MOTT MACDONALD

SLR Drinking Water Quality Risk Assessment Report

RAPID Gate Two Annex

November 2022

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SLR Drinking Water Quality Risk Assessment Report

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Glossary

Abbreviation	Definition
A2AT	Anglian to Affinity Transfer
ACWG	All Company Working Group
DBPs	Disinfection by-products
DWI	Drinking Water Inspectorate
DWSP	Drinking water safety plan
IL	Information Letter
INNS	Invasive non-native species
MIB	Methylisoborneol
PCV	Prescribed concentration or value
PFAS	Poly and perfluorinated alkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulphonate
RAPID	Regulator's Alliance for Progressing Infrastructure Development
SLR	South Lincolnshire Reservoir
SRO	Strategic Resource Option
SWRA	Surface water risk assessment
The Regulations	The Water Supply (Water Quality) Regulations 2016
THMs	Trihalomethanes
TOC	Total organic carbon
TSS	Target supply standard
UV	Ultraviolet
UV AOP	Ultraviolet advanced oxidation process
WQRA	Water quality risk assessment
WTW	Water treatment works

Executive Summary

The Drinking Water Quality Risk Assessment Report is an annex prepared to support the gate two submission report to the Regulator's Alliance for Progressing Infrastructure Development (RAPID) for the South Lincolnshire Reservoir (SLR) Strategic Resource Option (SRO).

This report covers the water quality considerations of the SLR SRO. Limiting hazards and their associated risk scores have been considered in the form of a water quality risk assessment (WQRA), which follows the guidance developed for the All Company Working Group (ACWG)[1]. The WQRA has been developed in a grid format (see Appendix A) and reviewed in a collaborative strategic WQRA workshop.

A limiting hazard is defined in the ACWG guidance as hazards and hazardous events which are most likely to drive the development and/or acceptability and/or viability of the SRO. Throughout the WQRA process, the list of limiting hazards for the SRO has been reviewed and refined to give a representative, high-level view of the parameters which are likely to require treatment, and this has guided the concept design of the proposed treatment facility.

The gate one WQRA included limiting hazards from the following groups:

- Pathogens
- Acceptability due to change in chemistry
- Acceptability due to taste and odour
- Pesticides
- Nitrate/nitrite
- Change in metal types and form
- Disinfection by-product formation potential

During gate two, the following additional limiting hazards were identified through the WQRA process:

- Aluminium
- Poly and perfluorinated alkyl substances (PFAS)
- Perfluorooctane sulfonate (PFOS)
- Perfluorooctanoic acid (PFOA)

The WQRA process has also identified the information requirements and residual risk considerations that would need to be addressed moving forward into gate three. This would provide a more detailed understanding of the water quality risks associated with each option and, therefore, enable refinement of the treatment process design. Key considerations for this are whether nitrate treatment or additional PFAS (including PFOS and PFOA) treatment are required in the treatment process. Further water quality monitoring data can be used at gate three to help determine these treatment requirements.

Consumer acceptability is a key risk when transferring water. For SLR there is a risk to consumers associated with the change in water source. This risk is applied to taste, odour and other aesthetic limiting hazards. The risk can be reviewed and updated as the design progresses. Customer engagement will be important as the scheme develops.

The requirement for ongoing water quality monitoring and further stakeholder engagement, including the Drinking Water Inspectorate, has been identified.

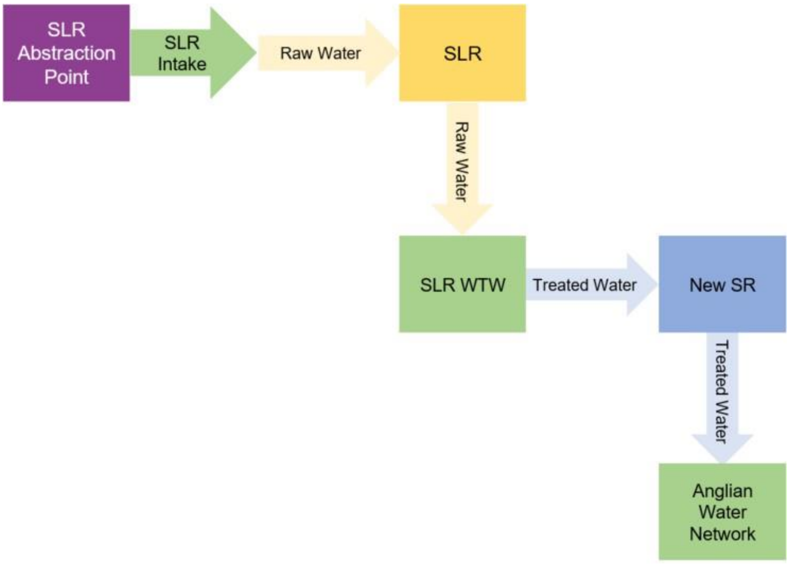
[1] B19589BJ-DOC-001 Rev 06 ACWG WQ Risk Framework Report – Final (Strategic WQ Risk Framework FINAL Report) | 19/01/21 | ACWG

1 Introduction

This Drinking Water Quality Risk Assessment Report accompanies the gate two submission to RAPID for the South Lincolnshire Reservoir (SLR) Strategic Resource Option (SRO). The report summarises the water quality risk assessment (WQRA) that has been undertaken for the SLR SRO, which has been updated from gate one using the most recent available water quality data.

The scheme includes the abstraction and treatment of water from SLR in the Anglian Water region, followed by delivery of treated water into a different receiving Anglian Water zone, where the water meets the final water quality requirements and is distributed to consumers. The option is illustrated in the following Figure 1.1.

Figure 1.1: Flow Diagram for the SLR SRO



SLR – South Lincolnshire Reservoir
WTW – Water Treatment Works
SR – Service Reservoir

Source: Mott MacDonald Ltd.

1.1 WQRA Process

The WQRA process has been developed by the All Company Working Group (ACWG) as a strategic semi-quantitative water quality risk assessment from source to consumer to determine the impact of new SRO schemes on drinking water quality. More specifically to this SRO, the SLR WQRA has been completed to assess the treated water quality risks associated with transfer of water from SLR (in the Anglian region) to a different Anglian Water recipient supply zone. This risk assessment would therefore help inform the design and development of the option and ensure no deterioration in the water quality of the supply zone. The WQRA has been undertaken using current knowledge of water quality and the judgement of water company experts who are familiar with the sources and supply zones. The WQRA process can continue to feed into the design process as the project continues.

The purpose of this report is to summarise the gate two WQRA process from methodology through to results. The ACWG Water Quality Risk Framework Report[2] has been used to guide the risk assessment and splits the WQRA process into 5 stages, as seen in Figure 1.2.

Figure 1.2: ACWG water quality risk process approach

Source: ACWG Strategic WQ Risk Framework Report

For gate two, relevant data was collected in the form of SRO monitoring data for the SLR catchment, and the knowledge of water quality experts for the receiving Anglian Water supply zone.

