ANNEX B7

Environmental Regulatory Assessments (INNS)

This document has been written in line with the requirements of the RAPID gate two guidance and to comply with the regulatory process pursuant to Severn Trent Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Severn Trent 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.

STSources SRO
Severn Trent Water

ATKINS

Member of the SNC-Lavalin Group

Severn Trent Sources Strategic Resource Option

B7 STS SRO INNS Assessment

Severn Trent Water Limited

29 July 2022

5213609 / 9.7 / DG / 007

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1. Invasive Non-Native Species (INNS)

1.1. Introduction

This report examines the potential risks of invasive non-native species (INNS) introduction as part of the Severn Trent Sources (STS) Strategic Resource Option (SRO) ('the Scheme'). The Scheme was identified as an SRO in the PR19 Final Determination, with funding provided to Severn Trent Water (STW) as an individual company. The STS SRO is considered integral to the Severn Thames Transfer (STT) SRO. The central aspect of the STT is the interconnector which enables the transfer of raw water from the River Severn to the River Thames (Deerhurst to Culham pipeline). To support this transfer, additional sources of water are required to support baseline river flows. These additional sources of water will be supported by United Utilities and STW, which comprise of water resources that can be added, or not abstracted (redeployed), from the Rivers Vyrnwy, Severn and Avon. This assessment only considers the STS SRO option, which comprises:

- A transfer of up to 35 Ml/d of final effluent from Netheridge Wastewater Treatment Works (WwTW) to the River Severn at Haw Bridge.
- A 15 Ml/d licence transfer from Mythe Water Treatment Works (WTW) to the Severn to Thames Transfer pipeline abstraction location at Deerhurst.

This report is a Technical Appendix to the STS SRO Interim Environmental Assessment (IEA), which provides further background information to the Scheme.

An INNS is any "non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live"[1]. Whilst this definition does not include pathogens, it is widely acknowledged that INNS can also carry (non-native) pathogens which can affect native populations more than they do the INNS themselves, for example crayfish plague (*Aphanomyces astaci*).

INNS are considered the second biggest threat, after habitat loss and destruction, to biodiversity worldwide and carry a significant cost burden for UK water companies annually, both through the cost of their direct control and from damage to infrastructure and operational disruption[2]. Understanding the risk presented by INNS is an essential stage in the process of developing mitigation measures for this Scheme to reduce the risk of their introduction and spread as a consequence of the Scheme.

As there is no new infrastructure associated with the Mythe WTW licence transfer, this has not been included as part of the INNS assessment. Also excluded are risks associated with the construction of the WwTW upgrade and pipeline itself which will be controlled through good practice construction methodologies and supplementary construction mitigation as required - to be outlined and agreed as part of formal approvals for the construction of the STS SRO during subsequent Gates. It is noted that the SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) methodology does not allow for the assessment of construction associated with the Scheme.

A methodology for the assessment of all SROs[3] was developed by the National Appraisal Unit (NAU) Environment Agency teams. The NAU issued a standardised risk assessment approach in the form of a risk assessment tool (hereafter the SRO Aquatic INNS Risk Assessment Tool; SAI-RAT). Through this Scheme, INNS transfer pathways are mediated through the transfer of final effluent from Netheridge WwTW to the River Severn. Further details of the method are summarised in Section 3, with full details provided in the SAI-RAT user guide[3].

Plans for the Scheme are in development and will be finalised as part of subsequent Gates. Therefore, the risk assessment for the Netheridge WwTW transfer has been completed using the most up-to-date design and operational information available at the time of submission. This has been gathered through consultation with relevant stakeholders (e.g., design engineers) and a review of Gate 1 documentation.

The Environment Agency has stated that there are no plans at this stage to set thresholds or a figure on acceptable risk, as the objective of the tool is to provide a comparative analysis of INNS risk across SROs[4]. Full details of the SAI-RAT risk assessment method are provided by the Environment Agency[3]. A summary is provided in Section 3.1, noting where supplementary analysis has been undertaken. The remainder of the

[1] Great Britain Non Native Species Secretariat (GB NNSS). Definition of terms: Invasive Non Native Species. [online]. Available at: http://www.nonnativespecies.org/index.cfm?pageid=64 [Accessed on: 13/05/2022]
[2] UKWIR. (2016). Invasive Non-Native Species (INNS) Implications on the Water Industry. [online]. Available at: https://ukwir.org/Invasive-and-Non-Native-Species-(INNS)-Implications-on-the-Water-Industry [Accessed on: 13/05/2022]
[3] EA Asset tool 6610_ Final user version and EA SRO assessment tool handbook v1- Final – issued 30 November 2022.
[4] EA Asset tool 6610_ Responses to Feedback from Industry – issued 30 November 2022.

chapter then reports on the application of the SAI-RAT, the results from the risk assessment of the Scheme during Gate 2, and the options appraisal of potential biosecurity measures that could help mitigate risks identified.

1.2. Purpose of report

This report sets out the INNS assessment for the STS SRO scheme at Gate 2 and builds upon work undertaken at Gate 1 of the design process. The scheme is integral to a larger STT system, which does not form part of this assessment and is being assessed separately.

