii*	52
Spanish Bluebell	*Hyacinthoides hispanica*	52
Rhododendron	*Rhododendron ponticum*	46
Greater Periwinkle	*Vinca major*	44
Zebra Mussel	*Dreissena polymorpha*	43
Montbretia	*Crocosmia pottsii x aurea = C. x crocosmiiflora*	39
Demon Shrimp	*Dikerogammarus haemobaphes*	38
Floating Pennywort	*Hydrocotyle ranunculoides*	34
Variegated Yellow Archangel	*Lamiastrum galeobdolon subsp. argentatum*	34
Chinese Mitten Crab	*Eriocheir sinensis*	32
Giant Hogweed	*Heracleum mantegazzianum*	31
Asian Clam	*Corbicula fluminea*	30
Wall Cotoneaster	*Cotoneaster horizontalis*	29
Tree-of-Heaven	*Ailanthus altissima*	21
Ponto-Caspian Polycheate Worm	*Hypania invalida*	20
Himalayan Cotoneaster	*Cotoneaster simonsii*	17
Myrtle	*Vinca minor*	14
Quagga Mussel	*Dreissena rostriformis bugensis*	12
Canadian Pondweed	*Elodea canadensis*	12
Slipper Limpet	*Crepidula fornicata*	12
Japanese Rose	*Rosa rugosa*	10
Marsh Frog	*Pelophylax ridibundus*	9
New Zealand Barnacle	*Austrominius modestus*	9
Wautier's Limpet	*Ferrissia (Petancylus) californica*	9
Everlasting Pea	*Lathyrus latifolius*	9
False Angelwing	*Petricolaria pholadiformis*	8
Swamp Stonecrop	*Crassula helmsii*	8

Common Name	Scientific Name	Occurrences
Northern River Amphipod	*Crangonyx pseudogracilis*	7
False Virginia-creeper	*Parthenocissus quinquefolia*	7
Western Hemlock	*Tsuga heterophylla*	7
American Skunk Cabbage	*Lysichiton americanus*	6
Ponto-Caspian Hydroid	*Cordylophora caspia*	5
Rainbow Trout	*Oncorhynchus mykiss*	5
Water Fern	*Azolla filiculoides*	5
Few-flowered Garlic	*Allium paradoxum*	5
Three-cornered Garlic	*Allium triquetrum*	5
Entire-leaved Cotoneaster	*Cotoneaster integrifolius*	5
Sweet Flag	*Acorus calamus*	4
Common Carp	*Cyprinus carpio*	4
Pacific Oyster	*Magallana gigas*	4
Pirri-pirri Burr	*Acaena novae-zelandiae*	4
Pink Purslane	*Claytonia sibirica*	4
Monkey Flower	*Mimulus guttatus*	4
Zander	*Sander lucioperca*	3
Bloody-red Mysid	*Hemimysis anomala*	3
Cape Pondweed	*Aponogeton distachyos*	3
Goldfish	*Carassius auratus*	3
Red-gilled Mudworms	*Marenzelleria viridis*	2
Carpet Sea-Squirt	*Didemnum vexillum*	2
North American Ostracod	*Eusarsiella zostericola*	2
Curly Waterweed	*Lagarosiphon major*	2
Parrot's Feather	*Myriophyllum aquaticum*	2
Red Swamp Crayfish	*Procambarus clarkii*	2
Rum Cherry	*Prunus serotina*	2
Large-flowered Waterweed	*Egeria densa*	1
Sitka Spruce	*Picea sitchensis*	1
Common Midwife Toad	*Alytes obstetricans*	1
Intermediate Periwinkle	*Vinca difformis*	1
Nuttall’s Waterweed	*Elodea canadensis/nutallii*	1
Atlantic Jackknife Clam	*Ensis leei*	1
Giant Knotweed	*Fallopia sachalinensis*	1
Soft-shell Clam	*Mya arenaria*	1
Yellow Azalea	*Rhododendron luteum*	1
Broadleaf Arrowhead	*Sagittaria latifolia*	1
Perfoliate Alexanders	*Smyrnium perfoliatum*	1

2.2.3 Freshwater River Thames

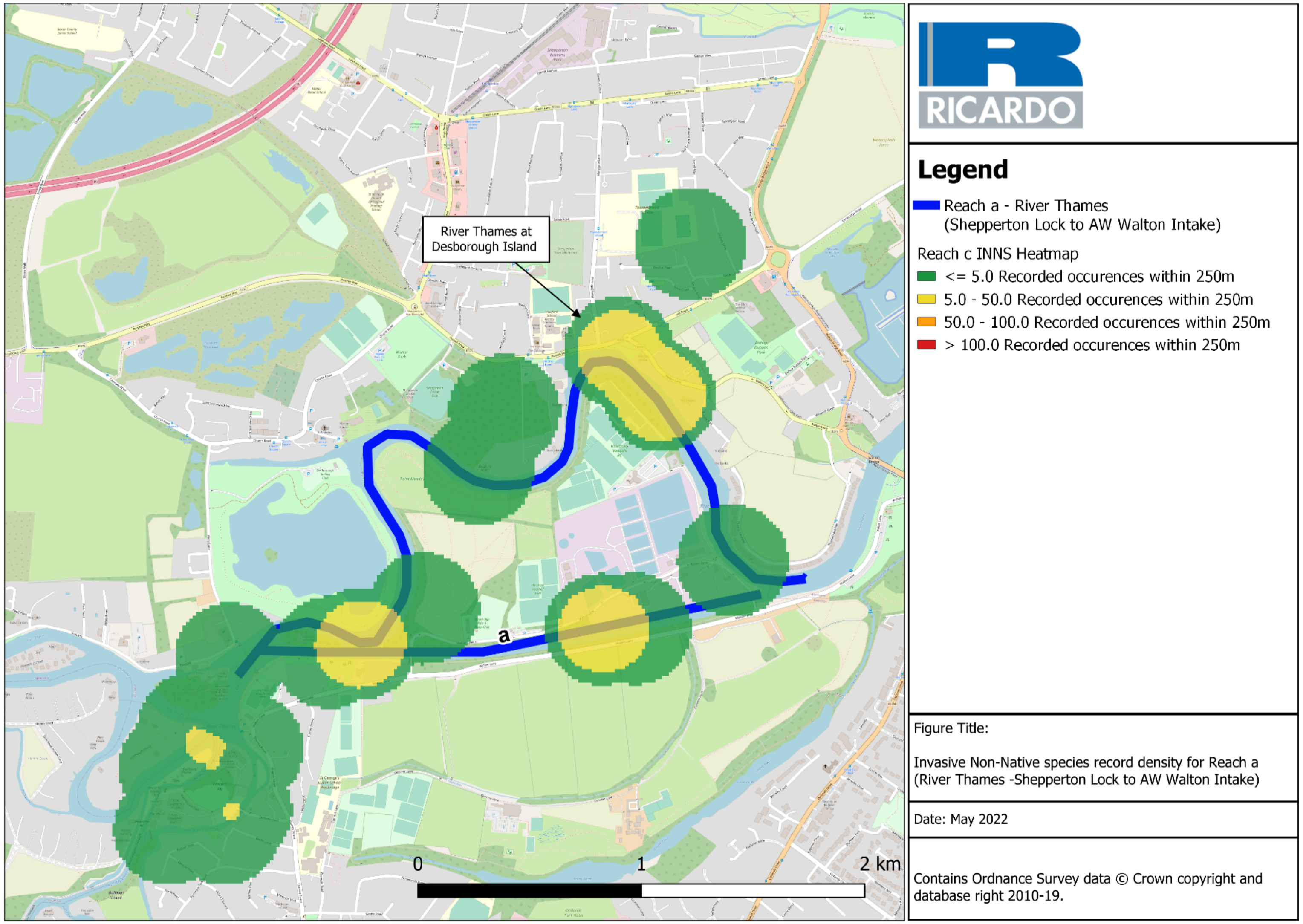
Reach A – Shepperton Weir to Affinity Water Walton Intake

A total of 14 INNS of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen within Table 2-3 below. The most frequently recorded species within this reach is the aquatic plant species Floating pennywort (*Hydrocotyle ranunculoides*), followed by several aquatic invertebrate species including Zebra Mussel (*Dreissena polymorpha*) and terrestrial plant species such as Japanese Knotweed (*Fallopia japonica*). A heatmap representation of data indicates several areas within the reach at which there is a higher frequency of occurrence records. For Reach A, Figure 2-1 - Reach A INNS Heatmap shows these areas, which includes the section of the River Thames at Desborough Island closest to Russel Road. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort. It should be noted that Reach A is located upstream of the currently preferred Mogden water recycling discharge location.

Table 2-3 INNS recorded with Reach A (Shepperton Weir to Affinity Water Walton Intake) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
Floating Pennywort	*Hydrocotyle ranunculoides*	21
Caspian Mud Shrimp	*Chelicorophium curvispinum*	8
Demon Shrimp	*Dikerogammarus haemobaphes*	8
Ponto-Caspian Polycheate Worm	*Hypania invalida*	8
Zebra Mussel	*Dreissena polymorpha*	8
Japanese Knotweed	*Fallopia japonica*	6
Asian Clam	*Corbicula fluminea*	4
Nuttall's Waterweed	*Elodea nuttallii*	4
Chinese Mitten Crab	*Eriocheir sinensis*	4
Zander	*Sander lucioperca*	4
Least Duckweed	*Lemna minuta*	4
Spanish Bluebell	*Hyacinthoides hispanica*	3
Quagga Mussel	*Dreissena rostriformis bugensis*	2
Himalayan Balsam	*Impatiens glandulifera*	2

Figure 2-1 - Reach A INNS Heatmap



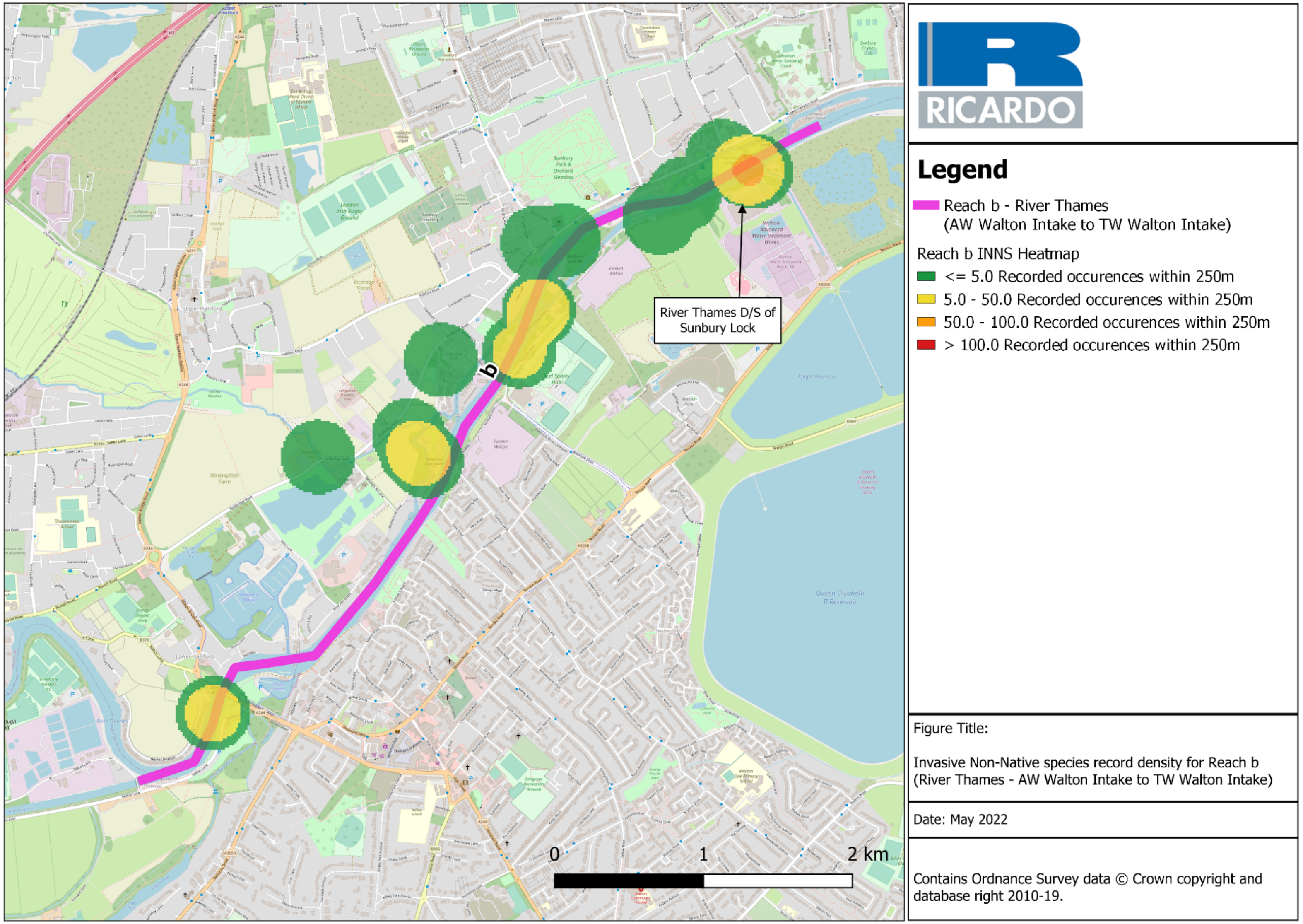
Reach B – Affinity Water Walton Intake to Thames Water Walton Intake