This information was built upon from the gate one surface water risk assessments (SWRAs). This updated data set was used to populate the WQRA for the SLR SRO and helped determine the relevant hazards. Following this, the risks of these hazards to drinking water safety were analysed and a draft WQRA for SLR was produced. An assessment team for reviewing the draft WQRA was then assembled, consisting of water quality representatives and project stakeholders from Anglian Water as well as the relevant engineering expertise from Anglian Water, Jacobs, and Mott MacDonald. The draft was assessed in a collaborative strategic WQRA workshop where option-specific hazards, their risk ratings and associated mitigation techniques were discussed and agreed upon. The outputs of the workshop included identification of any data gaps, residual risk considerations and a fully populated WQRA. Further to this, Mott MacDonald were subsequently included in alignment meetings with Anglian Water, at which the South Lincolnshire Reservoir (SLR) SRO WQRA and the Fens Reservoir SRO WQRA were reviewed against each other to ensure alignment of the respective methodologies.

In summary, the gate two WQRA for the SLR SRO has identified the need to review the proposed concept treatment design based on developing water quality data sets, and from the data available has identified that the key drinking water quality parameters requiring further analysis at future stages of development are poly and perfluorinated alkyl substances (PFAS), nitrate and consumer acceptability parameters. It should be noted that there are still data gaps, particularly with emerging hazards and therefore further analysis is required at gate three where possible. Sections 3 and 4 detail the actions to be completed for gate three that would allow for a more comprehensive understanding of the water quality risks going forward. The WQRA is an iterative process, and as further information becomes available and the schemes are developed further it is expected that the WQRA would be developed in greater detail.

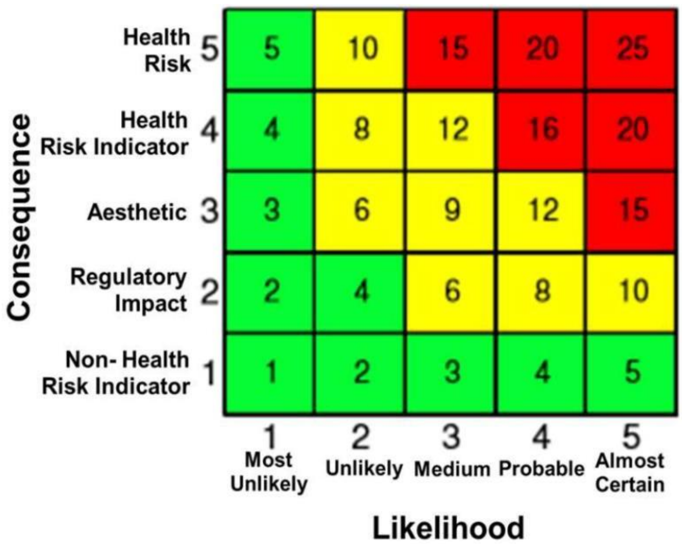
[2] B19589BJ-DOC-001 Rev 06 ACWG WQ Risk Framework Report – Final (Strategic WQ Risk Framework FINAL Report) | 19/01/21 | ACWG

2 Methodology

The process of undertaking the steps outlined in Figure 1.2 is detailed in sections 2.1–2.7. The steps taken to complete the SLR SRO WQRA have been guided and organised by the responsible lead technical author, Mott MacDonald. As suggested in the ACWG WQ Risk Framework Report, this party is responsible for collating and analysing water quality risk data to provide an initial draft of the WQRA for the SRO. This party is also responsible for convening the strategic water quality risk assessment workshop to review and develop the risk assessment. This review should be completed to the agreement of all water companies affected by the SRO. The framework states a WQRA should be completed for each materially different option at each RAPID stage gate, with the resulting risk assessment remaining a live document to eventually be overtaken by the development of a drinking water safety plan (DWSP) in line with DWI regulations.

The Strategic WQ Risk Framework provides guidance for completing the assessment of water quality risks based on existing water company risk assessment techniques. This has allowed for an easier integration of existing risk assessment data into the WQRA. For example, the approach outlined adopts a 5 x 5 matrix of hazard likelihoods and consequences, seen in Figure 2.1, that aligns with the scoring system used by water companies.

Figure 2.1: WQ risk framework 5 x 5 matrix



Source: ACWG Strategic WQ Risk Framework Report

A key consideration in the methodology recommends focussing on only the limiting hazards likely to affect the development of an option design. These limiting hazards are defined within the WQ Framework as:

"Hazards and hazardous events which are most likely to drive the development and/or acceptability and/or viability of the SRO or water supply scheme"

This definition has been produced in recognition of the need to complete a strategic, high level WQRA appropriate for the conceptual development of the SRO. As there are numerous waterborne pathogens and chemicals that could affect drinking water wholesomeness, as defined in The Water Supply (Water Quality) Regulations 2016[3] (The Regulations), the practical suggestion is to consider the few that are limiting. That is, where the magnitude of risks and their required mitigation determines the design of treatment. This allows for a more focussed assessment of risks, better aligned with the design development and data types and availability at early stages of RAPID gated analysis.

The methodology undertaken for this SRO follows the approach set out in the ACWG WQ Framework Report. It is anticipated that moving through future gates, the WQRA would continue to follow ACWG methodology as further information becomes available and the SLR SRO is developed.

To complete the risk assessment, a strategic WQRA was used to capture the risks associated with hazards across seven stages from catchment through to consumer. Each stage contains a pre-mitigated risk section and post-mitigated risk section, with space for suggested controls, residual risk considerations and actions. The results of the SLR SRO workshop can be seen in Appendix A.

2.1 Data Collection

To best inform the SLR SRO WQRA and support option design considerations, data relevant to the option catchment, abstraction location, distribution networks and consumer regions were collected.

A list of required data was produced and distributed to Anglian Water. DWSPs were not available for the exact abstraction zone, as the option involves new abstraction points. Raw water quality data collected as part of the SLR SRO monitoring programme developed following gate one was used to inform the stages upstream of the treatment stage of the WQRA.

For the receiving Anglian Water zones water quality expert knowledge was used to inform risk ratings post-treatment stage of the WQRA.

2.2 Development assessment team

The ACWG Risk Framework report states that an assessment team should be convened to include representatives from any water company affected by the SRO. Therefore, staff who provided information during data collection, had experience in water quality risk assessments or were involved in the conceptual design and intended operation of the SRO were invited to participate in reviewing the WQRA. Appropriate representatives from the water quality team were included in the assessment, as seen in Table 2.1, to ensure their insight was captured.

Table 2.1: Assessment team

Organisation	Attendee Role
Anglian Water	Water Quality Policy and Strategy Manager
Anglian Water	Water Quality Risk Manager
Jacobs	Treatment Design Engineer on behalf of Anglian Water for SLR WTW
Mott MacDonald	Senior Process Engineer
Mott MacDonald	Chartered Process Engineer
Mott MacDonald	Process Engineer and Workshop Lead

[3] The Water Supply (Water Quality) Regulations 2016 | 2016 No.614 | 26/05/16 | UK GOV

2.3 Engagement and liaison to gate two

Specific engagement activities undertaken for gate two can be seen in Table 2.2. It should be noted the WQRA process for the SLR SRO was completed in conjunction with the A2AT (Anglian to Affinity Transfer) SRO WQRA and the Fens Reservoir SRO WQRA, and therefore some engagement activities covered all three SROs.