1.3. Structure of report

The remainder of this report is divided into the following sections:

- Section 2: Scheme Description
- Section 3: Methodology used for the INNS assessment
- Section 4: Assessment outcomes
- Section 5: Recommended mitigation measures
- Section 6: Conclusions and recommendations

2. Scheme Description

A summary of the two main STS SRO components is provided in Sections 2.1 and 2.2, and their joint operation in Section 2.3. A detailed overview of the scheme is presented within the main IEA report and a map of the STS SRO Scheme is available in Technical Appendix B3.2. The Scheme description provided at Gate 2 (on which Gate 2 assessments have been based) will be subject to further review in Gates 3 and 4.

2.1. Mythe WTW abstraction licence transfer (15 Ml/d)

This part of the Scheme provides support to the STT System from the Severn catchment by redeploying 15 Ml/d of the existing STW abstraction licence at its Mythe WTW intake in the lower River Severn. This infrequently used licensed volume from Mythe would now remain in the River Severn for abstraction downstream at Deerhurst. STW has advised that no construction works would be required to redeploy the spare licence volume for abstraction. It is understood from STW that no specific additional resource to replace this current abstraction licence volume has been determined to date. The Mythe WTW abstraction licence Scheme will not operate alone and will operate in-combination with the Netheridge WwTW discharge diversion to Haw Bridge.

2.2. Netheridge WwTW discharge diversion to Haw Bridge pipeline (35 Ml/d)

The outfall location to the River Severn will be located just upstream of the level gauge at Haw Bridge (see Scheme map in Technical Appendix B3.2). The discharge diversion from Netheridge WwTW would be pumped by a new pumping station, located at the WwTW via a 700 mm diameter pipeline approximately 15.5 km long with tunnelling under named watercourses, such as the River Severn.

The pipeline discharge to Haw Bridge will not be continuous. It will range from zero (when flows are high enough in the River Severn to support the STT transfer) to 35 Ml/d when fully operational (during periods of lower flows in the River Severn). The pipeline will include nine drain-down points through which water in the pipeline will be discharged during maintenance activities (Technical Appendix B3.3). These drain-down points will be set back at least 10 m from water courses. The Netheridge WwTW final effluent would receive additional treatment to mitigate any water quality issues, which includes the removal of ammonia using a Multi-Bed Bio Reactor (MBBR), removal of phosphorus using 'CoMag'®, and removal of selected organic compounds including phenols, Perfluorooctane sulfonic (PFOS) and some pesticides using Ozone, Biological Aerated Flooded Filter (BAFF) and Granulated Activated Carbon (GAC). More detail on the treatment processes has been provided in Technical Annex B1 (Initial Environmental Appraisal).

2.3. Indicative operation of STS SRO

There are the following modes of operation. Please note the duration of the Scheme's operation is indicative at this stage and could be refined based on further modelling or changes to river flow triggers.

- **Mode 1 -STT SRO sweetening flow provided by unsupported river abstraction**: STS SRO is not in operation and STT is also off. There is enough water in the River Severn at Deerhurst to provide the 20 Ml/d STT sweetening flow between the River Severn to the Thames, with no undesirable effects on the River Severn.
- **Mode 2- STT SRO sweetening flow provided by STS Netheridge WwTW effluent transfer at 20 Ml/d**: STS is 'on' but STT off. This means 20 Ml/d is piped from Netheridge WwTW to Haw Bridge because STT is not working and thus only requires the sweetening flow, which the river can't provide. This mode of operation would be expected to occur 12 % of the time (modelled over a 47-year period).
- **Mode 3- STT SRO water resources provided by the STS Netheridge WwTW effluent transfer at 35 Ml/d**: STS is 'on' and STT is 'on'. This means 35 Ml/d is piped from Netheridge to Haw Bridge to allow a 35 Ml/d STT abstraction. STT takes the additional 15 Ml/day from Mythe WTW abstraction licence transfer, so STT takes a 50 Ml/d contribution from STS overall. This mode of operation would be expected to occur 16 % of the time (modelled over a 47-year period).

3. Methodology

3.1. Risk assessment tool

The SAI-RAT has been developed to standardise risk assessments across all SROs and was developed based on common working methodologies from previously developed tools, such as the Wessex Water Asset Risk Assessment Tool, and the Northumbrian Water Group (NWG) Raw Water Transfer (RWT) Risk Assessment Tool. The latter was specifically developed to meet the requirements of Environment Agency PR19 guidance for the assessment of raw water transfers[5]. A high-level overview of the SAI-RAT process is provided in Figure 3-1.