A total of 17 INNS of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen within Table 2-4 below. The most common species recorded within this reach were aquatic invertebrate species, with the most abundant being Caspian Mud Shrimp followed by Zebra Mussel and Demon shrimp (*Dikerogammarus haemobaphes*). A heatmap representation of data indicates several areas within the reach at which there is a higher frequency of occurrence records. For Reach B, Figure 2-2 shows these areas, which includes the section of the River Thames immediately upstream of Sunbury Lock. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-4 INNS recorded with Reach B (Affinity Water Walton Intake to Thames Water Walton Intake) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
Caspian Mud Shrimp	*Chelicorophium curvispinum*	34
Zebra Mussel	*Dreissena polymorpha*	24
Demon Shrimp	*Dikerogammarus haemobaphes*	20
New Zealand Mudsnail	*Potamopyrgus antipodarum*	20
Ponto-Caspian Polycheate Worm	*Hypania invalida*	14
Bladder Snail	*Phusela acuta*	7
Asian Clam	*Corbicula fluminea*	6
Nuttall's Waterweed	*Elodea nuttallii*	5
Japanese Knotweed	*Fallopia japonica*	5
Himalayan Balsam	*Impatiens glandulifera*	5
Floating Pennywort	*Hydrocotyle ranunculoides*	4
Chinese Mitten Crab	*Eriocheir sinensis*	4
Quagga Mussel	*Dreissena rostriformis bugensis*	2
Spotted Touch-me-not	*Impatiens capensis*	2
Least Duckweed	*Lemna minuta*	2
Spanish Bluebell	*Hyacinthoides hispanica*	1
Bloody-red Mysid	*Hemimysis anomala*	1

Figure 2-2 - Reach B INNS Heatmap



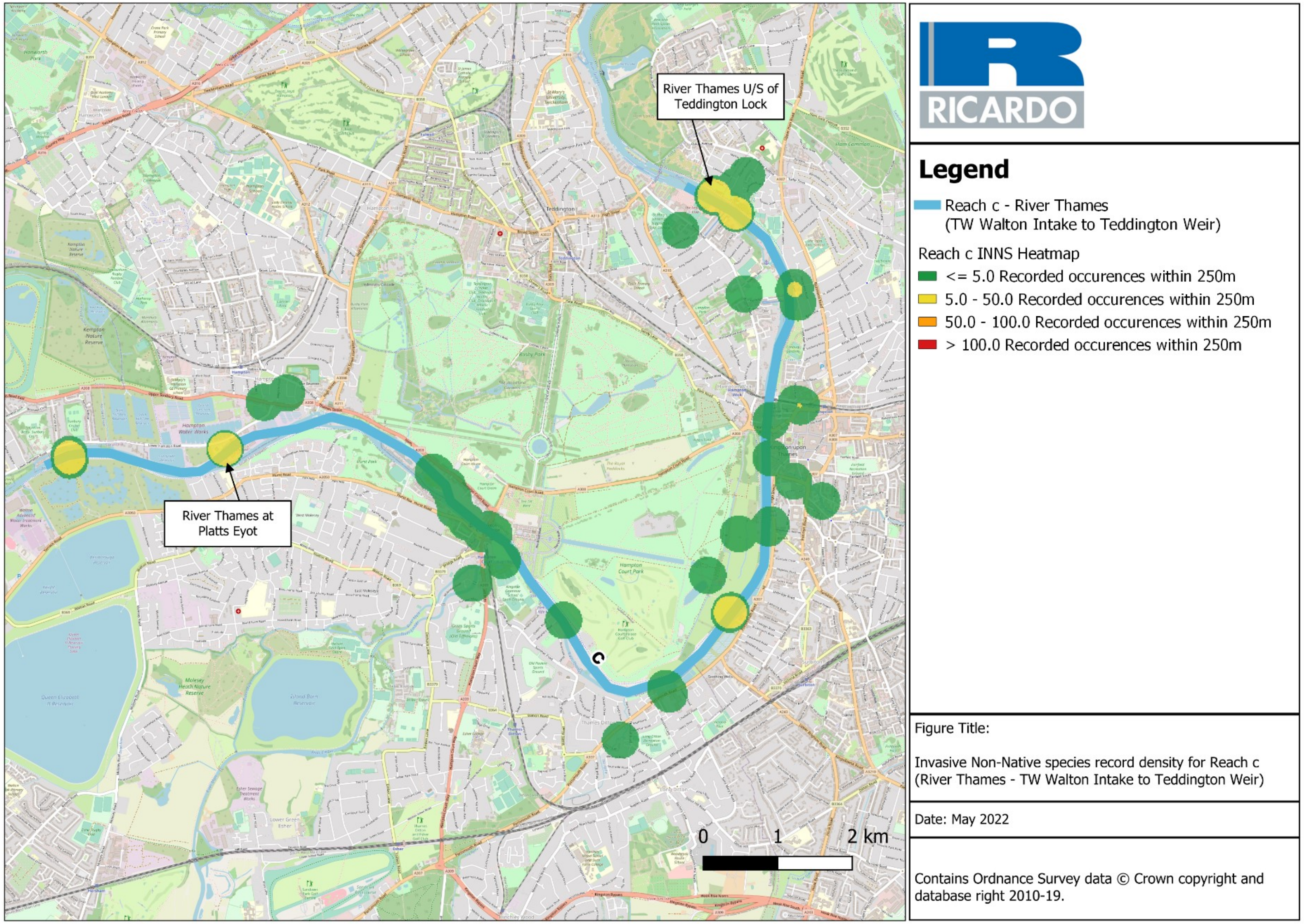
Reach C – Thames Water Walton Intake to Teddington Weir

A total of 30 INNS of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen within Table 2-5 below. The most frequently recorded species was Caspian Mud Shrimp, followed by Demon shrimp and Ponto-Caspian Polycheate Worm (*Hypania invalida).* A heatmap representation of data indicates several areas within the reach at which there is a higher frequency of occurrence records. For Reach C, Figure 2-3 shows these areas, which includes the section of the River Thames at Platts Eyot, and the section immediately upstream of Teddington Lock. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-5 INNS recorded with Reach C (Thames Water Walton Intake to Teddington Weir) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
Caspian Mud Shrimp	*Chelicorophium curvispinum*	41
Demon Shrimp	*Dikerogammarus haemobaphes*	33
Ponto-Caspian Polycheate Worm	*Hypania invalida*	30
Zebra Mussel	*Dreissena polymorpha*	29
Asian Clam	*Corbicula fluminea*	27
New Zealand Mudsnail	*Potamopyrgus antipodarum*	25
Nuttall's Waterweed	*Elodea nuttallii*	17
Floating Pennywort	*Hydrocotyle ranunculoides*	15
Chinese Mitten Crab	*Eriocheir sinensis*	13
Japanese Knotweed	*Fallopia japonica*	12
Quagga Mussel	*Dreissena rostriformis bugensis*	11
Tadpole Physa	*Physella acuta/gyrina*	11
Zander	*Sander lucioperca*	9
Florida Crangonyx	*Crangonyx pseudogracilis/floridanus sens. lat.*	5
Spanish Bluebell	*Hyacinthoides hispanica*	3
Tubificid Worm	*Branchiura sowerbyi*	3
Spotted Touch-me-not	*Impatiens capensis*	3
Canadian Pondweed	*Elodea canadensis*	3
Grass Carp	*Ctenopharyngodon idella*	3
Least Duckweed	*Lemna minuta*	2
Verrucata Leech	*Glossiphonia verrucata*	2
Physella Snail	*Physella acuta/gyrina agg.*	2
Bladder Snail	*Physella acuta*	1
Bloody-red Mysid	*Hemimysis anomala*	1
Signal Crayfish	*Pacifastacus leniusculus*	1
Atlantic-boreal Gammarus	*Gammarus zaddachi*	1
Amphipod	*Cryptorchestia cavimana/garbinii agg.*	1
Long Finger Clam	*Musculium transversum*	1
Caspian Mud Shrimp	*Chelicorophium robustum*	1
Quagga Mussel	*Dreissena bugensis*	1

Figure 2-3 - Reach C INNS Heatmap



2.2.4 Estuarine Thames Tideway

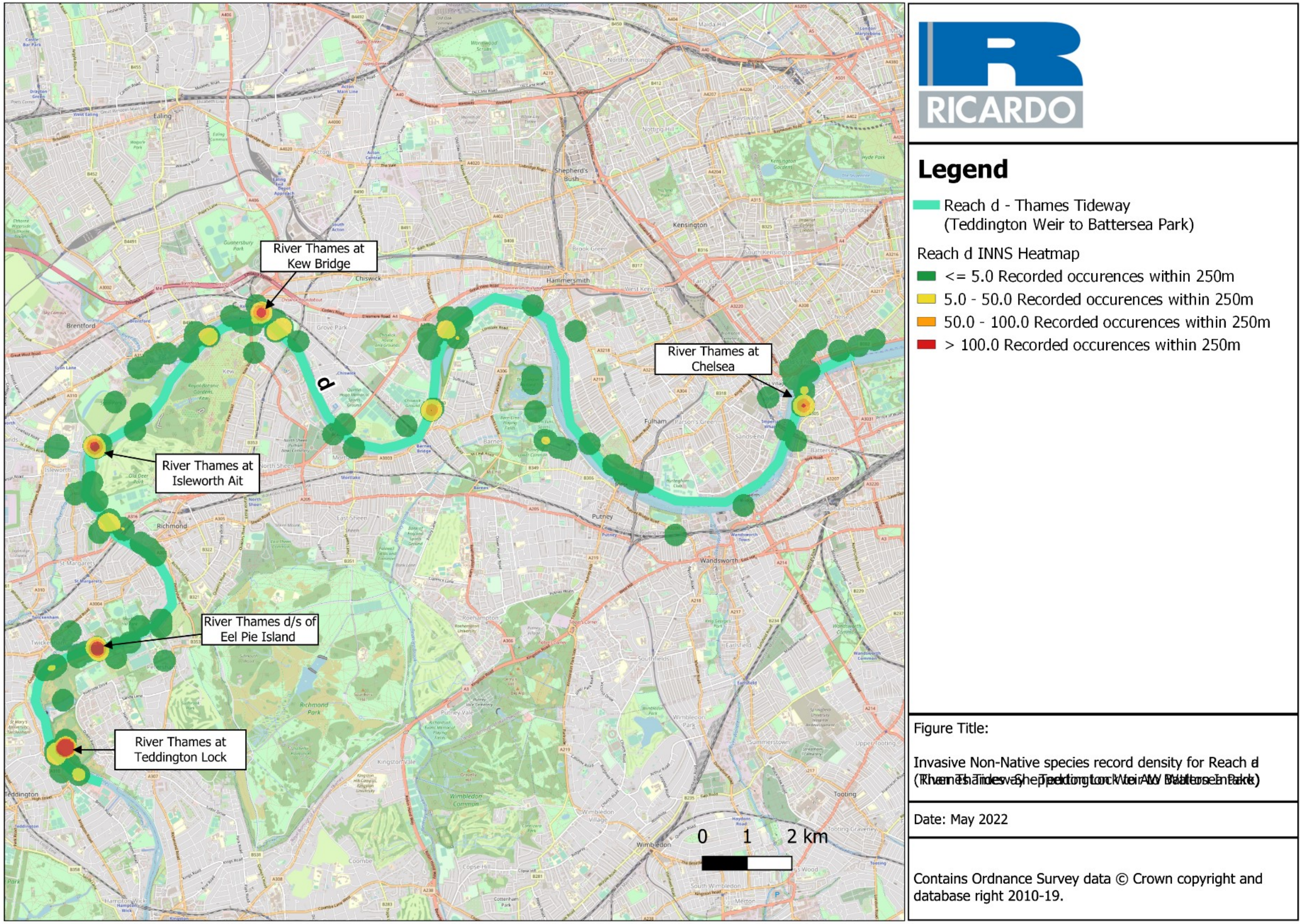
Reach D – Teddington Weir to Battersea Park