Table 2.2: Engagement activities to gate two

Activity	Date	Organisation involved	Purpose
Pre-workshop meeting	22/06/2022	Affinity Water, Anglian Water, Jacobs, Arup, Mott MacDonald	To outline WQRA process and workshop expectations.
Data requests	Multiple	Anglian Water, Mott MacDonald	Updated DWSPs and water quality data requested to inform the WQRA draft ratings.
SLR SRO pre-workshop correspondence	Throughout	Anglian Water, Mott MacDonald	Set-up workshop outline /content
SLR Workshop	26/07/2022	Anglian Water, Jacobs, Mott MacDonald,	Conducting a review of the drafted WQRA for the SLR SRO.
SLR Workshop consolidation	24/08/2022	Anglian Water, Mott MacDonald	Consolidation session reviewing decisions made during the previous workshop and addressing any concerns from stakeholders not present at the first workshop.
SLR workshop alignment	30/08/2022	Anglian Water, Mott MacDonald	Alignment of the SLR SRO with other Anglian Water SROs.
Liaison with water quality teams	Throughout	Anglian Water, Mott MacDonald	Agreement of WQRA content.
Post workshop review	07/09/2022	Anglian Water, Mott MacDonald	WQRA developed in workshop sent to workshop attendees for final review and comments.

2.4 WQRA draft

Drafting the SLR SRO water quality risk assessment consisted of several stages and revisions to prepare it adequately for review in the workshop. The initial stage involved collecting and processing the water quality data, then inputting the draft likelihood ratings and finally ensuring the risk scores flowed appropriately across all seven WQRA stages from catchment through to consumer.

2.4.1 Consequence ratings

To ensure consistency across all stages and options in gate two, a list was produced that standardised the consequence ratings of each hazardous parameter. The ratings were based on information sourced from the WHO Guidelines for Drinking Water Quality[4] and followed the 5x5 risk matrix system of grading consequences.

The ratings were built on the assumption that the hazards were present above the limits set by The Water Supply (Water Quality) Regulations 2016, and the effects would therefore range from “non-health risk indicator” to “aesthetic” impacts to “health impacts” as shown in Figure 2.1. Where no limits were available from The Regulations, the consequence ratings were chosen assuming the hazard was present at a concentration high enough to attain the most severe consequence category possible as shown in Figure 2.1; for example, total organic carbon (TOC) has no specific limit in The Regulations other than a requirement for “no abnormal change”, but is an indicator for

[4] Guidelines for drinking-water quality: fourth edition incorporating the first addendum | 2017 | Geneva: World Health Organization | Licence: CC BY-NC-SA 3.0 IGO.

bacterial growth, and therefore earns a consequence rating of 4. This rating is for health risk indicators, because while TOC does not inherently classify as a “health risk”, it also does not cause purely “aesthetic” consequences. The standardised consequence ratings were then input into the SLR SRO WQRA.

It should be noted that at gate one, while metaldehyde was given a consequence rating of 5 in the draft WQRA, in the gate one workshop the water quality experts determined that metaldehyde concentrations seen in the water were not high enough to cause a health impact, but could still breach the DWI regulatory limit, so for gate one the metaldehyde consequence rating was adjusted to a 2 on the basis of it having no more than a “Regulatory Impact” (see Figure 2.1).

At gate two the water quality monitoring data showed that there has been no breach in DWI regulatory limit, so no change was made from gate one to the metaldehyde consequence rating. Further monitoring in the future may change this view.

2.4.2 Likelihood ratings

Following the consequence ratings, the draft likelihood ratings were determined based on the water quality monitoring programme data and water quality expert knowledge and input into the WQRA. Following this the ratings were then reviewed by water quality experts during the workshop meetings as listed in Table 2.2.

For certain parameters where no data was available, but the hazard was deemed limiting, assumptions were made as to likelihoods based on expert opinion. An example of this is the “Trihalomethanes (THMs)” parameter that was deemed low risk until the treatment stage where the likelihood would increase pre-mitigation as THMs are formed as a result of the disinfection process. Once mitigated through organics removal and careful consideration of the operation of the disinfection process the risk falls. Other parameters in the catchment that required expert opinion to score as no data was available included odour, taste, and viruses. There were several parameters with no data available in the abstraction stage and these were scored according to the method set out in Section 2.4.3.

For the catchment stage, water quality monitoring data from Anglian Water at the possible abstraction locations and expert judgment was used to assess the likelihood of a parameter breaching The Water Supply (Water Quality) Regulations 2016 limits. In addition, Anglian Water has Target Supply Standard (TSS) limits, which in some instances are stricter than the limits imposed by The Water Supply (Water Quality) Regulations 2016. The likelihood scoring was based on how often the parameter historically breached The Water Supply (Water Quality) Regulations 2016 and TSS limits on an annual basis.

Where possible, likelihood ratings in the treatment stage were reduced between pre- and post-mitigation based on expert opinion to determine the effectiveness of control measures on hazard reduction. These assumptions were also applied during the WQRA drafting stage of gate two, with the knowledge they would be reviewed and agreed upon in the WQRA collaborative workshop.

Combined with the standardised consequence ratings, the likelihood ratings populated the WQRA with overall risk scores for each parameter at every stage.

2.4.3 Data flow

Having populated the risk assessment with risk scores, gaps in data for certain stages or variations in scores between adjacent stages were evident. Therefore, to ensure a sensible flow of risk scores from catchment through to consumer, where no data was available for a particular stage of the WQRA, the risk rating was carried forward from an upstream stage where this data was available e.g., raw water conveyance stage. Furthermore, for parameters where risk ratings increased from an upstream to a downstream stage the transition was retained and discussed in the workshop. For example, it was discussed in the workshop that there is an elevated risk in the Anglian Water distribution network of dirty/discoloured water as a result of increased flow velocity and flow direction changes due to unplanned network activity. Therefore, the parameter likelihood increased after the treatment stage of the WQRA in the distribution stage.

2.4.4 Limiting hazards

An initial review of the SLR SRO indicated that at a minimum, the hazardous parameters that should be considered for analysis in the WQRA included pathogens, cryptosporidium, turbidity, pesticides, and metals as these parameters are key to developing the design of a water treatment works.