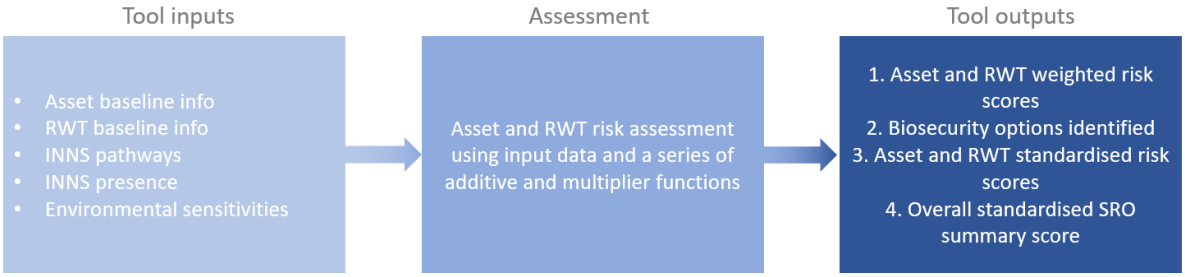

Figure 3-1 - High-level overview of the SAI-RAT process

The SAI-RAT retains discrete modules for the assessment and (relative) quantification of asset and raw water transfer risk, as well as high-level identification of INNS mitigation measures. Similar to its predecessor tools, the SAI-RAT focuses on a pathway-based approach to INNS transfer, rather than a species-based approach, however, to future-proof against pathway risks from INNS that are not yet recorded within the SRO environs (or indeed the United Kingdom) only baseline INNS presence (or absence) is considered within the tool. Where INNS are known to be present within the baseline (one or more confirmed high impact[6] INNS species) this is accounted for within the risk assessment scoring.

Alongside baseline sensitivities of the SRO environs (such as the presence of protected and priority habitats), and the characteristics of the transfer (such as whether water is transferred within or between catchments), the presence and frequency of INNS transfer pathways (such as recreation e.g., at the source of the transfer) drives the quantitative output of SAI-RAT. Based on these input criteria, a total risk score for any given SRO is provided as an output, supporting an assessment of the relative risk of the STS SRO and comparative assessments across SROs.

Within the SAI-RAT, the risk of any given scenario is standardised and expressed as a percentage of the highest potential risk score that can be calculated within the SAI-RAT. This produces a final risk score of between 1 and 100 percent (from low to high risk) for each scenario. The SAI-RAT does not provide an interpretation of the risk scores; instead, this is an indicative risk categorisation to facilitate comparison between SROs. The assessment of risk must always be considered on a case-by-case basis, with professional judgement to support the findings of the tool.

[5] Environment Agency. 2017. PR19 - Assessing the risks of spread of Invasive non-native species posed by existing water transfers - OFFICIAL
[6] WFD TAG high impact species, any species on the WCA Schedule 9 and any species on the European List of Concern.

3.2. Datasets reviewed

Along with design and operational information from the Gate 1 submission of the STS SRO report, a number of datasets were used within the Gate 2 assessment process, to identify INNS, environmental designations and priority habitats within a 1 km radius of the Scheme (as per the SAI-RAT guidance). The following datasets and sources were used for the assessment:

- Environment Agency Ecology and Fish Data Explorer data[7];
- National Biodiversity Network (NBN) data[8];
- Atkins and Ricardo SRO monitoring data[9];
- DEFRA MAGIC website[10];
- Natural England Habitat Networks GIS layers[11]; and
- Gate-1 submission for Severn Trent Sources Strategic Resource Option[12].

3.2.1. INNS data searches

The SAI-RAT considers baseline presence of 'high-priority' INNS only. The pathway approach for INNS risk assessments and management takes account of life cycle strategies through the use of functional groups, meaning the mitigation measures appraisal considers INNS transfer risk and mitigation predominantly on a group-by-group basis. This helps ensure that any horizon species not yet established will be accounted for within their respective functional group (26 such groups are defined in the guidance).

High priority INNS are defined by the SAI-RAT guidance as any species:

- categorised as "high impact" on the Water Framework Directive UKTAG aquatic alien species list[13];
- on the list of Invasive Alien Species of Union Concern (Regulation (EU) 1143/2014)[14]; and/or,
- listed on Schedule 9 of the Wildlife and Countryside Act (as amended) 1981[15].

The SAI-RAT guidance requires that aquatic and riparian INNS records within a 1 km buffer from the source and the pathway of the transfer are included within the raw water transfer risk assessment. Due to subjectivity in distinguishing riparian from terrestrial plants (with even archetypal 'riparian' plants such as Japanese knotweed (*Reynoutria japonica*), Himalayan balsam (*Impatiens glandulifera*) and giant hogweed (*Heracleum mantegazzianum*) being terrestrial in the strictest sense but associated with waterways through which they spread[16]), all plants within the above lists are included.

The SAI-RAT guidance outlines processes to support this search through desk-based analysis of open-source data, which is documented in Section 3.2.

[7] Environment Agency. 2022. EA Ecology & Fish Data Explorer. [online]. Available at: https://environment.data.gov.uk/ecology/explorer/ [Accessed on: 13/05/2022]
[8] National Biodiversity Network. 2022. NBN Atlas. [online]. Available at: https://nbnatlas.org/ [Accessed on: 13/05/2022]
[9] As documented in: Ricardo. 2021. Severn Trent Transfer INNS Evidence Report. [STT Technical Annex B2.5]
[10] DEFRA. 2022. MAGIC website. [online]. Available at: https://magic.defra.gov.uk/MagicMap.aspx [Accessed on: 13/05/2022]
[11] Data.gov.uk. 2022. Habitat Networks (England). [online] Available at: https://data.gov.uk/dataset/0ef2ed26-2f04-4e0f-9493-ffbdbfaeb159/habitat-networks-england [Accessed on: 16/05/2022]
[12] Severn Trent Water. 2021. Strategic regional water resources solutions: Preliminary feasibility assessment. Gate-1 submission for Severn Trent Sources Strategic Resource Option. Issued 01 July 2021.
[13] Gov.UK. 2015. The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. [online]. Available at: https://www.legislation.gov.uk/uksi/2015/1623/pdfs/uksiod_20151623_en_auto.pdf [Accessed on: 07/03/2022]
[14] European Commission. (2015). EU Regulation 1143/2014 on Invasive Alien Species. [online]. Available at: https://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm [Accessed on: 16/05/2022]
[15] Gov.UK (2021). Wildlife and Countryside Act 1981 – Schedule 9. [online]. Available at: https://www.legislation.gov.uk/ukpga/1981/69/schedule/9 [Accessed on: 16/05/2022]
[16] Environment Agency (2014), Aquatic and riparian plant management: controls for vegetation in watercourses. Project: SC120008/R1.