A total of 32 INNS of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen in Table 2-6. The most abundant species were aquatic invertebrates, with New Zealand mudsnail being the most frequent, followed by Asian clam and Caspian Mud shrimp. A heatmap representation of data indicates several areas within the reach where there is a higher frequency of occurrence records. For Reach D, Figure 2-4 shows these areas, which includes Teddington Lock, downstream of Eel Pie island, and Kew Bridge. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-6 INNS recorded with Reach D (Teddington Weir to Battersea Park) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
New Zealand Mudsnail	*Potamopyrgus antipodarum*	461
Asian Clam	*Corbicula fluminea*	298
Caspian Mud Shrimp	*Chelicorophium curvispinum*	194
Chinese Mitten Crab	*Eriocheir sinensis*	194
Ponto-Caspian Polycheate Worm	*Hypania invalida*	130
Zebra Mussel	*Dreissena polymorpha*	118
Demon Shrimp	*Dikerogammarus haemobaphes*	67
Himalayan Balsam	*Impatiens glandulifera*	49
Atlantic-boreal Gammarus	*Gammarus zaddachi*	24
Japanese Knotweed	*Fallopia japonica*	21
Spanish Bluebell	*Hyacinthoides hispanica*	17
Floating Pennywort	*Hydrocotyle ranunculoides*	16
Nuttall's Waterweed	*Elodea nuttallii*	11
Quagga Mussel	*Dreissena rostriformis bugensis*	11
Bladder Snail	*Physella acuta*	10
Ponto-Caspian Hydroid	*Cordylophora caspia*	8
Tree-of-Heaven	*Ailanthus altissima*	8
False Acacia	*Robinia pseudoacacia*	6
Tadpole Physa	*Physella acuta/gyrina*	5
Tubificid Worm	*Branchiura sowerbyi*	5
Marsh Frog	*Pelophylax ridibundus*	5
Florida Crangonyx	*Crangonyx pseudogracilis/floridanus sens.*	4
Bloody-red Mysid	*Hemimysis anomala*	4
Canadian Pondweed	*Elodea canadensis*	3
Cherry Laurel	*Prunus laurocerasus*	3
Zander	*Sander lucioperca*	2
Spotted Touch-me-not	*Impatiens capensis*	2
Long Finger Clam	*Musculium transversum*	2
Giant Hogweed	*Heracleum mantegazzianum*	2
Least Duckweed	*Lemna minuta*	1
Red-gilled Mudworms	*Marenzelleria viridis*	1
Northern River Amphipod	*Crangonyx pseudogracilis*	1

Figure 2-4 - Reach D INNS Heatmap



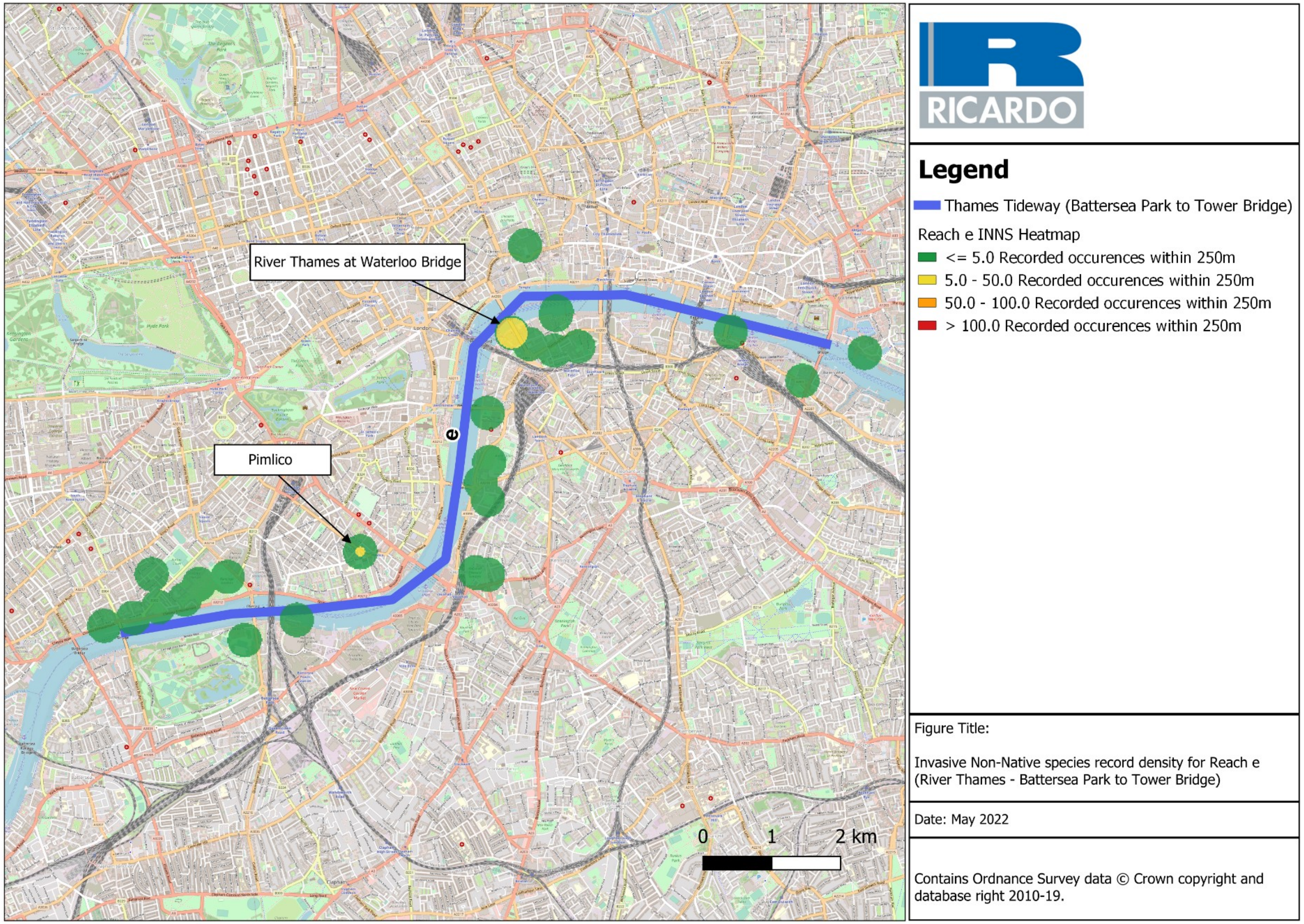
Reach E – Battersea Park to Tower Bridge

A total of 11 species of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen in Table 2-7. The most frequently recorded species was the aquatic invertebrate species New Zealand mudsnail, followed by two terrestrial plant species False acacia and Spanish bluebell. A heatmap representation of data indicates areas within the reach at which there is a higher frequency of occurrence records. For Reach E, Figure 2-5 shows these areas, which includes the Thames Tideway at Waterloo Bridge, and near Pimlico. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-7 INNS recorded with Reach E (Battersea Park to Tower Bridge) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
New Zealand Mudsnail	*Potamopyrgus antipodarum*	32
False Acacia	*Robinia pseudoacacia*	14
Spanish Bluebell	*Hyacinthoides hispanica*	8
Chinese Mitten Crab	*Eriocheir sinensis*	7
Red-gilled Mudworms	*Marenzelleria viridis*	7
Asian Clam	*Corbicula fluminea*	6
Ponto-Caspian Hydroid	*Cordylophora caspia*	6
Cherry Laurel	*Prunus laurocerasus*	4
Tree-of-Heaven	*Ailanthus altissima*	4
Butterfly Bush	*Buddleia davidii*	2
Zebra Mussel	*Dreissena polymorpha*	1

Figure 2-5 – Reach E INNS Heatmap



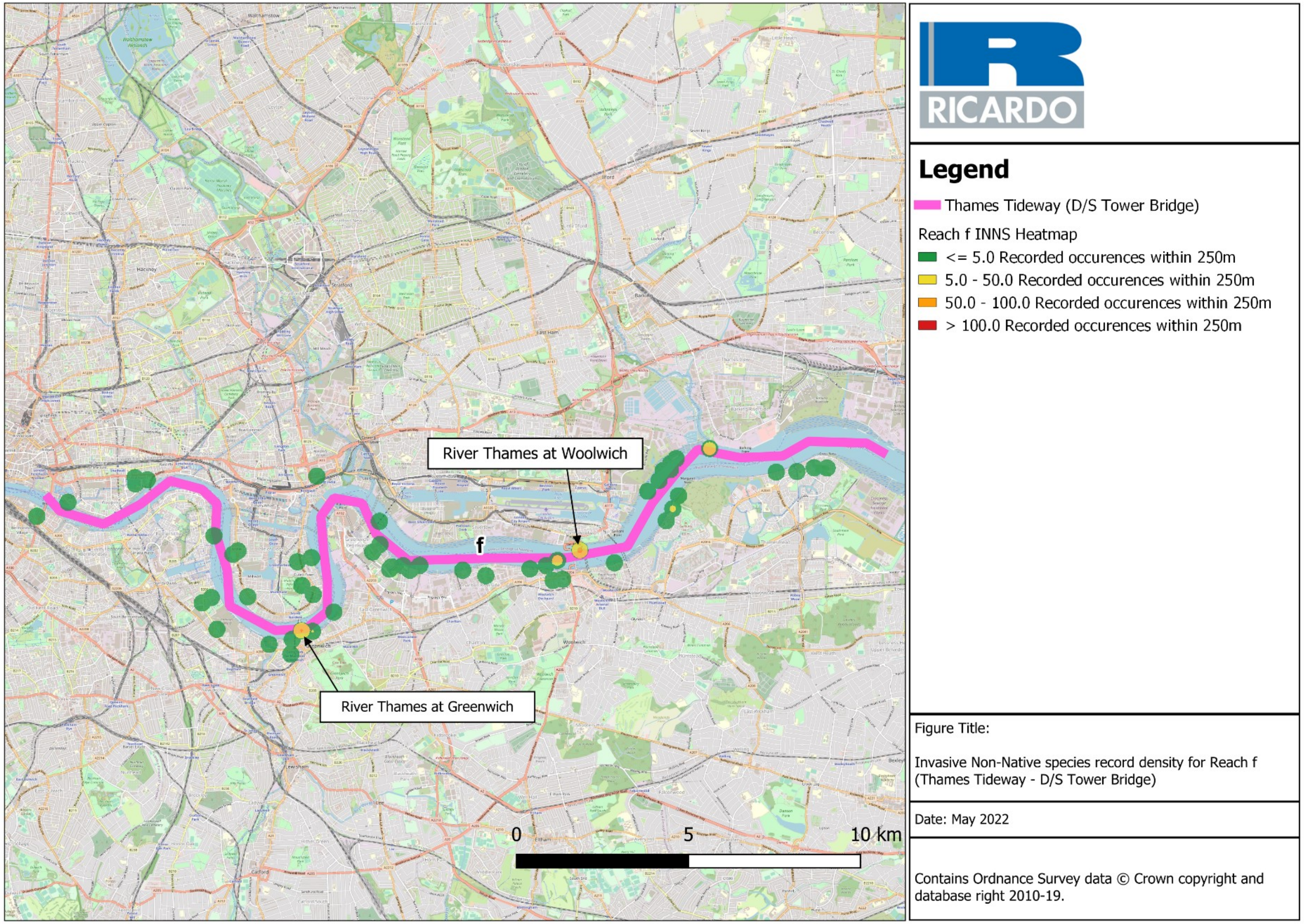
Reach F Tower Bridge to 3km seawards of Beckton Sewage Treatment Works (STW)

A total of 20 INNS species of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen in Table 2-8. The most frequently recorded species were aquatic invertebrates, with the most abundant being New Zealand mudsnail, followed by Chinese mitten crab *and* red-gilled mudworms (*Marenzelleria viridis*). A heatmap representation of data indicates areas within the reach at which there is a higher frequency of occurrence records. For Reach F, Figure 2-6 shows these areas, which include the Thames Tideway at Greenwich and at Woolwich. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-8 INNS recorded with Reach F (Tower Bridge to 3km seawards of Beckton STW) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
New Zealand Mudsnail	*Potamopyrgus antipodarum*	97
Chinese Mitten Crab	*Eriocheir sinensis*	36
Red-gilled Mudworms	*Marenzelleria viridis*	36
Ponto-Caspian Hydroid	*Cordylophora caspia*	23
False Acacia	*Robinia pseudoacacia*	12
Cherry Laurel	*Prunus laurocerasus*	12
Sea-buckthorn	*Hippophae rhamnoides*	6
New Zealand Barnacle	*Austrominius modestus*	4
Spanish Bluebell	*Hyacinthoides hispanica*	3
Zebra Mussel	*Dreissena polymorpha*	2
Japanese Knotweed	*Fallopia japonica*	2
Bladder Snail	*Physella acuta*	2
Tree-of-Heaven	*Ailanthus altissima*	2
Marsh Frog	*Pelophylax ridibundus*	2
Asian Clam	*Corbicula fluminea*	1
Nuttall's Waterweed	*Elodea nuttallii*	1
Zander	*Sander lucioperca*	1
Canadian Pondweed	*Elodea canadensis*	1
Common Carp	*Cyprinus carpio*	1
Pacific Oyster	*Magallana gigas*	1