Following this, the ACWG Water Quality Risk Framework Report recommends including limiting hazards from the following groups seen in Table 2.3:

Table 2.3: WQ risk framework: limiting hazard categories

Type of SRO -> Likely limiting hazards	Reservoir source	Ground water source	Influence of sewage	Raw water transfer	Treated water transfer
Pathogens – e.g. Cryptosporidium, viruses	✓	✓	✓	✓	✓
Emerging hazards – e.g. nitrosamines, 1,4-dioxane, PFAS	✓	✓	✓		
Acceptability due to change in chemistry – e.g. alkalinity	✓	✓	✓	✓	✓
Acceptability - taste and odour	✓	✓	✓	✓	✓
Pesticides – e.g. metaldehyde	✓		✓	✓	
Nitrate/Nitrite		✓	✓	✓	
Corrosion potential					✓
Change in metal types and form	✓	✓		✓	
Disinfection byproduct formation potential	✓		✓	✓	✓

Source: ACWG Strategic WQ Risk Framework Report

Taking at least one limiting hazard from each of these categories to ensure each category was represented, an initial set of limiting hazards was developed in conjunction with the available data.

Additionally, any further SLR SRO-specific water quality hazards deemed likely to drive the development and/or acceptability and/or viability of the SRO or water supply scheme were then assessed. These limiting hazards were determined using water quality monitoring data sets and water quality expert knowledge during the workshops. By choosing parameters that were either high risk in the water quality monitoring suite, above The Water Supply (Water Quality) Regulations 2016 limits, above Anglian Water TSS limits, or could not be mitigated by the treatment technology required for another limiting hazard, a further set of the key parameters for the SLR SRO was produced. These full list of limiting hazards is shown in Table 2.4 below. The limiting hazards were reviewed and confirmed during the collaborative WQRA workshop, utilising the expert knowledge of workshop attendees.

Table 2.4: Limiting hazards

Limiting Hazard	Category	Justification
Coliform bacteria	Pathogen	Standard limiting hazard covering pathogens and is considered the most suitable indicator of faecal contamination. Coliform bacteria drives the development of the water supply scheme as it is an indicator of health risks.
Cryptosporidium	Pathogen	Limiting hazard because the parameter is a microbiological contaminant uniquely treated. Cryptosporidium is likely to drive the development of the water supply scheme due to associated high health risks. Traditional methods of pathogen treatment are not effective against cryptosporidium.
Iron	Change in metal types and form	Naturally occurring limiting hazard requiring removal. Iron is likely to drive the development of the water supply scheme due to natural abundance in the catchment.
Manganese	Change in metal types and form	Naturally occurring limiting hazard requiring removal. Manganese is likely to drive the development of the water supply scheme due to natural abundance.
Bromide	Disinfection by-product formation potential	Bromide is not a health concern itself, but harmful bromide-related by-products (such as bromate) can be formed through the oxidation and disinfection processes, so bromide is a limiting hazard to ensure this risk is considered when selecting treatment processes.
Sulphate	Acceptability and Corrosion	Limiting hazard because sulphate is likely to drive the acceptability of the water supply scheme by consumers due to its effect on taste. Possibility of sulphate concentrations changing and impacting on water perception when water is supplied from a new catchment. A combination of sulphate, chloride and alkalinity is used to determine the Larson-Skold index corrosivity indicator. Close control of Larson-Skold index is therefore required.
Bromate	Disinfection by-product formation potential	By-product of ozonation of bromide. As ozonation is considered as part of the treatment train it is a limiting hazard as it impacts design considerations for the oxidation and disinfection processes.
Lead	Change in metal types and form	Lead is a health risk and is most likely to occur in drinking water as a result of plumbosolvency issues in the distribution network. Chosen as a limiting hazard because lead is likely to drive the requirement for orthophosphate dosing (where orthophosphate is a measure for plumbosolvency control).
Trihalomethanes (THMs)	Disinfection by product formation potential	Limiting hazard because parameter is likely to drive the viability of the water supply scheme due to introduction of disinfection by-product (DBP) health risks. DBPs could be formed through the disinfection process at the new water treatment works, so careful selection of disinfection process is required.
Nitrate	Nitrate/Nitrite	Limiting hazard requiring removal as nitrate is likely to drive the development/viability of the water supply scheme due to associated health risks and formation potential of nitrite.
Nitrite	Nitrate/Nitrite	Limiting hazard requiring removal as nitrite is likely to drive the development/viability of the water supply scheme due to associated health risks.
Pesticides (total)	Pesticides	Limiting agricultural chemical hazard requiring removal. Pesticides are likely to drive the development/viability of the water supply scheme due to associated high health risks.

Limiting Hazard	Category	Justification
Propyzamide	Pesticides	Limiting agricultural chemical hazard requiring removal. Pesticides are likely to drive the development/viability of the water supply scheme due to associated high health risks.
Metaldehyde	Pesticides	Metaldehyde is selected as a limiting hazard because it is recognised as being particularly challenging to remove from water. Therefore, it could drive the treatment process selection.
1,2-dichloroethane	Chemical hazard	1,2-dichloroethane is selected as the standard limiting hazard covering solvents. 1,2-dichloroethane is likely to drive the development of the water supply scheme due to being a health risk.
Benzo(a)pyrene	Chemical hazard	Benzo(a)pyrene to be limiting hazard covering hydrocarbons and requiring removal. Limiting hazard because parameter is likely to drive the development of the water supply scheme due to associated high health risks. Additionally, there is a risk of uptake of benzo(a)pyrene from the coal, tar or bitumen linings of the pipes in the distribution network.
Dirty/discoloured water	Acceptability	Limiting hazard because parameter is likely to drive acceptability of water supply scheme by consumers and therefore requires adequate treatment and mains conditioning flows.
Odour	Acceptability	Limiting hazard because parameter is likely to drive acceptability of water supply scheme by consumers and therefore requiring treatment. The transfer of water from a different Anglian Water zones could lead to customers experiencing a change in perception of their water therefore, it is assumed that odour is a key factor in the requirement for final water conditioning.
Taste	Acceptability	Limiting hazard because parameter is likely to drive acceptability of water supply scheme by consumers and therefore requiring treatment. The transfer of water from a different Anglian Water zone could lead to customers experiencing a change in perception of their water, therefore it is assumed that taste is a key factor in the requirement for final water conditioning.
Change in hardness/alkalinity	Acceptability and Corrosion	Limiting hazard because parameter is likely to drive the acceptability of the water supply scheme by consumers. Catchment hardness and alkalinity may be different to that in the consumer region and therefore water supply may require conditioning, as well as a comprehensive customer engagement plan to address residual concerns over change in water supply that cannot be treated or removed. A combination of sulphate, chloride and alkalinity is used to determine the Larson-Skold index corrosivity indicator. Close control of Larson-Skold index is therefore required.
Geosmin/2-Methylisoborneol (MIB)	Acceptability	Geosmin is an algal by-product and is a limiting hazard because it can lead to taste and odour issues affecting customer acceptability.
Change in source type (e.g. Groundwater - surface)	Acceptability	Limiting hazard because parameter is likely to drive the acceptability of the water supply scheme by consumers. The transfer of water from a different Anglian Water zone could lead to customers experiencing a change in perception of their water, therefore it is assumed that this parameter is a key factor in the requirement for final water conditioning as well as a comprehensive customer engagement plan to address residual concerns over change in water supply that cannot be treated or removed.
Pathogens – Bacteria, Viruses, Protozoa	Pathogens	This parameter is to be a standard limiting hazard covering viruses and therefore requiring disinfection. Viruses are likely to drive viability of water supply scheme due to associated health risks.
Total organic carbon	Disinfection by-product formation potential and Pathogens	Limiting hazard because parameter is likely to drive the development/viability of the water supply scheme and therefore requires removal (e.g. activated carbon or membrane filtration). Total organic carbon (TOC) can be a factor in DBP formation and is an indicator for bacterial growth and therefore introduces associated health risks. Additionally, if the chlorine residual post-treatment is low, TOC could be a factor in biofilm growth in the network downstream of the WTW.