3.3. Design considerations and transfer pathways

The intrinsic characteristics of the effluent transfer underpins the relative quantification of risks within the raw water module of SAI-RAT; type, distance, volume and frequency of transfer – as well the activities likely to be present on the transfer (e.g., recreation and maintenance). Further details on the methodology are available in the guidance[3].

For the purpose of the risk assessment and based on latest design information (Section 2), no sweetening flow within the Netheridge pipeline is assumed. The raw water transfer module of the SAI-RAT has been used to run the risk assessment for the effluent reuse transfer, noting that this module allows for this assessment of effluent transfer to take place.

The following criteria within the SAI-RAT underpin the inherent risk of the transfer operation:

- Volume of water to be transferred;
- Frequency of transfer operation;
- Physical transfer distance;
- Transfer relative to Water Framework Directive (WFD) waterbodies and catchments;
- Source, pathway and receptor type;
- Any existing connections;
- Number of RWT inputs; and,
- Number of washout points.

The pathways of INNS transfer that may be selected as present within the raw water transfer risk assessment include:

- Navigation at source;
- Navigation on pathway;
- Angling at source;
- Angling on pathway;
- Watersports at source; and
- Watersports on pathway.

3.4. Mitigation measures options appraisal

A generalised biosecurity module included within the SAI-RAT identifies potential biosecurity measure types from a defined list of 30 options which may be considered by the user. This is an automated process taking account of the INNS transfer pathways identified to be present. Should a specific INNS pathway (e.g., angling, watersports etc.) be 'activated' within the assessment, this high-level options identification is completed automatically by the tool, highlighting which options may be broadly applicable for targeting that specific pathway.

The SAI-RAT does not consider mitigation measures within, or revise risk scores in the context of, mitigation measures being 'selected'. Therefore, all risks and scores reported should be considered as a worst-case prior to any mitigation (within the context of the scenario to which they apply). The quantitative risk assessment scoring approach facilitates comparison of scenarios based on their intrinsic relative risk. The qualitative biosecurity module is effectively a bolt-on which helps identify which types of mitigation measures may help further reduce risk for any given scenario. Further details on the methodology are available in the guidance[3].

Acknowledging that the biosecurity module of the SAI-RAT cannot take account of the specific context of a given pathway, or the feasibility of implementation of a given measure, in the context of the STS SRO, a supplementary options appraisal has been undertaken by Atkins. This options appraisal exercise has been summarised in Section 4.2, with further detail on the options recommended provided in Section 5. The mitigation measures options appraisal involved reviewing those biosecurity approaches identified within the SAI-RAT, as well as additional known biosecurity approaches, and assessing their appropriateness of use within the Scheme, in relation to the key identified pathways. This includes measures to reduce INNS risk through prevention and management.

A simple scoring system has been applied for each mitigation measure to help assess its suitability for application against the identified transfer pathways. All options were scored from 1 to 3 for efficacy and feasibility and given a Red, Amber and Green (RAG) colour code from which a cumulative score has been generated, which was also colour coded on a RAG scale (Table 3-1). This cumulative score (e.g., between 2 and 6) has been used to assess the potential applicability of each option to STS, from an efficacy and feasibility perspective. The cumulative nine-point scoring matrix is shown in Table 3-2. At this stage and based on the scoring approach presented, the mitigation measures appraisal identifies that:

- measures with a cumulative score of 3 or less (or 4, where either efficacy or feasibility is scored as 1) are **not recommended** for inclusion in future design/site use optioneering;

- measures with a cumulative score of 4 (where both efficacy and feasibility are scored as 2) **may be considered** for inclusion in future design/site use optioneering; and
- measures with a cumulative score of 5 or 6 are **recommended** for inclusion in future design/site use optioneering.

The options identification focusses on those measures which mitigate the risk of INNS transfer via, or remove INNS from, transfer pathways identified by the SAI-RAT. It does not focus on eradication measures for INNS following their establishment, however, it is acknowledged that some measures will induce mortality and therefore reduce INNS spread. Acknowledging that there is a degree of overlap in this respect within some of the measures identified (i.e., measures that can be both preventative and used in efforts to eradicate INNS following establishment); efficacy scores are assigned on the basis of the measure effectiveness in managing transfer/introduction risks via transfer pathways. Feasibility scores are assigned based on the applicability of the measure considering operational, environmental, and social costs and factors. These scores are derived from professional judgement and are used as an indication only of which methods are best recommended for consideration as part of future project stages. Following the selection of any measure for the STS SRO in the future, a more detailed appraisal would be required to explore all possible implications of the proposed measure.