Figure 2-6 - Reach F INNS Heatmap



2.2.5 Freshwater Lee Diversion Channel

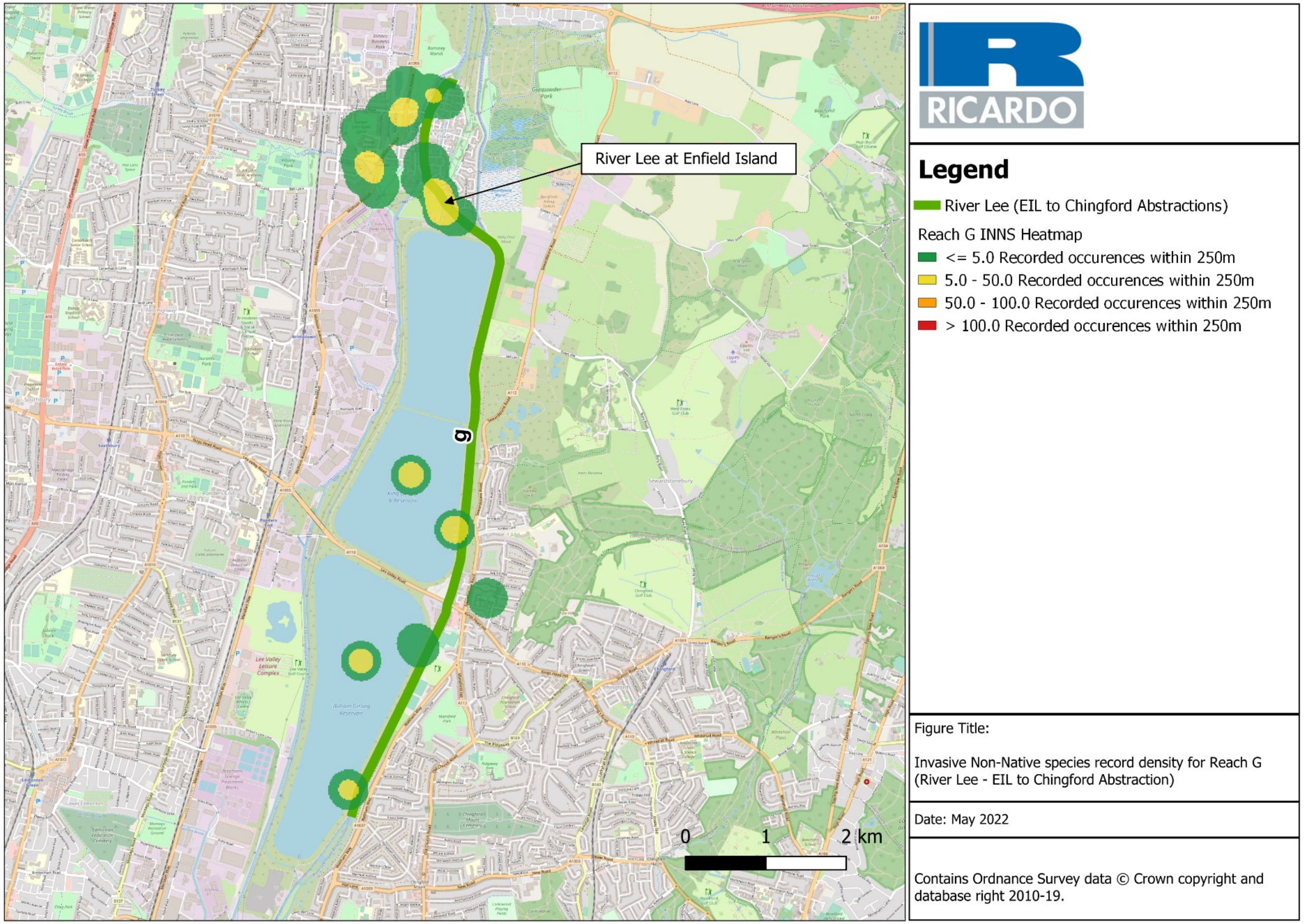
Reach G – Newman's Weir on the Enfield Island Loop to Chingford Abstractions

A total of 26 INNS species of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen in Table 2-9. The species that was recorded most frequently was the terrestrial plant Himalayan Balsam. Other frequently recorded species includes aquatic invertebrate species such as New Zealand mudsnail and Demon shrimp. A heatmap representation of data indicates areas within the reach at which there is a higher frequency of occurrence records. For Reach G, Figure 2-7 shows these areas, which include the northern part of the reach around the River Lee at Enfield Island. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-9 INNS recorded with Reach G (Newman's Weir on the Enfield Island Loop to Chingford Abstractions) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
Himalayan Balsam	*Impatiens glandulifera*	30
New Zealand Mudsnail	*Potamopyrgus antipodarum*	15
Demon Shrimp	*Dikerogammarus haemobaphes*	14
Nuttall's Waterweed	*Elodea nuttallii*	13
Quagga Mussel	*Dreissena rostriformis bugensis*	12
Tadpole Physa	*Physella acuta/gyrina*	11
Florida Crangonyx	*Crangonyx pseudogracilis/floridanus sens. lat.*	10
Floating Pennywort	*Hydrocotyle ranunculoides*	6
Japanese Knotweed	*Fallopia japonica*	6
Caspian Mud Shrimp	*Chelicorophium curvispinum*	5
Zebra Mussel	*Dreissena polymorpha*	5
Spotted Touch-me-not	*Impatiens capensis*	5
Physella Snail	*Physella acuta/gyrina agg.*	3
False Acacia	*Robinia pseudoacacia*	3
Virile Crayfish	*Orconectes virilis*	3
Ponto-Caspian Polycheate Worm	*Hypania invalida*	2
Zander	*Sander lucioperca*	2
Canadian Pondweed	*Elodea canadensis*	2
Least Duckweed	*Lemna minuta*	2
Quagga Mussel	*Dreissena bugensis*	2
Cherry Laurel	*Prunus laurocerasus*	2
Verrucata Leech	*Glossiphonia verrucata*	1
Signal Crayfish	*Pacifastacus leniusculus*	1
Tree-of-Heaven	*Ailanthus altissima*	1
Northern River Amphipod	*Crangonyx pseudogracilis*	1
Spiny-cheek Crayfish	*Orconectes limosus*	1

Figure 2-7 - Reach G INNS Heatmap



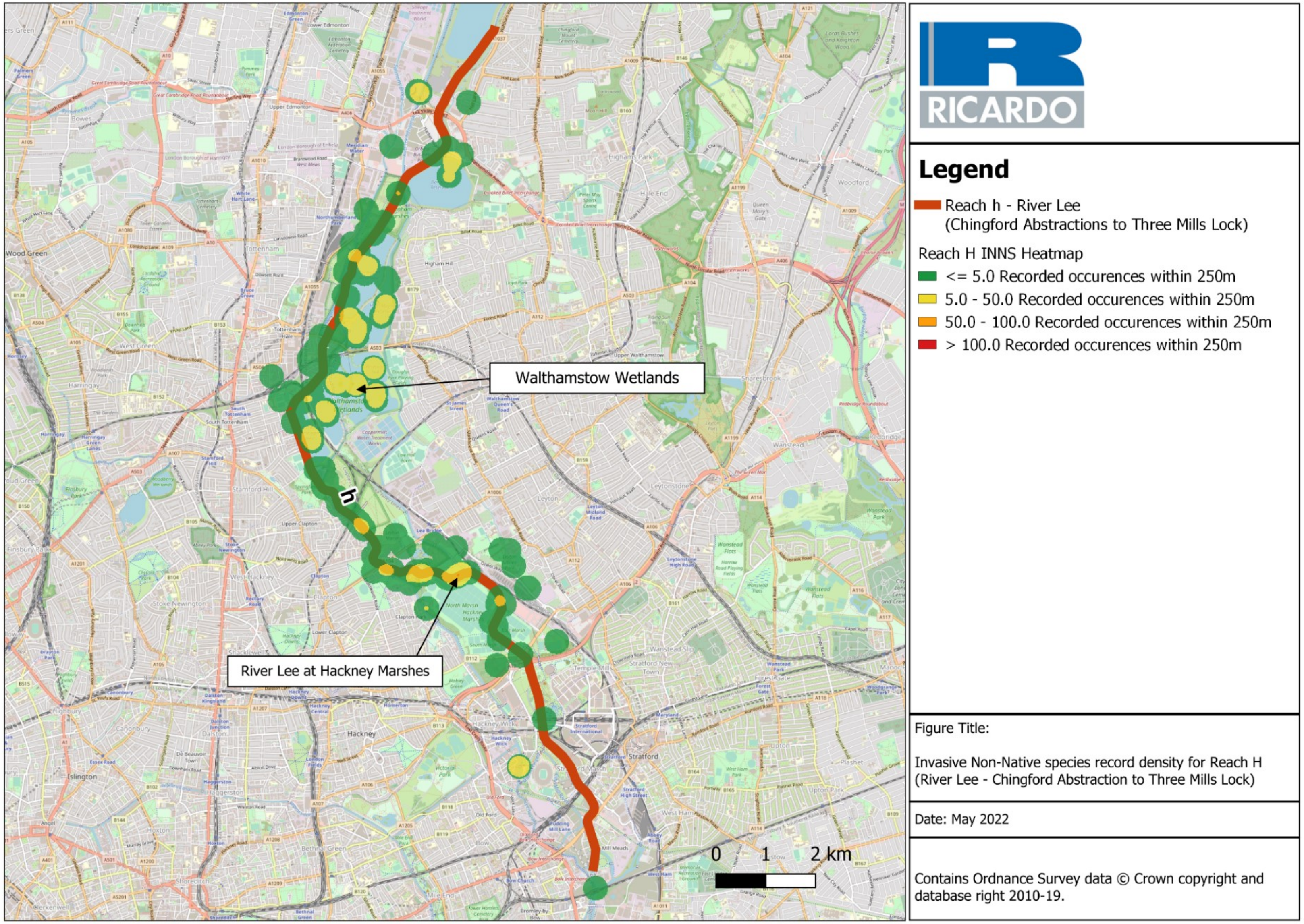
Reach H – Chingford Abstractions to Three Mills Lock

A total of 32 INNS species of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen in Table 2-10. The most commonly recorded species was the terrestrial plant species giant hogweed. Other abundant species includes the aquatic plant species floating pennywort and aquatic invertebrate species such as zebra mussel and quagga mussel. A heatmap representation of data indicates areas within the reach at which there is a higher frequency of occurrence records. For Reach H, Figure 2-8 shows these areas, which include the reservoirs that make up Walthamstow Wetlands, and the River Lee around Hackney Marshes. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-10 INNS recorded with Reach H (Chingford Abstractions to Three Mills Lock) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
Giant Hogweed	*Heracleum mantegazzianum*	68
Zebra Mussel	*Dreissena polymorpha*	66
Floating Pennywort	*Hydrocotyle ranunculoides*	66
Quagga Mussel	*Dreissena rostriformis bugensis*	61
New Zealand Mudsnail	*Potamopyrgus antipodarum*	56
Demon Shrimp	*Dikerogammarus haemobaphes*	54
Japanese Knotweed	*Fallopia japonica*	44
Nuttall's Waterweed	*Elodea nuttallii*	43
Florida Crangonyx	*Crangonyx pseudogracilis/floridanus sens.*	43
Tadpole Physa	*Physella acuta/gyrina*	33
Himalayan Balsam	*Impatiens glandulifera*	27
Caspian Mud Shrimp	*Chelicorophium curvispinum*	12
Least Duckweed	*Lemna minuta*	12
Physella Snail	*Physella acuta/gyrina agg.*	12
Sweet Flag	*Acorus calamus*	11
Quagga Mussel	*Dreissena bugensis*	10
Large-flowered Waterweed	*Egeria dense*	9
Chinese Mitten Crab	*Eriocheir sinensis*	8
Bloody-red Mysid	*Hemimysis anomala*	7
False Acacia	*Robinia pseudoacacia*	7
Bladder Snail	*Physella acuta*	6
Amphipod	*Cryptorchestia cavimana/garbinii agg.*	6
Cherry Laurel	*Prunus laurocerasus*	6
Verrucata Leech	*Glossiphonia verrucata*	5
Ponto-Caspian Polycheate Worm	*Hypania invalida*	4
Signal Crayfish	*Pacifastacus leniusculus*	4
Spanish Bluebell	*Hyacinthoides hispanica*	3
Tubificid Worm	*Branchiura sowerbyi*	2
Spotted Touch-me-not	*Impatiens capensis*	2
Tree-of-Heaven	*Ailanthus altissima*	2
Marsh Frog	*Pelophylax ridibundus*	2
Red-gilled Mudworms	*Marenzelleria viridis*	1