Limiting Hazard	Category	Justification
Invasive Non-Native Species (INNS)		With any raw water transfer there is a risk of transfer of non-native species. INNS is included as a limiting hazard to drive the development of treatment processes to ensure the risk of INNS transfer is mitigated.
Chloride	Acceptability and Corrosion	Limiting hazard because chloride is likely to drive the acceptability of the water supply scheme by consumers due to its effect on taste. Possibility of chloride concentrations changing and impacting on water perception when water is supplied from a new catchment. A combination of sulphate, chloride and alkalinity is used to determine the Larson-Skold index corrosivity indicator. Close control of Larson-Skold index is therefore required.
Radioactivity (Alpha, Beta, Tritium)	Emerging hazard	Limiting hazard because parameter can cause a health risk to consumers, and therefore requires removal.
Turbidity	Pathogens and acceptability	Turbidity is likely to drive the development of the water supply scheme, specifically plant design and operability. The turbidity of the water needs to be below 1.0 NTU when it enters the disinfection process to comply with DWI Regulation 26. It is also likely to drive the acceptability of the water supply scheme by consumers and therefore requires removal.
Algae	Acceptability	Limiting hazard because parameter can impede the effectiveness of the clarification and filtration processes, and also can have an impact on customer acceptability.
DBPs (Disinfection by-products)	Disinfection by product formation potential	Limiting hazard because parameter is likely to drive the viability of the water supply scheme due to introduction of DBP health risks. DBPs could be formed through the disinfection process at the new water treatment works, so careful selection of disinfection process is required.
PFAS	Emerging hazard	Limiting hazard because parameter is emerging hazard of concern. Present in the South Lincolnshire Reservoir catchment area at the River Witham and River Trent.
PFOS	Emerging hazard	Limiting hazard because parameter is emerging hazard of concern. Present in the South Lincolnshire Reservoir catchment area at the River Witham and River Trent.
PFOA	Emerging hazard	Limiting hazard because parameter is emerging hazard of concern. Present in the South Lincolnshire Reservoir catchment area at the River Witham and River Trent.
Aluminium	Change in metal types and form	Limiting hazard because choice of coagulant during the concept design is an aluminium coagulant.

2.5 Strategic WQRA draft

The WQRA workshop process is summarised as follows:

1. Introduction to WQRA and summary of water supply scheme
2. Identification of a limiting hazard
3. Assigning a pre-mitigated risk score (both likelihood and consequence)
4. Identify the recommended mitigations
5. Assigning a post mitigated risk score (both likelihood and consequence), and
6. Detailing any residual risk considerations

The ACWG guidance states a collaborative workshop between all SRO stakeholders should be completed to fulfil the recommendation outlined in Section 7 (RAPID) of the DWI Guidance Note on Resilience of Water Supplies in Water Resources Planning[5]. The first iteration of this workshop contained high level analysis of the risks associated with the option and the gate two iteration built upon this with more detailed analysis, using updated data sets and a team of experts with a more developed understanding of the SLR SRO.

The workshop began with an introduction to water quality risk assessments and a summary of the SLR SRO. The WQRA methodology and updates since gate one were discussed and the SLR SRO WQRA was reviewed in a grid format (the WQRA itself can be seen in Appendix A, and from this changes from gate one to gate two can be seen). The first step of the WQRA involved a data review to confirm if the data collected was representative of the actual hazards present.

Next, the WQRA was filtered to show limiting hazards chosen during drafting. The list of limiting hazards was discussed and agreed to be representative of the water quality risks faced by the scheme. At the beginning of the workshop any limiting hazards which were previously not considered (such as aluminium) were agreed as they were deemed by those present to likely drive the development and acceptability of the scheme. They were then included as limiting hazards.

Having identified the relevant limiting hazards, the draft likelihood scores of all parameters were then reviewed across all stages. Where necessary, scores were updated based on attendees' expert opinions. During this likelihood review, appropriate control measures were discussed for each limiting hazard and updated accordingly. Where applicable, residual risk considerations were noted, and actions listed. These actions detailed the treatment technologies to be considered in the option design and where further information is required for WQRA analysis at gate three.

2.5.1 Key workshop conclusions

The key conclusions of the workshop were:

- Further water quality data is required for the gate three WQRA, particularly from the SLR abstraction locations.
- The workshop identified that customer engagement during the RAPID gated process would be key in reducing the risk of acceptability issues. Consumer research for changes in source type is ongoing and the results can tie into the gate three drinking water quality risk assessment process.
- Chloride, sulphate, and alkalinity need to be considered in the risk analyses as they are foundational in understanding the Larson-Skold index.
- Removal or inactivation of cryptosporidium to Anglian Water standards should be considered in the SLR SRO treatment design. The SLR is expected to provide sufficient attenuation of

[5] Guidance Note: Resilience of Water Supplies in Water Resources Planning | Long Term Planning for the Quality of Drinking Water Supplies | Guidance to water companies | July 2021 | Drinking Water Inspectorate

cryptosporidium in conjunction with the treatment process outlined in the gate two concept design.

- For DBPs and THMs, disinfection process operational parameters need to be carefully considered at gate three of the drinking water quality assessment process to ensure low likelihood of formation.
- Nitrate/nitrite removal would need to be carefully considered as part of the treatment process design to achieve PCV level requirements.
- Continuous monitoring of emerging hazards particularly PFAS including PFOS and PFOA needs to continue to assess the need for dedicated treatment at SLR WTW.
- Aluminium was considered as a limiting hazard due to the choice of coagulant in the treatment works concept design. As such, careful consideration of dosing would be required in the design.
- According to the discussions by water quality experts there are dirty/discoloured water risks associated with iron and/or manganese deposits in the distribution network. These existing risks are currently monitored and managed and would be continuously monitored with the addition of the SLR SRO. They are reflected in the medium scores given to iron, manganese, and dirty/discoloured water in the distribution stage through to the consumer stage.
- For customer acceptability parameters such as odour, taste and changes in source type, the risk likelihood post-treatment was not reduced to 1 and remained an amber risk through to the consumer stage of the WQRA. This is as a result of uncertainty around customer acceptability, as it is unlikely there would be immediate categorical acceptance of the change in water after the SRO is implemented. As customer engagement continues through the RAPID gated process it is expected that the risk for customer acceptability parameters would reduce, which can then be reflected in future WQRAs.
- Further consideration is required as to which Anglian Water Public Water Supply Zones the SRO is applicable to, due to the current assumption that it is entering a free-chlorinated zone. Should the water be transferred to a chloraminated zone, chloramination would be required, and this would have to be reflected at future stages of the RAPID gated process.