Table 3-1 - Three-point scoring for efficacy and feasibility of mitigation measures

Score and Colour Code	Efficacy	Feasibility
1	Not effective at preventing or removing INNS	Significant negative operational, environmental or social cost
2	Moderately effective at preventing or removing INNS	Moderate operational, environmental or social cost
3	Highly effective at preventing or removing INNS	Minimal operational, environmental or social cost

Table 3-2 - Cumulative scoring matrix for mitigation measures

	Not effective at preventing or removing INNS	Moderately effective at preventing or removing INNS	Highly effective at preventing or removing INNS
Significant negative operational, environmental or social cost	2	3	4
Moderate operational, environmental or social cost	3	4	5
Minimal operational, environmental or social cost	4	5	6

3.5. Consultation/engagement held

The INNS risk assessment being undertaken within the Environment Agency mandated tool for the Gate 2 submission has been summarised during Technical Working Groups held with the Environment Agency on 22 November 2021, 1 March and 07 April 2022. Stakeholder workshops supporting the review and update of the mandated SAI-RAT, whilst it was in development were also attended by the STS SRO project representatives on 03 August 2021 and 22 September 2021, with feedback provided to the Environment Agency on the functionality of the tool.

3.6. Understanding of the baseline

3.6.1. INNS records

Following a review of available data, INNS recorded within 1 km of the proposed pipeline source and route were identified (Table 3-3). This includes all species which are classified as 'high priority', as per the SAI-RAT guidance. The INNS search identified one high priority species, zander (*Sander lucioperca*), located on the River Severn within 1 km of the source of the transfer. A total of eight high priority INNS were located within 1 km of the pathway or the receptor of the transfer, including an additional record of zander. Of these eight high priority INNS identified within 1 km of the transfer pathway, five were recorded on or adjacent to the main channel of the River Severn, within a reach extending 16.5 km upstream from the source of the transfer at Netheridge WwTW, to the receptor of the transfer at Haw Bridge.

Table 3-3 - Recorded presence of high priority invasive species within 1 km of the Severn Trent Sources SRO

Location	Scientific name	Common name	Recorded location
Source	*Sander lucioperca*	Zander	River Severn
Pathway	*Azolla filiculoides*	Water fern	River Twyver
	Elodea canadensis	Canadian waterweed	Horsbere Brook, River Chelt
	Elodea nuttallii	Nuttall's waterweed	Hatherley Brook
	Impatiens glandulifera	Himalayan balsam	Wide coverage of study reach
	Cyprinus carpio	Common carp	Coombe Hill Canal
	Dikerogammarus haemobaphes	Demon shrimp	River Severn
	Dreissena polymorpha	Zebra mussel	River Severn
	Sander lucioperca	Zander	River Severn

Colour coding correlates with the overarching functional group category:
Yellow = Aquatic Plants;
Green = Terrestrial/riparian Plants;
Blue = Aquatic Animals.

Other notable INNS that are not listed as 'high priority' (as per the SAI-RAT guidance – i.e., in legislative documents) are present within the 1 km search area of the Scheme, including the notable Asian clam (*Corbicula fluminea*), which has been recorded on the River Severn. 'Other' INNS include those which are listed as INNS in Ricardo SRO monitoring records, but which are not listed in legislation (as documented in section 3.2.1). These 'other' INNS not listed as 'high priority' but have been recorded within the 1 km search area include:

- Caspian mud shrimp *(Chelicorophium curvispinum)*
- Asian clam *(Corbicula fluminea)*
- Freshwater amphipod *(Crangonyx floridanus)*
- Aquatic flatworm *(Dugesia tigrina)*
- Wautier's limpet *(Ferrissia wautieri)*
- Freshwater amphipod *(Gammarus zaddachi)*
- Bristle worm *(Hypania invalida)*
- Freshwater bivalve *(Musculium transversum)*
- Acute bladder snail *(Physella acuta)*
- Tadpole physa *(Physella gyrina)*
- New Zealand mud snail *(Potamopyrgus antipodarum)*

3.6.2. Site designations and priority habitats

A review of the MAGIC website did not identify any statutory designations within 1 km of the receptor of the transfer (Haw Bridge, River Severn). However, a review of Natural England's Priority Habitat Inventory (PHI) identified 70 individual priority habitat units within a 1 km buffer of the indicative pipeline route, excluding network enhancement and expansion zones (i.e., opportunity areas not yet recognised as containing priority habitat). These priority habitats include lowland fens, calcareous grassland and meadows, traditional orchards, ancient woodland, and wood pasture and parkland, and are located in the vicinity of the pipeline route and at Haw Bridge on the River Severn. We are also aware that it is Natural England's view that the freshwater River Severn forms functional habitat for nearby designated sites. As such, using the precautionary principle, the presence of priority habitats was 'activated' within the tool.

4. Assessment outcomes

4.1. INNS transfer risk assessment

The risk assessment of the effluent re-use transfer from Netheridge WwTW to the River Severn has been completed using a range of open-source information (i.e., presence of INNS, priority habitats etc.) and available design information to inform the expected operation of the transfer.