Figure 2-8 - Reach H INNS Heatmap



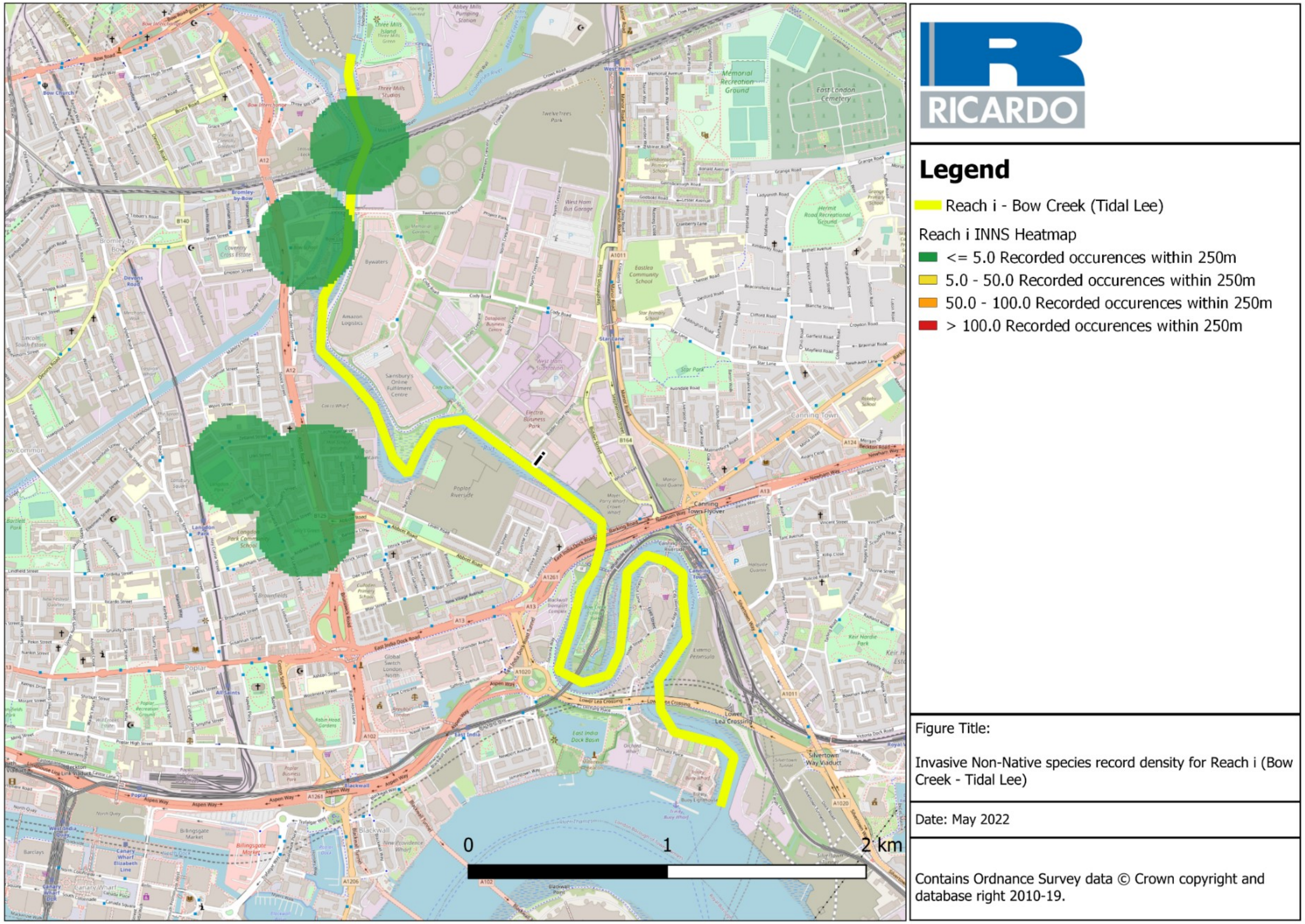
Reach I – Estuarine Bow Creek (tidal River Lee)

A total of five INNS species of interest were recorded during the baseline period within the NBN atlas and during project specific baseline monitoring surveys, as can be seen in Table 2-11. The most frequently recorded species were the terrestrial plant species Japanese Knotweed and False acacia. Only one record for aquatic invertebrate species was returned within this reach, which was for Chinese mitten crab. A heatmap representation of data indicates areas within the reach at which there is a higher frequency of occurrence records. Figure 2. shows these areas. These areas may represent INNS hotspots or increased occurrence recording resulting from survey effort.

Table 2-11 INNS recorded with Reach I Estuarine Bow Creek (tidal River Lee) between 2002 and 2022, inclusive of NBN records and project specific baseline monitoring.

Common Name	Scientific Name	Occurrences
Japanese Knotweed	*Fallopia japonica*	2
False Acacia	*Robinia pseudoacacia*	2
Chinese Mitten Crab	*Eriocheir sinensis*	1
Cherry Laurel	*Prunus laurocerasus*	1
Tree-of-Heaven	*Ailanthus altissima*	1

Figure 2.9 - Reach I INNS Heatmap



3 INNS ASSESSMENT OF BECKTON WATER RECYCLING SCHEME

3.1 INTRODUCTION

The Beckton water recycling scheme would divert final effluent which is currently discharged into the estuarine Thames Tideway. The treated effluent would be advanced-treated at a new AWRP within Beckton STW, from which it would be conveyed via tunnel for discharge into the freshwater River Lee Diversion upstream of the King George V reservoir.

Three proposed scheme sizes are assessed below for their potential impacts on the distribution of invasive species within the estuarine Thames and River Lee, due to potential changes in physico-chemical conditions that they may cause.

3.2 IMPACT ON PREFERENTIAL PHYSICO-CHEMICAL CONDITIONS FOR INNS

Table 3-1 summarises the potential physical environment impacts for each of the sizes of a Beckton water recycling scheme.

Table 3-1 Potential Physical Environment impacts from a Beckton water recycling scheme

Size	Flow	Outfall design	Wetted habitat	Barrier passability	Estuarine sediment
100 Ml/d	Major. 80% increase in very low flows(Q95) in ~100m reach of Enfield Island Loop, with 0-80% increase in flows downstream in ~500m reach of Enfield Island Loop and downstream Lee Diversion. Zero change beyond Flanders Weir.	Negligible. Not set out in detail at Gate 2 but due to extent of flow increase, a 0.3m/s exit velocity and the shallow channel depth would result in full dispersal of plume within metres of the outfall in a heavily modified channel.	Minor. No change in water width and ~40% increase in mean flow velocity in ~100m reach of heavily modified channel of the Enfield Island Loop at very low flow conditions. Unknown change downstream in a largely artificial channel without aquatic habitat. Indiscernible change in intertidal exposure in the estuarine Thames Tideway	Negligible. One low barrier, KGV North Weir, in the Enfield Island Loop with potential for increase in depth of water over crest and reduction in head difference both of which reduce any barrier effect.	Negligible. Negligible changes in Sediment transport within the Thames Tideway from final effluent flow reductions at Beckton STW.
200 Ml/d	Major. 160% increase in very low flows (Q95) in ~100m reach of Enfield Island Loop, with 0-160% increase in flows downstream in ~500m reach of Enfield Island Loop and downstream Lee Diversion. Zero change beyond Flanders Weir.		Moderate. No change in water width and ~80% increase in mean flow velocity in ~100m reach of heavily modified channel of the Enfield Island Loop at very low flow conditions. Unknown change downstream in a largely artificial channel without aquatic habitat. Indiscernible change in intertidal exposure in the estuarine Thames Tideway		
300 Ml/d	Major.		Moderate.		

Size	Flow	Outfall design	Wetted habitat	Barrier passability	Estuarine sediment
	240% increase in very low flows (Q95) in ~100m reach of Enfield Island Loop, with 0-240% increase in flows downstream in ~500m reach of Enfield Island Loop and downstream Lee Diversion. Zero change beyond Flanders Weir.		No change in water width and ~120% increase in mean flow velocity in ~100m reach of heavily modified channel of the Enfield Island Loop at very low flow conditions. Unknown change downstream in a largely artificial channel without aquatic habitat. Indiscernible change in intertidal exposure in the estuarine Thames Tideway		

Details of the outfall design of the Beckton water recycling scheme are currently still at an early stage, so no assessment into the nature of the velocity plume at Enfield Island Loop has been conducted at this point. Taking into account the basic design which includes an exit velocity of the water at 0.3m/s, and the cross-section profile of the channel being wide and shallow, it is assumed that the plume would extend across the full width of the channel and fully disperse within metres of the discharge point.

INNS Preference Impacts

Localised increases in flows immediately adjacent to the discharge outfall may exceed the tolerance range of several species listed within Table 1-2, particularly the dressenid mussels. Mobile species such as the amphipod and decapod crustaceans are likely to tolerate flow increase even within close proximately to the outfall. Overall increased flows have the potential to increase the fitness and available habitat for species with a preference or tolerance to faster flows, may facilitate the distribution of INNS propagules, or may limit the ability for INNS propagules to settle for certain species. Increased fitness of INNS with a higher tolerance to flow increase may result in a greater competitive advantage over native species in some cases which could impact community structure in the short and long term.

No change in wetted width during low flow conditions will not result in any change to available habitat within the channel. As noted in the Annex B.2.1. Physical Environment report, much the channel is artificial channel, so may provide limited availability to most aquatic species. However, both invasive Dreissena species have a preference for artificial surfaces as can be seen in Table 1-2.

3.2.1 Water Quality

Assessment of water quality impacts for the Beckton water recycling schemes are presented in the Annex B.2.2 Water Quality Assessment Report.

3.2.1.1 Temperature

Freshwater River Lee

The water temperature when the scheme is on is within the ranges experienced in the baseline. Over the annual period, for the 100 Ml/d scheme the 98th percentile for A82 scenario reduced by 0.2^{o}C to 21.5^{o}C and in the M96 scenario the 98th percentile was reduced by 1.1^{o}C to 20.6^{o}C, within the High WFD status threshold. There would not be deterioration in water temperature status as a result of a 100 Ml/d scheme.

For the 200 Ml/d scheme over the annual period, the 98th percentile for the A82 scenario reduced by 0.2^{o}C to 21.5^{o}C and in the M96 scenario the 98th percentile was reduced by 1.5^{o}C to 20.1^{o}C, well within the High WFD status threshold. There would not be deterioration in water temperature status as a result.

For the 300 Ml/d scheme over the annual period, the 98th percentile for the 1 in 5-year (A82) scenario reduced by 0.2^{o}C to 21.5^{o}C and in the 1 in 20 (M96) scenario the 98th percentile was reduced by 1.7^{o}C to 20.0^{o}C, well within the High WFD status threshold. As a result, there would not be deterioration in water temperature status.

Estuarine Thames Tideway

Water temperature in the middle Thames Tideway would not change as consequence of reduced discharge from Beckton STW discharge. As such, water temperature has not been included in the modelling suite for the 2D/3D Telemac modelling for the Beckton water recycling Scheme.

INNS Preference Impacts

Minor reductions in temperature summarised above on the freshwater Enfield Island Loop are not likely to exceed the tolerable range of any of the species listed within Table 1-2. The tolerable range of the species listed above and of INNS in general are broad, and minor changes are not likely to exceed these. However, there is a possibility that temperature changes as predicted above could lead to competitive advantages for both Non-native and native species which could result in long- or short-term changes to community dynamics. Current understanding of functional niche overlaps and water quality preferences non-native species is not sufficient to predict with certainty how relatively small changes to physical parameters will impact INNS fitness.

3.2.1.2 Dissolved Oxygen

Freshwater River Lee

For the 100 Ml/d scheme, there is a general increase in dissolved oxygen saturation throughout the on period with the 10th percentile across the annual period for the A82 scenario remaining unchanged at 113.1% and the 10th percentile across the annual period for the M96 scenario increasing from 113.1% to 114.0%. As a result, there would not be deterioration in the dissolved oxygen saturation status.

For the 200 Ml/d scheme, there is also a general increase in dissolved oxygen saturation throughout the on period with the 10th percentile across the annual period for the A82 scenario increasing from 113.1% to 113.6% and the 10th percentile across the annual period for the M96 scenario increasing from 113.1% to 115.5%. As a result, there would not be deterioration in the dissolved oxygen saturation status.