2.6 Key assumptions and uncertainties

In order to progress the water quality risk assessment through gate two, several assumptions had to be made. These assumptions are summarised below.

- It has been assumed the SRO water quality monitoring programme is a suitable gate two representation of water quality at the proposed new SLR abstraction points at the River Trent and River Witham (it should be noted that the abstraction locations may change as the project progresses).
- Having assumed the data collected was reflective of the water quality risks, it was then presented during the collaborative strategic workshop for review. It was assumed that the suggestions made by the water quality experts present were accurate and the WQRA scorings were updated accordingly. Where possible, these updates were noted in the comments section of the WQRA (see Appendix A).
- When drafting the WQRA, as discussed in Section 2.4.4 a list of limiting hazards applicable to the SRO was produced. It was assumed this list sufficiently covered the minimum limiting hazard assessment requirements outlined in the ACWG WQ Framework. This was then discussed in the WQRA workshop, and an opportunity was given to the water quality experts present to highlight any further limiting hazards of concern. The only known parameter group that has not been fully analysed in gate two is the ‘emerging hazards’ category, which is discussed further in Section 3.8.

- Where appropriate, as discussed in Section 2.4.3, the available water quality risk data was merged to ensure a coherent flow in risks from catchment through to consumer. As some data sets were not available, particularly in the abstraction stage, expert opinion was instead used to review how risks changed throughout the system. It is assumed that as more data becomes available, as discussed in Section 3.10, the need for data merging would reduce.
- Metaldehyde was included in the gate two analysis as a limiting hazard due to it currently being a high-risk agricultural chemical. However, it has been prohibited from the end of March 2022 and so it is assumed that by the time this SRO is implemented metaldehyde would be a less relevant hazard. Nonetheless, despite it being prohibited, it cannot be guaranteed that metaldehyde levels in the catchment would drop, as there is a risk that reserve stores may still be used, and long-term persistence in the environment is unknown. Therefore, this should still be considered in future WQRAs based on monitoring data.
- At this stage in the RAPID gated process, it is assumed that the receiving Anglian Water consumer zone will be a free chlorine zone. This is to be reviewed as the SRO progresses to gate three.

2.7 Check outputs

By reviewing and agreeing on data sources in the strategic WQRA workshop, it is assumed that all the appropriate and available water quality risk information has been identified. Where data is yet to be drawn into the assessment, this has been noted in Section 3.10 with the aim of filling the identified data gaps for gate three. These data gaps have been communicated for inclusion in the SRO water quality monitoring programme. The water quality risk assessment itself has been used to confirm that changes may be needed to the gate two concept treatment design, as discussed in Section 3.

3 Discussion of initial assessment results

The gate two WQRA has identified the need to review the proposed concept treatment design based on developing water quality data sets. Building on the key workshop conclusions listed in the Section 2.5.1 several considerations need to be made, which may impact the concept design, as the option progresses through the RAPID gated process. These considerations are discussed in Section 3.1 - 3.10.

Considering the iterative nature of the risk assessment, supplementary data may reveal updated risks from limiting hazards and this would feed into updated design considerations. Therefore, a key outcome from the initial assessment is that as more information becomes available the additional data would be used in future WQRAs. Analysis of emerging hazards is also imperative moving forward to gate three and is discussed further in Section 3.8.

The SLR SRO WQRA reviewed during the strategic workshop can be found in Appendix A. This document summarises the flow of risks from catchment through to consumer and highlights the limiting hazards that should be considered and researched as the treatment design progresses through the RAPID stage gates.

3.1 Risk Level Change

SLR would provide a new source of drinking water, and therefore implementation of the SLR SRO would result in Anglian Water customers receiving water from a different source at their taps. This new water would have different properties to that currently received, and therefore there would be an inherent change in the probabilities associated with many of the hazards, and therefore a change in risk level. Active management of these hazards through public engagement throughout the scheme development would be required to ensure that the risk of change in customer acceptability of the water is minimised. A key part of the DWI definition of water wholesomeness is that the water be acceptable to consumers, so public engagement to minimise the risk of changes to customer acceptability would be a crucial aspect of option development.

3.2 Customer Acceptability

There is likely to be a change in customer perception of the water as a result of scheme implementation. Odour, taste, changes in hardness/alkalinity and changes in source type are all included in the WQRA as limiting hazards which mainly impact customer acceptability. These hazards may occur as a result of the change of supply source. Therefore, customer engagement is required to minimise the likelihood of consumer rejection.

A current assumption of the SLR SRO is that the treated water is disinfected using ultraviolet (UV) irradiation followed by addition of a free chlorine residual. However, it was discussed in the workshop that there is the possibility of some water being transferred into a chloraminated Anglian Water Public Water Supply Zone. Water with a free chlorine residual cannot enter a chloroaminated zone without undergoing a chloramination process. Further consideration as the option progresses through the RAPID gated process needs to occur and be reflected in the WQRA at subsequent stages if there is a plan to deliver to a chloraminated zone.

Initially for gate one, for customer acceptability parameters a medium risk was retained across the distribution and consumer stages pre-mitigation, where customer engagement as a mitigation reduced the risk to a low risk. However, at this stage in the gated process it was decided in the workshop to increase the likelihood risk to a 2 to retain a medium risk rating at the consumer stage post mitigated control. This was decided based on feedback from the DWI where it was suggested that it is unlikely there would be an immediate categorical acceptance of the change in water after the SRO is implemented. The likelihood risk occurring is to be reviewed at future gates based on the proposed continuous customer engagement.

3.3 Corrosivity

A change in water source as proposed can lead to a change in corrosivity of the water. Anglian Water representatives indicated that chloride, sulphate, and alkalinity need to be considered in the risk analyses as they are foundational in understanding the Larson-Skold index. This index is used by Anglian Water as an indicator of corrosivity in the network and therefore tracing these three parameters is an important aspect to reduce corrosion of galvanised iron pipes in the network. This requirement would be confirmed in detailed design but is proposed at the new SLR water treatment works (WTWs).

3.4 Cryptosporidium removal

Due to water quality events highlighted during the gate one workshop, removal or inactivation of cryptosporidium must be achieved to Anglian Water standards. This is to be accomplished through using a combination of treatment at the WTW and reservoir storage at SLR. It was discussed and agreed that the reservoir storage would provide sufficient attenuation of cryptosporidium in conjunction with the treatment process outlined in the concept design to achieve the required removal without the need for advanced treatment.

3.5 Nitrates and nitrites

The need for nitrate/nitrite treatment was reviewed in the workshop. It was decided that further investigation on nitrate levels needed to occur, as nitrate in the catchment at the River Trent, River Witham and River Bain exceeded The Water Supply (Water Quality) Regulations 2016 levels on multiple occasions. In the workshop it was discussed that there is a potential for blending and buffering in the SLR reservoir. However, it was also decided that the risk likelihood would not be reduced in the upstream stages from treatment as the extent of the buffering/blending was not certain.