It is expected that the transfer will be in the form of a pipeline, with an operation over half of the year only, with no sweetening flow. The transfer is predicted to pass forward up to 35 Ml/d during operation, over a 15.5 km route (pipeline length). The pipeline is expected to include nine washout points at low points along the route, which will direct the treated effluent back to the River Severn and to other watercourses in the vicinity. These other watercourses include the River Chelt, Cox's Brook and a local unnamed watercourse.

Whilst no statutory designations have been observed within 1 km of the receptor, INNS have been observed within 1 km of the source and pipeline route, and priority habitats have been identified within 1 km of the pipeline route and at the receptor, contributing to the INNS transfer risk. The full range of inputs to SAI-RAT are shown in Table 4-1.

Based on these inputs, the risk assessment produced a score of 513, or 38.0 % out of the maximum risk score possible within the SAI-RAT (i.e., 100 %).

Despite the Scheme sitting at 38.0 % risk score for INNS transfer, it is noted that just four input variables account for approximately 66 % of the total risk. The highest contributing variable relates to the transfer between WFD operational catchments, providing an individual risk score of 121.5 / 9 % (or approximately 24 % of all risk associated with the transfer). The next highest contributing variables are the receptor type (river) and the frequency of operation (year round – intermittent) at 6 % individual risk each, followed by the pathway type (pipeline) at 4 % individual risk. All other input variables contribute 2.5 % or lower risk each.

It may be argued that the risk score generated as a result of the transfer between WFD operational catchments is disproportionately high in the context of the transfer operation. This is because in operation the final effluent will still discharge to the River Severn (albeit to a location 16.5 km upstream of the current discharge point at the WwTW) and will be subject to improved treatment processes as part of the Scheme. Discounting the 'between WFD operational catchments' risk generated by the tool, the Scheme risk would reduce to 29.0 %, placing a lower predicted risk on the Scheme. The full breakdown of risk scores for each variable are presented in Table 4-1.

Table 4-1 - Risk assessment inputs applied for the transfer of effluent from Netheridge WwTW to the River Severn

Variable	Input	Individual risk score
Source name	Netheridge WwTW	Non-scoring input
Source easting / northing	380891 / 215805	Non-scoring input
Source management catchment	Severn Vale	Non-scoring input
Source operational catchment	Gloucester Trib	Non-scoring input
Source waterbody ID	N/A	Non-scoring input
Source type	Wastewater Treatment Site	6.75 (0.5 %)
Number of raw water transfer inputs to source	None*	0 (0 %)
Pathway type	Pipeline	54 (4 %)
Receptor name	Haw Bridge River Severn	Non-scoring input
Receptor easting / northing	384558 / 227900	Non-scoring input
Receptor management catchment	Severn Vale	0 (0 %)
Receptor operational catchment	Severn River and Trib	121.5 (9 %)
Receptor waterbody ID	GB109054044404	0 (0 %)
Receptor type	River	81 (6 %)
Isolated receptor catchment	No	0 (0 %)
Volume of water	6-50 Ml/d	13.5 (1 %)
Frequency of operation	Year round - intermittent	81 (6 %)
Transfer distance (km)	15.1-20 km	33.75 (2.5 %)
Number of washout/maintenance points	>3 (washout points)	27 (2 %)
Source navigable	No	0 (0 %)
Pathway navigable	No	0 (0 %)
Angling at source	No	0 (0 %)
Angling on pathway	No	0 (0 %)
Water sports at source	No	0 (0 %)
Water sports on pathway	No	0 (0 %)
Presence of high priority INNS – source	Known to be present	27 (2 %)
Presence of high priority INNS – pathway	Known to be present	27 (2 %)
Highest order site designation receptor	None	0 (0 %)
Presence of priority habitat – pathway	Known to be present	27 (2 %)
Presence of priority habitat – receptor	Known to be present	27 (2 %)
Other existing connections	1	-13.5 (-1 %)
Overall risk score (total score)	513	
Final RWT risk score (% out of 100)	**38.0 %**	

**As the water entering the transfer to Haw Bridge will already be treated effluent, even without additional treatment provided by the SRO, the number of raw water transfers into source has been described as 'none' for the purpose of the risk assessment.*

4.2. Mitigation measures screening assessment

The SAI-RAT identifies a range of potential biosecurity measure types which may be suitable for reducing INNS risk associated with the Scheme. These potentially suitable mitigation measures, summarised in Table 4-2, have been appraised for their relevance to the Scheme following scoring of their feasibility and efficacy to reduce INNS transfer risk. This appraisal recommends only those measures which are both applicable to the transfer, in the context of the upgraded treatment processes that will be in place at the WwTW, and where the cumulative score is 5 or greater, as shown in Table 4-2 (denoted by ticks).

General site biosecurity measures have not been scored as they are seen as fundamental to site biosecurity and their overall efficacy and feasibility may vary depending on the specific-scenario in which they're applied, and the INNS targeted. All general site biosecurity measures should be viewed as risk reduction measures, because even with a high level of implementation, no general measure can provide full mitigation for the risk of the INNS introduction.

It is noted that the SAI-RAT does not specifically consider mitigation measures within, or revise risk scores in the context of, mitigation measures being 'selected', however, it is assumed for the purpose of the risk assessment that some level of treatment at a wastewater treatment site is accounted for within the 'source type' input of the SAI-RAT (scoring just 0.5 % individual risk). For example, it is noted that Netheridge WwTW already includes primary and secondary water treatment processes, which are inherent for a treatment works of this size.