For the 300 Ml/d scheme, there is also a general increase in dissolved oxygen saturation throughout the on period with the 10th percentile across the annual period for the A82 scenario increasing from 113.1% to 114.1% and the 10th percentile across the annual period for the M96 scenario increasing from 113.1% to 116.5%. As a result, there would not be deterioration in the dissolved oxygen saturation status.

INNS Preference Impacts

Minor increases dissolved oxygen concentration predicted above on the freshwater river Lee are not likely to exceed the tolerable range of any of the species listed within Table 1-2. The tolerable range of the species listed above and of INNS in general are broad, and minor changes are not likely to exceed these. However, there is a possibility that changes to dissolved oxygen concentration as predicted above could lead to competitive advantages for both Non-native and native species which could result in long- or short-term changes to community dynamics. Current understanding of functional niche overlaps and water quality preferences non-native species is not sufficient to predict with certainty how relatively small changes to physical parameters will impact INNS fitness and populations.

3.2.1.3 Phosphate

Freshwater River Lee

Across both flow scenarios there is a clear reduction in soluble reactive phosphate concentration compared to the baseline concentration with the decrease becoming greater with the increase in scheme size. The greatest decreases are experienced when the scheme is on however there is still a sizable decrease when the scheme is not on and just discharging a maintenance flow. Overall, there would not be deterioration in the phosphorus status associated with any of the Beckton water recycling scheme sizes.

INNS Preference Impacts

Minor decreases in phosphate concentration predicted above on the freshwater river Lee are not likely to exceed the tolerable range of any of the species listed within Table 1-2. The tolerable range of the species listed above and of INNS in general are broad, and minor changes are not likely to exceed these. However, there is a possibility that changes to phosphate concentration as predicted above could lead to competitive advantages for both Non-native and native species which could result in long- or short-term changes to community dynamics. Currently our understanding of functional niche overlaps and water quality preferences non-native species is not sufficient to accurately predict with certainty how relatively small changes to physical parameters will impact INNS fitness and populations. However, minor decreases in phosphorous concentrations could be beneficial for some macrophyte species within the reach which may include Nuttall's waterweed.

3.3 SAI-RAT ASSESMENT

The Beckton water recycling scheme will not result in the introduction or transfer of INNS as the effluent discharge is treated to a very high standard prior to discharge into the freshwater River Lee Diversion, therefore providing a high level of assurance for the removal of all INNS propagules and eliminating all pathways that may introduce or transfer INNS during normal operation. Therefore, the application of a pathway-based assessment such as SAI-RAT in this scenario is not applicable and is likely to provide a result which is not representative of the actual INNS transfer risk.

3.4 SUMMARY OF INNS ASSESSMENT OF BECKTON WATER RECYCLING SCHEME

Major changes in flow in all schemes, which has the potential to increase the distribution of INNS within the freshwater Lee Diversion Channel. The 300 Ml/d scheme has the most major predicted effects when compared to the other options.

Modelling predicts negligible effects on water quality within the Lee Diversion Channel, with slight increases in dissolved oxygen, and minor decreases in phosphate. This suggests that there will be minimal effect on distribution of INNS within the river.

The Beckton water recycling scheme was not assessed using the SAI-RAT tool. It is not likely that the introduction or transfer of INNS will occur during the operation of this option, as the effluent discharge is treated in several steps prior to discharge into the freshwater River Lee Diversion which eliminates all pathways that are likely to introduce or transfer INNS during normal operation.

4 INNS ASSESSMENT OF MOGDEN WATER RECYCLING SCHEME

4.1 INTRODUCTION

The Mogden water recycling scheme involves the transfer of final effluent from Mogden STW, to a new AWRP for advanced treatment. Recycled water would be discharged into the freshwater River Thames at a new outfall upstream of the existing Thames Water Walton intake.

Four proposed scheme sizes are assessed below for their potential impacts on the distribution of invasive species within the freshwater and estuarine Thames, due to potential changes in physico-chemical conditions that they may cause.

4.2 IMPACT ON PREFERENTIAL PHYSICO-CHEMICAL CONDITIONS FOR INNS

4.2.1 Velocity and Flow

Results of the Annex B.2.1 Gate 2 Physical Environment assessment[12] of the Mogden water recycling schemes conclude;

"(the) schemes may lead to up to moderate impacts on flows when compared to the baseline conditions in the River Thames. However, these changes are negligible when considering impacts to water level depth and average flow velocities. Additionally, the data indicates that there are negligible impacts on fish pass barrier passibility, negligible impacts on the Richmond Pound and on wetted habitat, water level and suspended sediment concentration within the Thames Tideway."

Table 4-1 summarises the potential physical environment impacts for each Mogden water recycling scheme volume scenarios.

Table 4-1- Summary of potential physical environment impacts for Mogden water recycling schemes

Size	Flow	Outfall design	Wetted habitat	Richmond Pound drawdown	Estuarine sediment
50 Ml/d	Minor 5% increase in very low flows (Q95) with main flow increase affecting 3.4km reach (Walton Bridge outfall to Walton intake) and no change 5.4km downstream of outfall (Hampton intake)	Negligible Plume velocity characteristics inferred from larger schemes modelling.	Very minor increase in flow velocities in Sunbury Weir pool inferred from larger schemes modelling. No change in wetted habitats modelled in Molesey Weir pool as no expected change in flows over Molesey Weir. Negligible changes in exposure of estuarine wetted habitat inferred from larger schemes modelling.	Negligible changes in physical environment within Richmond Pound.	Negligible changes in suspended solids concentration within the estuary.
100 Ml/d	Minor 11% increase in very low flows (Q95) with main flow increase affecting 3.4km reach (Walton Bridge outfall to Walton intake) and				

[12] Ricardo (2022) London Effluent Reuse SRO, Annex B.2.1. Gate 2 Physical Environment Assessment Report.

Size	Flow	Outfall design	Wetted habitat	Richmond Pound drawdown	Estuarine sediment
	no change 5.4km downstream of outfall (Hampton intake)				
150 Ml/d	Moderate 16% increase in very low flows (Q95) with main flow increase affecting 3.4km reach (Walton Bridge outfall to Walton intake) and no change 5.4km downstream of outfall (Hampton intake)				
200 Ml/d	Moderate 21% increase in very low flows (Q95) with main flow increase affecting 3.4km reach (Walton Bridge outfall to Walton intake) and no change 5.4km downstream of outfall (Hampton intake)	Negligible. Increased velocities from plume of (0.05-0.075m/s) stretches downstream to around 260m for discharge into 970Ml/d (Q91) scenario.	Very minor increase in flow velocities in Sunbury Weir pool modelled. No change in wetted habitats modelled in Molesey Weir pool as no expected change in flows over Molesey Weir. Negligible changes in exposure of estuarine wetted habitat.		

The Mogden water recycling scheme is expected to result in moderate impacts to flow conditions within the freshwater River Thames, the main flow increase is likely to occur between Walton Bridge outfall and Walton intake, no change is predicted at 5.4km downstream of Walton Bridge outfall (150 Ml/d and 200 Ml/d scenario). Under the developed Scenario 1 (600 Ml/d river flow, 200 Ml/d outfall discharge) simulation, the discharge leads to a plume which increases flow velocities in channel by 0.05-0.1m/s. The area of increased velocity is spatially restricted to the outfall area and in the thalweg. The modelled difference shows that velocities in the majority of the channel downstream of the outfall increase by 0.005-0.05m/s, with higher velocities between 0.05-0.3m/s in very close proximity to the outfall. There are some areas of reduced velocity (-0.01 to -0.05m/s) immediately upstream and downstream of the outfall. The model suggests the increased velocity of the plume rapidly declines by ~150m downstream of the outfall, with remaining flow velocities in the channel range from 0.025-0.05m/s, similar to upstream of the proposed discharge point, although a small tongue of higher velocities (0.05-0.075m/s) persists for ~250m downstream on the right bank. It should be noted that higher velocities of the outfall discharge are concentrated towards the surface of the river, the higher velocities rapidly declining with depth towards the channel bed.

The impact to non-native species preference to negligeable changes in average channel velocity such as those predicted >150m downstream of the discharge point cannot be predicted accurately at this stage. INNS preference impacts resulting from minor modifications to flow are subject to interspecific competition and functional niche overlaps which are extremely complex and not well understood for the majority of INNS, particularly in scenarios where interspecific competition and niche overlaps occur between INNS with differing geographical origins.

Increased flows immediately adjacent to the discharge outfall may exceed the tolerable range of several species listed within Table 1-2 particularly the dressenid mussels. Mobile species such as the amphipod and decapod crustaceans are likely to tolerate flow increase even within close proximately to the outfall. Overall increased flows have the potential to increase the fitness and available habitat for species with a preference or tolerance to faster flows, may facilitate the distribution of INNS propagules, or may limit the ability for INNS propagules to settle for certain species. However, velocity increases appear to be limited to the surface of the watercourse therefore the impact to the preference of the INNS listed within Table 1-2 being predominantly benthic species are likely to be limited.

Conversely, immediately upstream and downstream of the outfall the simulation predicts that there will be areas with a flow reduction. These areas, although relatively small, may act to increase the potential for INNS propagule settlement particularly for species which possess a planktonic life stage such as the Dressined mussels.

4.2.2 Water Quality

Modelling of water quality impacts for Mogden water recycling scheme are presented in the Annex B.2.2. Water Quality Assessment Report.

4.2.2.1 Temperature

Freshwater Thames Temperature impacts

The modelled data utilised within the Annex B.2.2. Water Quality Assessment Report indicates that under a 50 Ml/d discharge the maximum modelled temperature was identified as 19.8^{o}C with a maximum change of 0.3^{o}C. During maintenance flow only periods with a discharge of 12.5 Ml/d the maximum modelled temperature was identified as 19.8^{o}C with a maximum change identified of 0.1^{o}C.

Under a 100 Ml/d discharge the maximum modelled temperature was identified as 19.8^{o}C with a maximum change of 0.6^{o}C. During maintenance flow only periods with a discharge of 25 Ml/d the maximum modelled temperature was identified as 19.8^{o}C the maximum change identified was 0.2^{o}C.

Under a 150 Ml/d discharge the maximum modelled temperature was identified as 19.8^{o}C with a maximum change of 0.8^{o}C. During maintenance flow only periods with a discharge of 37.5 Ml/d the maximum modelled temperature was identified as 19.8^{o}C the maximum change identified was 0.2^{o}C.

Under a 200 Ml/d discharge the maximum modelled temperature was identified as 19.9^{o}C with a maximum change of 1.1^{o}C. During maintenance flow only periods with a discharge of 50 Ml/d the maximum modelled temperature was identified as 19.8^{o}C the maximum change identified was 0.3^{o}C.

Estuarine Thames Temperature impacts

Temperature changes were modelled for the Mogden water recycling scheme 200 Ml/d discharge rate for both the M96 and A82 flows series at both the 50th and 95th percentile temperature, therefore, representing the greatest temperature differences associated with the various scheme sizes. Under both the 95th and 50th percentile this represents a difference in temperature of approximately 1 °C within the M96 scenario and less than 1 °C within the A82 scenario.

Impact Upon INNS Preference

The impacts summarised above on the freshwater and the estuarine Thames are not likely to exceed the tolerable range of any of the species listed within Table 1-1. There is a possibility that temperature increases of up to 1.1 °C such as those predicted above may potentially improve the fitness of individual INNS currently present resulting in a competitive advantage over native and other non-native species. Temperature increases are likely to increase the metabolic rates for all of the species listed which may increase growth rates, fecundity or spawning periods, particularly for species close to their climatic range. However, as previously discussed, the realised impact on individual INNS preference resulting from relatively small changes to the physical environment cannot be predicted accurately as they are reliant upon numerous biotic and abiotic factors.

4.2.2.2 Oxygen Saturation

Freshwater Thames dissolved oxygen impacts

Across all percentiles the greatest predicted change to dissolved oxygen between the A82 Mogden 200 Ml/d scenario and reference conditions is observed immediately downstream of Mogden water recycling outfall, with disolved oxygen values becoming more consistent between scenarios towards Teddington Weir. Under the 25%ile scenario dissolved oxygen is predicted toincrease by increase by up to 2.88 % when compared to reference (note that this value represents percentage change and not percentage satuaration) as can be seen in Table 4-2. This increase in oxygen saturation represents an improvement in water quality between Mogden water recycling outfall and Teddington Weir.