The need for nitrate treatment at the treatment stage of the WQRA was also reviewed in the workshop. At this stage in the RAPID gated process nitrate removal is not proposed as part of the concept design for the water treatment works. However, it was decided that modelling and further study is required at future gates to determine if treatment is required. The WQRA was updated to include a medium water quality risk post-treatment to the consumer stage due to the uncertainty of the risk being fully mitigated. It was clearly stated that as the gated stages progress this risk would be reduced to green at consumer stage and that the level at the final water sample tap at the WTW must be compliant with the nitrate PCV (see Appendix A).

3.6 Metaldehyde

As of March 2022, metaldehyde use has been prohibited. As at gate one it was discussed in the workshop that the assumption that metaldehyde use will stop cannot be made, and also the risk of legacy metaldehyde within the catchment is not currently understood. As such metaldehyde remained a limiting hazard. It was recommended in the workshop that water quality monitoring be continued to check levels of metaldehyde and the need for removal to be reviewed at future gates through processes such as UV AOP (ultraviolet advanced oxidation process).

3.7 Poly and perfluorinated alkyl substances (PFAS)

Poly and perfluorinated alkyl substances (PFAS) are a large group of manufactured organofluorine chemicals that have a wide range of industrial applications. Two examples of PFAS chemicals are PFOS (perfluorooctane sulphonate) and PFOA (perfluorooctanoic acid). They are widely used, bioaccumulate, are not readily biodegradable and are known to have high impact on human health. In accordance with recently published regulatory DWI guidance, PFAS have been highlighted as a particularly significant emerging hazard.

DWI guidance classifies PFAS (including PFOS and PFOA) into three tiers: Tier 1 is <0.01 µg/l, Tier 2 is <0.1 µg/l and Tier 3 is > or equal to 0.1 µg/l. PFAS levels between 0.01 µg/l and 0.1 µg/l are considered risks and are to be highlighted as drinking water quality risks to the wholesomeness of consumers' supply. Guidance from the DWI also introduced 47 PFAS compounds for analysis. An investigation into the full 47 compounds is currently underway, therefore there is uncertainty surrounding the risk of PFAS in the catchment.

During the workshop a consensus was reached to keep the PFAS, PFOS and PFOA risk ratings as 'medium' up to the treatment stage of the WQRA due to uncertainty and need of further monitoring data. Additionally, Anglian Water (in line with PFAS risk assessments that Anglian Water have carried out for other surface water WTWs) would assume that this would be a medium risk site. At the time of the workshop the data sets available were not extensive and further monitoring alongside the investigation into the 47 compounds is to be continued through gate three.

The proposed concept design for the treatment stage which includes granular activated carbon (GAC) may be effective at removing PFAS thus reducing the likelihood of additional treatment being required as discussed in the workshop. The water quality sampling programme and future DWI research into PFAS treatability can continue to inform any further design requirements. As the SRO scheme progresses through the RAPID gated process, a PFAS risk assessment can be developed for the SLR catchment in accordance with DWI information letter - IL 03/2022[6] which can inform the concept design at gate three and be reflected in the water quality risk assessment.

3.8 Emerging hazards

Data available for the SLR SRO was analysed at gate two, which included PFAS (specifically PFOS and PFOA) (Section 3.7), beta radioactivity, and chromium hexavalent. The data used to produce the list of limiting hazards did not raise any parameters as being of concern, however the data available is limited. As stated in Section 3.7 any emerging information with respect to the sample data, alongside future DWI guidance on PFAS would inform the WQRA and concept design through the gated process. Emerging hazards can continue to be monitored, therefore if the water quality monitoring programme determines that there are emerging hazards of concern, they can be assessed in the WQRA at future gated stages.

It should also be noted that DWI guidance on long term planning for the quality of drinking water supplies[7] recognises other enduring or emerging risks such as geosmin/MIB, endocrine disrupting chemicals, pharmaceuticals, personal and domestic care products. Any new DWI guidance or ACWG strategy for analysing emerging hazards should be reviewed and incorporated at future gates and the water quality monitoring programme extended accordingly.

3.9 DBPs

Following on from gate one careful consideration is still needed regarding disinfection by-product formation trihalomethanes (THMs) formation. The current concept design proposes UV disinfection followed by a chlorine residual to allow a measurable residual to be maintained in the network. However, it was identified in the workshop that the balance of UV disinfection strength vs chlorination dose has not been evaluated and would impact THM and DBP formation.

[6] Information Letter 03/2022 PFAS guidance | March 2022 | Drinking Water Inspectorate

[7] Guidance note | Long term planning for the quality of drinking water supplies | Guidance to water companies | September 2022 | Drinking Water Inspectorate

Therefore, this should be studied further and the risk at the treatment stage in the WQRA reviewed at gate three.

3.10 Additional data requirements

After the WQRA workshop the monitoring programme was aligned with the list of limiting hazards such that the applicable limiting hazards (or indicators thereof) were included. Data is required for the limiting hazards at the water sources to confirm and refine the information presented in the WQRA. Following gate two the monitoring programme can continue monitoring the water quality parameters for SLR abstraction through to gate three.

4 Further work plan and summary

4.1 Water quality monitoring activities

Section 3 summarises additional considerations required for an updated WQRA, and by extension an updated design required moving forward to gate three, potentially including nitrate/nitrite removal and PFAS removal considerations to meet water quality standards. The SRO water quality monitoring programme, undertaken in agreement with the Environment Agency and Natural England, was initially implemented at gate one to capture water quality data required at key abstraction locations, and is ongoing.

Additional water quality monitoring requirements for emerging hazards (including 47 PFAS compounds) has been included in the monitoring programme. This monitoring programme is to be continued through to gate three. As discussed in Section 3.10 the monitoring programme has been aligned with the list of limiting hazards to ensure all limiting hazards are included. These data sets are recommended to be used to inform the gate three water quality risk assessment and to resolve the data gaps highlighted during the gate one and gate two processes, apart from some emerging hazards as discussed in Section 3.8.

4.2 Future engagement

As options are further developed and a greater understanding of water quality risks is available, it could become appropriate to undertake further WQRA workshops where additional SRO stakeholders may be invited to attend for their input on option development. Future engagement would also include liaising with DWI to ensure feedback on risks considered are in line with current policies and recommendations. Water quality representatives can continue to be included to ensure that the design is developed in line with their expert knowledge and latest updates to water company policies.

4.3 Summary

A WQRA was developed to identify key hazards associated with the SLR SRO, and their risk across the seven WQRA stages of catchment, abstraction, raw water conveyance, treatment, storage, distribution and consumer. The WQRA assessment team included water quality representatives, as well as the relevant engineering expertise such as the treatment design engineer. The WQRA was reviewed and agreed at a collaborative workshop.

Key outcomes from the workshop were that it should be considered whether nitrate treatment or additional PFAS (including PFOS and PFOA) treatment are required in the treatment process. Further water quality monitoring data can be used at gate three to help determine these treatment requirements.