Despite the SAI-RAT identifying mitigation measures which are potentially suitable for the transfer of raw water, the Scheme consists of a WwTW upgrade and effluent transfer scheme in which primary, secondary and tertiary water treatment processes occur, meaning the majority of measures suggested by the SAI-RAT are redundant, owing to the extensive treatment already taking place at the works. Therefore, for the purpose of the mitigation measures options appraisal, it assumes that some measures specific to the raw water transfers and water treatment are already in place at the WwTW (or will have no impact due to the measures in place) and are therefore **not relevant**. This includes measures that score high (5 or 6) for their cumulative efficacy and feasibly score (Table 4-2), such as:

- Passive filtration – e.g., fish screens and conveyor screens;
- Active filtration – e.g., screen filters and deep bed filters;
- Chlorination;
- Coagulation and flocculation;
- Ultraviolet (UV) treatment; and,
- Integrated treatment systems.

Those measures which are applicable to the Scheme, but score low in the context of efficacy and feasible (i.e., cumulative score of 4 or lower) are **not recommended**, and include:

- Anti-fouling measures – e.g., biocidal paint and silicone-based coating;
- Changes to flow regime – e.g., stoppage of water flow and transfers at high velocity;
- Manual cleaning of the pipeline; and
- Biochemical – e.g., BioBullets® and Zequanox®.

Based on this screening exercise and a review of the cumulative efficacy and feasibility scores, the most applicable mitigation measures that are **recommended** for consideration in Scheme design include:

- a general biosecurity strategy and management plan, including consideration of the transfer operation and maintenance;
- stringent Check Clean Dry protocol associated with management of the transfer and the WwTW in general; and,
- the inclusion of INNS monitoring at the receptor of the transfer to support early detection of new INNS;

Further information on these four biosecurity approaches can be seen in Section 5.

Table 4-2 - Mitigation methods potentially suitable for the transfer of effluent from Netheridge WwTW to the River Severn

Mitigation option	Efficacy Score	Feasibility score	Cumulative score	Recommended
General site biosecurity				
Biosecurity strategy and management	N/A	N/A	N/A	✓
Check, clean, dry protocols	N/A	N/A	N/A	✓
INNS monitoring*	N/A	N/A	N/A	✓
Raw water transfers				
Active filtration (screen filters)	3	2	5	Not relevant
Active filtration (deep bed filters)	3	2	5	Not relevant
Passive filtration (fish screens)	2	3	5	Not relevant
Passive filtration (conveyor screens)	2	3	5	Not relevant
Passive filtration (rundown screens)	2	1	3	Not relevant
Biocidal paint	1	2	3	Not recommended
Silicone-based coating*	1	2	3	Not recommended
Stop water flow	1	3	4	Not recommended
Coincide with reproductive season*	1	2	3	Not recommended
High velocity flow*	1	2	3	Not recommended
Manual cleaning*	1	1	2	Not recommended
Water treatment				
Chlorination	3	2	5	Not relevant
Coagulation and flocculation*	3	2	5	Not relevant
Biochemical*	2	2	4	Not recommended
UV lighting	3	2	5	Not relevant
Integrated treatment systems	3	3	6	Not relevant

**Mitigation measures identified in addition to those suggested through the SAI-RAT.*

5. Recommended mitigation measures

5.1. Overview

A major advantage of considering biosecurity at this stage of the planning process is that it can be incorporated into the initial design and operation of the Scheme, with less retrospective action required in the future. This not only ensures that good biosecurity practices become an integrated feature of the Scheme but will further decrease the risk of INNS establishment and transfer.

Excluded are mitigation measures associated with the construction of the WwTW upgrade and pipeline itself which will be controlled through good practice construction methodologies and supplementary construction mitigation as required - to be outlined and agreed as part of formal approvals for the construction of the STS SRO during subsequent Gates.

As a minimum precaution to reduce the risk of INNS transfer via the pathways identified (i.e., treated effluent transfer), the Scheme should implement a biosecurity management plan as well as basic biosecurity measures. More detail on these two recommendations has been provided below. The European Union (EU) Invasive Alien Species (IAS) Regulation 1143/2014[17] which came into effect on 1 January 2015 discusses three overarching types of measures for combatting INNS, following a hierarchical approach to management. This includes, in order:

- the prevention of any INNS introductions;
- the early detection and eradication of any new introductions; and
- INNS management for those that are already well established and would benefit from mitigation.

This hierarchical approach should be considered at all stages of identifying relevant INNS mitigation measures, as prevention will always be the preferred approach.

5.2. Biosecurity Management Plan

It is noted that Severn Trent Water Limited have developed their own company-wide General Biosecurity Plan[18] to meet their AMP7 Water Industry National Environment Plan (WINEP) objectives, which has been reviewed and agreed with the Environment Agency. This plan sets out a series of general biosecurity recommendations and assigns a priority for successful implementation.

5.3. Biosecurity strategy and management

It is recommended that a biosecurity strategy is implemented for the Scheme, which should be regularly reviewed by an appointed biosecurity manager. General biosecurity measures that are recommended for this Scheme include:

- Reinforcing Check Clean Dry protocols;
- Implementing a standardised training programme and supplementary INNS identification manuals;
- Formulating an INNS reporting system; and,
- An ongoing appraisal of biosecurity measures.