Table 4-2 Percentage change of modelled oxygen saturation under the A82 Mogden-200 scenario compared with reference at 14 nodes between Mogden water recycling outfall and Teddington Weir

Location	25%ile	50%ile	75%ile	10%ile
Upstream Mogden water recycling Outfall	-0.09	-0.01	0.00	-0.03
Mogden water recycling Outfall	2.88	1.08	0.18	1.41
Downstream 1km Mogden water recycling Outfall	2.80	1.01	0.18	1.22
Downstream 2km Mogden water recycling Outfall	2.56	1.03	0.17	1.10
Downstream Sunbury Weir	0.76	0.70	0.55	0.58
Downstream Walton Intake	0.32	0.50	0.57	0.47
Downstream Hampton Intake	0.14	0.12	0.15	0.15
Upstream Molesey Weir	0.19	0.22	0.24	0.14
Downstream Molesey Weir	0.09	0.09	0.22	0.11
Downstream of Molesey Lock	0.05	0.09	0.05	0.06
Upstream of the River Mole	0.06	0.08	0.07	0.06
Downstream of the River Mole	0.07	0.09	0.15	0.14
Upstream Hogsmill River	0.05	0.05	0.05	0.05
Teddington Weir	0.05	0.09	0.08	0.06

Estuarine Thames dissolved oxygen impacts

An assessment of the dissolved oxygen concentration impacts in the estuarine Thames Tideway arising from Mogden STW final effluent reduction associated with a Mogden water recycling scheme has been undertaken for the 200 Ml/d size of scheme. The 200 Ml/d Mogden water recycling and M96 flow series represents the greatest dissolved oxygen concentration differences associated with the various scheme sizes. Under both the 5th and 50th percentile this represents a difference in dissolved oxygen concentration of approximately 0.5 mg/l.

INNS Preference Impacts

The increases in oxygen saturation predicted downstream of the outfall under A82 conditions are not likely to result in any measurables impact upon INNS preference. Though the increases in dissolved oxygen may result in a general improvement in biological fitness overall for both native and non-native species this is not likely to result in impacts to the INNS community within the freshwater or estuarine Thames.

4.2.2.3 Phosphorous

Freshwater Thames Phosphorus Impacts

Total phosphorous concentrations are considerably lower under the 200 Ml/d Mogden water recycling scheme compared with reference conditions (Table 4-3). At the 25th percentile, the 200 Ml/d Mogden water recycling scheme exhibits lower concentrations than reference from the reuse outfall until approx. 6.6km upstream of Teddington where concentrations become consistent across both scenarios.

Table 4-3 Percentage change of modelled total phosphorous under the A82 Mogden-200 scenario compared with reference at 14 nodes between Mogden water recycling outfall and Teddington Weir

Location	25%ile	50%ile	75%ile	Mean
Upstream Mogden water recycling Outfall	0.05	0.02	-0.18	-0.03
Mogden water recycling Outfall	-1.26	-0.95	-7.45	-4.56
Downstream 1km Mogden water recycling Outfall	-1.24	-1.06	-7.49	-4.56
Downstream 2km Mogden water recycling Outfall	-1.17	-1.13	-7.55	-4.56
Downstream Sunbury Weir	-1.17	-1.13	-7.55	-4.56
Downstream Walton Intake	-1.12	-1.24	-7.70	-4.56
Downstream Hampton Intake	-0.78	-1.26	-8.25	-4.55
Upstream Molesey Weir	-0.32	-1.19	-7.65	-4.52
Downstream Molesey Weir	-0.32	-1.19	-7.65	-4.52
Downstream of Molesey Lock	-0.32	-1.22	-7.64	-4.52
Upstream of the River Mole	-0.29	-1.26	-7.64	-4.51
Downstream of the River Mole	0.00	-2.78	-7.38	-3.83
Upstream Hogsmill River	0.00	-3.03	-6.61	-3.83
Teddington Weir	0.00	-3.11	-7.32	-3.83

INNS Preference Impacts

Minor decreases in phosphorus concentration predicted above on the freshwater river Thames are not likely to exceed the tolerable range of any of the species listed within Table 1-2. The tolerable range of the species listed above and of INNS in general are broad, and minor changes are not likely to exceed these. However, there is a possibility that changes to phosphorus concentration as predicted above could lead to competitive advantages for both Non-native and native species which could result in long- or short-term changes to community dynamics. Currently our understanding of functional niche overlaps and water quality preferences non-native species is not sufficient to accurately predict with certainty how relatively small changes to physical parameters will impact INNS fitness and populations. However, minor decreases in phosphorous concentrations could be beneficial for some macrophyte species within the reach which may include Nuttall's waterweed.

4.2.2.4 pH

Freshwater Thames pH impacts

The modelled data for pH indicates daily time-step mass balance for the 200 Ml/d Mogden water recycling scheme shows little variation between the flow scenarios, with minimum pH under both A82 and M96 flows being 7.6, and maximum under both flows being 8.6. Mean daily pH change is 0.1. There is no indication that pH change is affected by any of the proposed Mogden water recycling schemes, as inferred from the results of the modelling of the largest (200Ml/d) scheme.

INNS Preference Impacts

The minimal predicted change in pH within the freshwater River Thames is not likely to result in conditions exceeding the pH preference of any of the INNS listed in Table 1-2. Therefore, there is predicted to be no impact on INNS preference within the freshwater River Thames due to the scheme.

4.3 SAI-RAT ASSESMENT

The Mogden water recycling scheme would divert treated effluent which is currently discharged into the estuarine Thames Tideway downstream of Teddington weir. The effluent would be advanced-treated at a new AWRP near Kempton Park and discharged upstream in the freshwater River Thames above Sunbury weir. Treatment would provide a very high level of assurance to prevent the transfer of INNS during operation. All pathways that may introduce or transfer INNS are eliminated during normal operation. Therefore, the application of the SAI-RAT RWT risk assessment is not relevant for this option.

4.4 SUMMARY OF INNS ASESSMENT OF MOGDEN WATER RECYCLING SCHEME

Minor changes in physico-chemical conditions within the Thames are expected, with changes in flow conditions and localised changes in velocity, along with minor changes in oxygen saturation, phosphorous and pH. These changes in conditions may have minor impacts on the distribution of INNS within the freshwater River Thames, although they are not expected to be major and widespread. Impacts from the 200 Ml/d Mogden water recycling scheme are generally considered greatest among the four scheme volumes.

The Mogden water recycling scheme was not assessed using the SAI-RAT tool as the volume discharged would be advanced treated effluent, eliminating all pathways that are likely to introduce or transfer INNS during normal operation.

5 INNS ASSESSMENT OF TEDDINGTON DRA SCHEME

5.1 INTRODUCTION

The Teddington DRA scheme involves final effluent from Mogden STW being subject to further treatment at a tertiary treatment plant (TTP) at Mogden STW, which would be discharged into the freshwater River Thames at a new outfall upstream of the tidal limit at Teddington Weir. Additional abstraction for public water supply through a new intake from the freshwater River Thames, upstream of the new outfall would be pumped into the nearby Thames-Lee Tunnel (TLT) for transfer to Lockwood pumping station, part of Thames Water's Lee Valley reservoirs in North London. Four proposed options that make up this scheme are assessed below for their potential impacts on the distribution of invasive species with the freshwater, estuarine Thames and River Lee, due to potential changes in physico-chemical conditions that they may cause.

The Teddington DRA scheme has also been assessed using the SAI-RAT tool to analyse the risk associated with the raw water transfer between the freshwater Thames and River Lee in relation to the spread of INNS.

5.2 IMPACT ON PREFERENTIAL PHYSICO-CHEMICAL CONDITIONS FOR INNS

5.2.1 Velocity and Flow

Results of the Annex B.2.1. Gate 2 Physical Environment assessment[13] of the Teddington DRA schemes conclude;

"the Teddington DRA schemes may lead to up to moderate reduction in flows when compared to the baseline conditions in the ~250m of the River Thames between the intake and outfall. However, these changes are negligible when considering impacts to water level depth and flow velocities. Additionally, the data indicates that there are negligible impacts on fish pass barrier passability, negligible impacts on the Richmond Pound and on wetted habitat, water level and suspended sediment concentration in the Thames Tideway."

Table 5-1 summarises the potential physical environment impacts for each of the sizes of a Teddington DRA scheme.

Table 5-1 Summary of potential physical environment impacts for Teddington DRA schemes

Size	Flow	Outfall and intake design	Wetted habitat	Fish pass and barrier passability	Richmond Pound drawdown	Estuarine sediment
50 Ml/d	Moderate 17% reduction in exceptionally low flows for 250m between intake and outfall (300 Ml/d upstream of intake)	Negligible change in velocities at intake or outfall inferred from larger scheme modelling assessment of negligible	Negligible change in water level or velocities between intake and outfall inferred from larger scheme modelling assessment of negligible	Negligible water level change inferred from larger scheme modelling assessment of negligible	Negligible change in wetter habitat, water level and suspended sediment concentration.	Negligible change in wetter habitat, water level and suspended sediment concentration.
75 Ml/d	Moderate 25% reduction in exceptionally low flows for 250m between	Negligible change in velocities at intake or outfall modelled.	Negligible change in water level or velocities between intake and	Negligible water level change modelled		

[13] Ricardo (2022) London Effluent Reuse SRO, Annex B.2.1. Gate 2 Physical Environment Assessment Report.

Size	Flow	Outfall and intake design	Wetted habitat	Fish pass and barrier passability	Richmond Pound drawdown	Estuarine sediment
	intake and outfall (300 Ml/d upstream of intake)		outfall modelled. Negligible change in wetted habitat.			
100 Ml/d	Major 33% reduction in exceptionally low flows for 250m between intake and outfall (300 Ml/d upstream of intake)	Negligible change in velocities at intake or outfall modelled.	Negligible change in water level or velocities between intake and outfall modelled. Negligible change in wetted habitat.	Negligible water level change modelled		
150 Ml/d	Major 50% reduction in exceptionally low flows for 250m between intake and outfall (300 Ml/d upstream of intake)	Negligible change in velocities at intake or outfall modelled.	Negligible change in water level or velocities between intake and outfall modelled. Negligible change in wetted habitat.	Negligible water level change modelled		

The Teddington DRA scheme is expected to result in major impacts to flow conditions within the 250m section between the intake and outfall on the Thames at both 100 Ml/d and 150 Ml/d scenarios, with up to a 50% reduction in exceptionally low flows for 250m between intake and outfall.

There are negligible effects predicted on velocity, wetted habitat, barrier passability and estuarine sediment for both modelled Teddington DRA options.

Reductions in flow in the 250m section between the intake and outfall on the River Thames, may increase the potential for INNS propagule settlement particularly for species which possess a planktonic life stage such as the dressenid mussels. A reduced flow may also aid juvenile migration of Chinese mitten crabs within the 250m sections. The negligible effects predicted beyond the 250m stretch on the River Thames results in no predicted changes in the distribution of INNS in the wider Thames as a result of any of the Teddington DRA options.

5.2.2 Water Quality

Modelling of water quality impacts for the Teddington DRA schemes are presented in the Annex B.2.2. Water Quality Assessment Report.

River Lee

As per Section 6.1 of the Annex A.4. CDR issued by Jacobs "The raw water quality in the River Thames at the intake location is the same quality of the water already in the Thames Lee Tunnel which is currently abstracting at Hampton Intake and will therefore be suitable for discharge into the Lee Valley reservoirs and subsequently for treatment at Coppermills WTW". Due to this it has been assumed that there will be no difference in the water quality within the River Lee due to the Teddington DRA scheme.

5.2.2.1 Temperature

Freshwater Thames Temperature Impacts

The data utilised within the Annex B.2.2. Water Quality Assessment Report indicated that under a 50 Ml/d discharge the maximum modelled temperature was identified as 19.71°C with a maximum change of 0.7°C. During plant maintenance only times where the discharge is 12.5 Ml/d the maximum change identified was 0.05°C

Under a 75 Ml/d discharge the maximum modelled temperate was identified as 19.73°C with a maximum change of 1.1°C. During plant maintenance only times where the discharge is 18.75 Ml/d the maximum change identified was 0.07°C

Under a 100 Ml/d discharge the maximum modelled temperature was identified as 19.8°C with a maximum change of 1.5°C. During plant maintenance only times where the discharge is 25 Ml/d the maximum change identified was 0.07°C

Under a 150 Ml/d discharge the maximum modelled temperature was identified as 19.8°C with a maximum change of 2.2°C. During plant maintenance only times where the discharge is 37.5 Ml/d the maximum change identified was 0.1°C

Greater localised increases in temperature are to be expected within the direct vicinity of the outfall. Under a discharge 150 Ml/d with a 400 Ml/d river flow, 5.8% of the channel is affected by a temperature increase of at least 2°C. This decreases under greater river flow scenarios and/or smaller scheme sizes.