Further to this it was found that consumer acceptability is a key risk when transferring water. For SLR there is a risk to consumers associated with the change in water source. This risk is applied to taste, odour and other aesthetic limiting hazards. The risk can be reviewed and updated as the design progresses. Customer engagement will be important as the scheme develops.

Additionally the requirement for ongoing water quality monitoring and further stakeholder engagement, including the Drinking Water Inspectorate, has been identified.

A. Water Quality Risk Assessment

South Lincolnshire Reservoir

SLR WQRA, Gate 2

Catchment | Abstraction | Raw water conveyance | Treatment | Storage | Distribution | Consumer

Data source and certainty input	Limiting Hazard	Parameter details and commentary	Pre-mitigated Likelihood	Pre-mitigated Consequences	Risk	Risk Commentary	Control	Post mitigated Likelihood	Post mitigated Consequences
Cryptosporidium	Y	Gate 2: Present in SLR catchment and is assumed to be a limiting parameter requiring treatment (e.g. through coagulation and RGF, UV). SLR catchment area shows cryptosporidium instances in 2021-2022 with a maximum of 0.3 no/l in Considered a limiting hazard as microbiological contaminant is uniquely treated. Has associated high health risks which drive development of water supply scheme as traditional methods of treatment are not effective. Gate 1: Present in SLR catchment and is assumed to be a limiting parameter requiring treatment (e.g. through RGF, UV, or membrane filtration).	5	5	25	Gate 2: A consequence rate of 5 retained from gate 1. Present in the River Witham Langrick bottom therefore risk rating of 5 is assumed as it breaches PCV (0 no/l).	-	5	5
Coliform bacteria	Y	Gate 2: No change from gate 1. Gate 1: Present in SLR catchment and is assumed to be a limiting pathogen requiring disinfection.	5	5	25	Gate 2: A consequence rating of 5 retained from gate 1. This is because coliform are bacteria present at multiple instances breaching PCV (0 no/l). Presence reported at River Trent at Gunthorpe, River Trent at Kings Marina, River Witham Langrick Bottom	-	5	5
Iron	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Manganese	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bromide	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sulphate	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bromate	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lead	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Trihalomethanes	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nitrate	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nitrite	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pesticides: total	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Propyzamide	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Metaldehyde	Y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Benzo(a)pyrene	Y	Gate 2: There is a risk of uptake of benzo(a)pyrene and other PAHs from the coal/tar and bitumen linings of the pipes in the distribution network. Gate 1: Present in SLR catchment and is assumed to be a limiting parameter requiring removal (e.g. through clarification and RGF, or through membrane filtration).	1	5	5	Gate 2: Risk likelihood changed to 1 SLR catchment data shows below detection limit for benzo(a) pyrene	-	1	5
1,2 dichloroethane	Y	Gate 2: No change from gate 1. Gate 1: Solvents are present in SLR catchment, and it is assumed for Gate 1 that 1,2 dichloroethane is a limiting solvent requiring treatment.	3	4	12	-	-	3	4
		Gate 2: If typically operated at lower flows, then during drier periods with steep ramp-up then conditioning of the mains could be required.	5	3	15			5	3

Dirty/discoloured water

Parameter		Comments			Score					Score	Mitigation	
Odour	Y	Gate 1: The new water source could lead to customers experiencing a change in perception of their water, hence it is assumed that odour is a key factor in the requirement for selection of treatments at the new SLR WTW. Gate 2: No change from gate 1	5	3	15	-	-	5	3	15	Gate 2: Parameter will be managed by SLR water treatment works	-
Taste	Y	Gate 1: If water with a free chlorine residual is introduced into an area with chloraminated water (or vice versa) it could lead to customers experiencing a change in taste of their water, hence it is assumed that taste is a key factor in the requirement for selection of treatments at the new SLR WTW.	5	3	15	-	-	5	3	15		-
Geosmin/2-Methylisoborneol (MIB)	Y	Gate 2: No change from gate 1. Gate 1: Algal by-product that could be formed as a result of algal growth in SLR. SLR catchment data not indicative of geosmin/MIB presence	3	3	9	-	-	3	3	9	Gate 2: Parameter removed through GAC and ozonation at SLR WTW. Gate 1: Parameter will be removed (e.g. through activated carbon or UV AOP) at the new SLR WTW (see Treatment section of this WQRA).	-
Change in hardness/Alkalinity	Y	Gate 2: No change from gate 1. Gate 1: New water source is likely to cause a change in hardness and alkalinity. However, the new source is a surface water source which will supply existing surface water receiving zones, so this is not as great a risk as a change of source from surface water to a groundwater zone.	5	3	15	-	-	5	3	15	Gate 2: To be managed by new SLR treatment works	-
Change in source type (e.g. surface - groundwater)	Y	Gate 2: No change from gate 1. Gate 1: The SLR would be a new water source.	1	3	3	-	-	1	3	3	-	-
Pathogens - Bacteria, Viruses, Protozoa	Y	Gate 2: No change from gate 1. Gate 1: Present in SLR catchment, and is assumed to be a limiting factor requiring disinfection.	5	5	25	-	-	5	5	25	Gate 2: No change from gate 1. Gate 1: Parameter will be treated by disinfection (e.g. chlorine or UV) at the new SLR WTW (see Treatment section of this WQRA).	-
Total Organic Carbon (TOC)	Y	Gate 2: No change from gate 1. Gate 1: Present in SLR catchment and is assumed to be a limiting parameter requiring reduction (e.g. activated carbon or membrane filtration). Organic carbon increases the formational potential of DBPs and therefore introduces associated health risks.	5	4	20	-	-	5	4	20	Gate 2: No change from gate 1. Gate 1: Parameter will be treated by disinfection (e.g. chlorine or UV) at the new SLR WTW (see Treatment section of this WQRA).	-
Invasive non native species (INNS)	Y	Gate 2: No change from gate 1. Gate 1: The development of the new SLR could create a risk of INNS because of the potential for compensation flows from the SLR. Additionally the species constituting INNS will be treated at the new SLR WTW. INNS is not a drinking water quality risk, and is being considered in the environmental risk assessment.	5	1	5	Gate 2: SLR is within the Witham catchment, so low risk of transfer between basin to basin. Gate 1: Depending on the construction of the new SLR there may be a pathway for INNS.	Gate 2: There is INNS management at the River Trent abstraction to the River Witham. Gate 1: Consideration must be given to compensation flows in the construction of the new SLR	5	1	5	Gate 2: No change from gate 1. Gate 1: Parameter will be removed (e.g. through clarification and RGF, or through membrane filtration) at the new SLR WTW (see Treatment section of this WQRA).	Consideration must be given to compensation flows in the construction of the new SLR
Chloride	Y	Gate 2: No change from gate 1. Gate 1: Change of water source could change the levels of chloride carried through to the Anglian network, which could lead to changes in corrosivity in the Anglian network.	3	3	[illegible]	-	-	3	3	[illegible]	Gate 2: No change from gate 1. Gate 1: Parameter will be conditioned at SLR WTW.	-

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