Check Clean Dry and INNS monitoring are considered to be particularly relevant to this scheme for future site visits and are discussed below in Section 5.3.1 and 5.3.2.

5.3.1. Check Clean Dry protocols

Within their General Biosecurity Plan[18], Severn Trent Water Limited recommend the uptake of the Check Clean Dry initiative at all of their assets, which includes this Scheme. The Check Clean Dry campaign was launched in the UK in 2011 and was aimed at raising awareness of INNS and how stakeholders can act to reduce the risk of spread between waterbodies[19]. The process involves three steps:

1. Check – your equipment for mud, plants and animals and leave any attached organisms on site;

[17] European Commission. (2015). EU Regulation 1143/2014 on Invasive Alien Species. [online]. Available at: https://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm [Accessed on: 17/05/2022]
[18] Severn Trent Water Limited. (2022). General Biosecurity Plan. Issued March 2022.
[19] Angling Trust (n.d.). Invasive Non-Native Species. Available at: https://anglingtrust.net/invasive-non-native-species/ [Accessed on: 17/05/2022].

2. Clean – your equipment thoroughly, paying particular attention to hard to access crevices; and,
3. Dry – your equipment and clothing for as long as possible before it is used again. Some aquatic INNS can survive for up to two weeks in damp conditions, so this step is especially important.

In relation to this scheme, it is recommended that any equipment entering or leaving the WwTW is checked, cleaned and dried. This includes PPE and clothing and may also include survey equipment and vehicles that have been used to access the WwTW. The Biosecurity Plan[18] also recommends that running water is included at all assets to facilitate the Check Clean Dry protocol (for washing equipment), and where not possible, intermediate bulk carriers (1000 litre plastic containers) should be installed. The use of Check Clean Dry should also be promoted through education, which may include the provision of signposts, posters, leaflets and stickers[20] around the WwTW. Online biosecurity information and materials should also be made available to staff visiting the WwTW at the source of the transfer.

5.3.2. INNS monitoring

Ongoing monitoring of INNS (aquatic, riparian and terrestrial) around the source (i.e., the WwTW itself) and receptor of the transfer is recommended as part of the gated process to understand any changes to the distribution of INNS within the lower River Severn system.

It is recommended that staff working at Netheridge WwTW receive standardised training to support with the identification of high priority INNS which may become established at the WwTW site, with any suspected sightings to be reported by Severn Trent's existing reporting procedure[18]. Although INNS monitoring will not prevent the arrival of new INNS, it can support early detection and action against new invaders.

[20] GB NNSS (2020). Biosecurity and pathways. GB non-native species secretariat. Available at: https://www.nonnativespecies.org/biosecurity/. [Accessed on: 17/05/2022].

6. Conclusions and recommendations

A detailed analysis has been undertaken to assess the risk of INNS being introduced and spread via the effluent re-use transfer from Netheridge WwTW to the River Severn. This assessment has been undertaken through the application of the Environment Agency's standardised risk assessment tool for use by all SROs at Gate 2 (the SAI-RAT).

The inputs provided for the Scheme risk assessment provide a risk score of 38.0 %. The lack of recreation or external INNS pathways at the source or along the route of the transfer highlights that the inherent risk of unmitigated movements of large water volumes is the key factor in driving the risk score for this effluent reuse transfer, which is exacerbated by the presence of INNS around the vicinity of the source and along the transfer route.

The presence of priority habitats along the transfer route and at the receptor is a further contributor factor to the risk score of 38.0 %. The activity of transferring water from the WwTW to the River Severn is intrinsic to the STS SRO and thus further design mitigation is likely to be the key to reducing INNS transfer risk, where applicable.

The generalised biosecurity module included within the SAI-RAT identified potential biosecurity measure types from a defined list of 30 options. This automated process accounted for the INNS transfer pathways identified to be present and highlighted which options may be broadly applicable for targeting that specific pathway. These measures, alongside measures supplementary to those identified by SAI-RAT, have been further evaluated for the management of the transfer.

Within the appraisal of INNS mitigation measures, it has been considered that Netheridge WwTW already treats all final effluent to a high standard, which will be upgraded further with the addition of a MBBR, CoMag® system, ozone water treatment plant, BAFF and GAC filter. These additional treatments will effectively kill all INNS propagules, meaning there is limited relevance of additional INNS mitigation measures.

The shortlist of suitable biosecurity measures for further consideration as part of subsequent design stages has been based on an initial assessment of the efficacy and feasibility of implementing the measures. This shortlist contains only general site biosecurity measures which are currently recommended within the Severn Trent Water Limited Biosecurity Plan, including a biosecurity management plan and stringent Check Clean Dry protocols, as well as an INNS monitoring programme to detect any new INNS in the vicinity of the WwTW at the source of the transfer.

6.1. Next steps

The findings of the Gate 2 INNS risk assessment will continue to inform future STS SRO design iterations, including design mitigation for the Scheme and plans for appropriate biosecurity measures. At Gate 3, greater detail on the design options will have been provided allowing for a review of the Gate 2 INNS assessment.

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