Estuarine Thames Temperature impacts

It is noted that there would be temperature changes in the estuarine Thames Tideway as consequence of a Teddington DRA scheme associating with less discharge of final effluent from Mogden STW. That assessment of estuarine temperature changes is modelled for a 200 Ml/d Mogden water recycling scheme, and impacts from a 150 Ml/d, 100 Ml/d, 75Ml/d or 50Ml/d Teddington DRA scheme are proportionately less than those predicted through the reported modelling. The changes modelled for the 200 Ml/d Mogden water recycling scheme represent the greatest temperature differences associated with the various scheme sizes. Under both the 95th and 50th percentile this represents a difference in temperature of approximately 1 °C.

INNS Preference Impacts

Minor increases in temperature as predicted are unlikely to cause the temperature within the freshwater River Thames or estuarine Thames to exceed the tolerable range of any of the species listed within Table 1-2. There is a possibility that temperature increases may potentially improve the fitness of some individual INNS currently present resulting in a competitive advantage over native and other non-native species. Temperature increases are likely to increase the metabolic rates for all of the species listed which may increase growth rates, fecundity or spawning periods, particularly for species close to their climatic range.

The small areas of river channel experiencing larger increases in temperature surrounding the outfall of the Teddington DRA scheme does not represent a significant area of habitat, and therefore are not likely to cause a significant change to INNS distribution.

5.2.2.2 Oxygen Saturation

Freshwater Thames dissolved oxygen impacts

It is noted that there would be dissolved oxygen changes in the estuarine Thames Tideway as consequence of a Teddington DRA scheme associating with less discharge of final effluent from Mogden STW. That assessment of estuarine dissolved oxygen is modelled for a 200 Ml/d Mogden water recycling scheme in and impacts from a 150 Ml/d, 100 Ml/d, 75Ml/d or 50Ml/d Teddington DRA scheme are proportionately less than those predicted through the reported modelling. . Under the A82 series, there is no predicted changed in dissolved oxygen. Under the M96 series, there was a maximum increase of 1% dissolved oxygen within the freshwater Thames.

Estuarine Thames dissolved oxygen impacts

The dissolved oxygen concentration changes modelled for the Mogden 200 Ml/d scheme represent the greatest dissolved oxygen differences associated with the various scheme sizes at Mogden. Under the 5th percentile this represents a difference in dissolved oxygen of less than 0.5 mg/l.

INNS Preference Impacts

Though the increases in dissolved oxygen may result in a general improvement in biological fitness overall for both native and non-native species, the minor increases of a maximum of 1% or 0.5mg/l are not likely to result in impacts to the INNS community within the freshwater and estuarine Thames.

5.2.2.3 pH

Freshwater Thames pH impacts

The modelled data shows little variation between the flow scenarios, with minimum pH under A82 being 7.7 and under M96 being 7.8, and maximum under both flows being a pH of 8.8. Mean daily pH change is 0.3 and 0.2 (A82 and M96 respectively). There is little variation between the flow scenarios though measured data is not available past September.

INNS Preference Impacts

Changes of pH to more alkaline conditions, with a maximum pH of 8.8 within the freshwater River Thames may result in the freshwater River Thames becoming more preferable for INNS such as dressenid mussels, and aquatic plants such as *Elodea nuttalii*. Increases are not major, but a move to more preferential conditions may result in increased populations of these species.

5.3 SAI-RAT ASSESMENT

The Teddington DRA option consists of a treated effluent discharge and raw water abstraction on the freshwater River Thames. A portion of Mogden STW final effluent would be subject to tertiary treatment at Mogden STW. The treated water would be transferred to a discharge location upstream of Teddington Weir. A new abstraction from the freshwater River Thames, upstream of the new effluent transfer discharge location, would then pump water into the nearby TLT for transfer to the Lee Valley Reservoirs in East London.

The abstraction of water from the freshwater River Thames at Teddington and transfer via the TLT poses a risk in relation to the transfer of INNS, as raw untreated water is being transferred between two waterbodies.

The TLT currently operates to transfer water from the River Thames at the Hampton Intake. Between 2010 and 2020 an average volume of approximately 195 Ml/d was transferred within the pipeline with a maximum volume per day of approximately 560 Ml/d. The Teddington DRA scheme is currently being assessed in a capacity of 150 Ml/d, 100 Ml/d, 75 Ml/d and 50 Ml/d.

All four of the Teddington DRA abstraction scenario volumes and the current TLT transfer were assessed using the SAI-RAT. The input variables used in the INNS tool are presented in Appendix 1 Table A 1. In all four scenarios a number of variables remain the same:

- The transfer source in all scenarios water is to be abstracted from the same WFD waterbody, therefore the likely pathways that occur at the abstraction point that might distribute INNS to the source remain the same i.e. boating, water sports and angling.
- The transfer mechanism remains the same in both scenarios, being a pipeline transfer. The pipeline distance and route remain the same for all size variants of Teddington abstractions. Although the pipeline route for the current TLT transfer is longer all three transfers are categorised as a >30km transfer distance within the SAI-RAT tool.
- The transfer destination, in all scenarios remains the same.

The SAI-RAT tool assigns a risk value based on the characteristics of the transfer option. Each variable within the tool is input for each transfer option, to match the characteristics of the proposed routes as close as possible, as permitted by the scaling within the tool.

Variables within the tool are weighted differently based on the inherent risk to the distribution of INNS. Within the Teddington DRA scheme, factors that contribute heavily to the risk score are as follows:

- Transferring between management catchments – A difference in the source and receptor catchments of the option resulted in a higher risk score.
- Activity at source – Due to the source of the option being navigable by boat, and having angling and water sport activity, it is assigned a higher risk score. Species may utilise distribution pathways associated with use of boats and leisure craft at the connection source habitat where they may establish and be further distributed by the Raw Water Transfer (RWT).

- Functional group scores; source, pathway and receptor calculations for the functional group scores consider the differences in types of sources, pathways and receptors. Due to TLT Transfer source being a river, and receptor being an online waterbody, it gives these two categories higher scores when compared to other types of waterbodies.

As would be expected, the SAI-RAT assesses the 150 Ml/d volume as a greater risk when compared to the three other scenarios as can be seen in Table 5-2. The 150 Ml/d scenario scores 1% higher than the 100 Ml/d and 75 Ml/d scenario. In most RWT scenarios an increased volume equates to a greater propagule transfer potential. However, both Teddington abstraction volumes score marginally lower than the current TLT transfer assessed with an operating year-round with a variable flow averaging 195 Ml/d.

It should be noted that the scaling applied to the transfer volume within the SAI-RAT is subject to ordinal scaling. The 50 Ml/d Teddington abstraction option falls within the 6-50 Ml/d categorisation and the 75 Ml/d and 100Ml/d Teddington abstractions option falls within a 51-100 Ml/d categorisation. Therefore, the SAI-RAT tool assesses the 100 Ml/d Teddington abstraction option as having the same risk as the 75 Ml/d option. Therefore the difference in risk score observed between the four Teddington abstraction option is not representative of exact volume.

Table 5-2 Results of the SAI-RAT assessment of the Teddington abstraction component of the Teddington DRA TLT raw water transfer and existing TLT raw water transfer.

Name	Risk (%)
TLT Teddington DRA Abstraction 50 Ml/d	55.88
TLT Teddington DRA Abstraction 75 Ml/d	56.88
TLT Teddington DRA Abstraction 100 Ml/d	56.88
TLT Teddington DRA Abstraction 150 Ml/d	57.88
TLT Transfer current (195 Ml/d)	63.88

5.4 SUMMARY OF INNS ASSESSMENT OF TEDDINGTON DRA SCHEME

Changes in velocity and flow, and water quality within the freshwater Thames due to the Teddington DRA schemes may cause some changes in conditions that could affect distribution of INNS, including changes in dissolved oxygen, temperature, ammonia, BOD, suspended solids and pH. However, these changes are minor, and it is unlikely that they will cause widespread changes in distribution of INNS within the River Thames. The potential effects on INNS are predicted to be greater for the 75 Ml/d when compared to the 50 Ml/d options.

The 100 Ml/d and 150 Ml/d schemes are still subject to physico-chemical modelling and will be assessed in a second draft iteration.

The SAI-RAT assessment found the 150 Ml/d scheme to have the greatest risk involving the transfer of INNS between the River Thames and Lee Valley Reservoirs when compared to the other new options of the Teddington DRA scheme. This is solely down to the increased volume when compared to the other options, as all other variables within the SAI-RAT calculator remain the same for each of the new Teddington DRA scheme options.

The current 195 Ml/d TLT transfer that is in operation between the Thames and Lee was also assessed using the SAI-RAT tool, and it was found to have the highest risk score when compared to any of the new Teddington DRA scheme options. This is again due to higher volumes of water being transferred, and due to it being in year-round, continuous, variable flow operation compared to the occasional frequency of operation of the Teddington DRA schemes.

6 CURRENT KNOWLEDGE GAPS AND FUTURE INVESTIGATIONS AT GATE 3

6.1 SAI-RAT

The SAI-RAT assessment spreadsheet does not allow the user to interpret how variables impact the risk score, therefore confidence in the tool is based solely upon the final output scoring and the perception of its accuracy. Insight into the formulas used to calculate scores is hidden from the user therefore it is not clear how the risk score is calculated and therefore it is not possible to scrutinise the results of the SAI-RAT fully. Additionally the outcome scores are difficult for the user to interpret in terms of their relative risk, for example without direct comparison between RWTs with varying levels of risk and without knowledge of the variables which impact risk the risk score is arbitrary.

The risk scoring for the Teddington DRA schemes show low variation despite significant differences in operational volume. The difference in risk scoring between options is minimal overall with two of the operational schemes scoring the same risk score despite having a 25% difference in operational volume. During the operational period for the scheme a 25% difference in flow rate results in a substantial difference in the total transfer volume which is likely to result in a greater propagule transfer risk, therefore confidence in the weighting applied to operational volume within the tool is low.

The SAI-RAT assessment spreadsheet does not allow the user to interpret how variables impact the risk score, therefore confidence in the tool is based solely upon the final output scoring and the perception of its accuracy.

It is recommended that the SAI-RAT tool is reviewed and updated before the Gate 3 assessments to account for wider comments from other users following implementation during Gate 2.

6.2 INNS PREFERENCE ASSESMENT

The ability to accurately predict the impact to INNS resulting from changes to the physical environment is limit due to lack of relevant literature and remains a knowledge gap. Impacts due to relatively small changes to the physical environment and water quality resulting from the LRU scheme are difficult to predict as in reality the preference of INNS are relatively broad, evident in their ability to dominate in a broad range geographical areas. As such, in reality there are likely to be additional factors at play such as functional niche overlaps and interspecific competition between native and non-native species which are likely to be altered as a result of small-scale changes to hydrology and water quality.

APPENDIX 1 SAI-RAT INPUTS

Table A 1 SAI-RAT RWT risk assessment inputs used to assess the Teddington DRA Thames- Lee Tunnel raw water transfer and existing Thames- Lee Tunnel raw water transfer.

RWT Name	TLT Transfer 50 Ml/d	TLT Transfer 75 Ml/d	TLT Transfer 100 Ml/d	TLT Transfer 150 Ml/d	TLT Transfer current (195 Ml/d)
Source Name	River Thames				
Source Management Catchment	Maidenhead and Sunbury				
Source Operational Catchment	Thames Lower				
Source Type	River				
Number of RWT inputs into source	Unknown				
Pathway Type	Pipeline				
Receptor Name	Lower Lee Reservoirs				
Receptor Management Catchment	London				
Receptor Operational Catchment	Lower Lee Rivers and Lakes				
Receptor Type	Online waterbody				
Isolated receptor catchment	No				
Volume of water	6-50 Ml/d	51-100 Ml/d	51-100 Ml/d	100-150 Ml/d	151-200 Ml/d
Frequency of operation	Occasional i.e. infrequent, regulatory compliance				Year round - continuous, variable flow
Transfer distance (Km)	>30				
Washout/maintenance points outside of catchments	Unknown				
Source Navigable	Yes				
Pathway Navigable	No				
Angling at Source	Members and day ticket holders, international events				
Angling on Pathway	No				
Water sports at Source	National events				

RWT Name	TLT Transfer 50 Ml/d	TLT Transfer 75 Ml/d	TLT Transfer 100 Ml/d	TLT Transfer 150 Ml/d	TLT Transfer current (195 Ml/d)
Water sports on Pathway	No				
Presence of high priority INNS_Source	Known to be present				
Presence of high priority INNS_Pathway	Known to be present				
Highest order site designation_Receptor	International				
Presence of priority habitat _Pathway	Known to be present				
Presence of priority habitat_Receptor	Known to be present				
Other existing connections between source and receptor	None				
Risk Score (%)	**55.88**	**56.88**	**56.88**	**57.88**	**63.88**

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