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Groundwater Quality Mitigation Plan

Edithvale and Bonbeach Level Crossing Removal Projects

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Name:				
Signature:				
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Glossary of terms

Term	Description
Acidification	The action or process of reducing pH such that acidic conditions manifest and an existing beneficial use cannot be maintained
Affected land parcels	All properties and public land (including public parks, roads and rail) within the area where negative impacts due to changes in groundwater quality as a result of the projects have occurred
Beneficial use of groundwater	As defined in Section 4 of the *Environment Protection Act 1970*, a use of the environment or any element or segment of the environment which: a) is conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges, emissions or deposits or of the emission of noise; or b) is declared in State environment protection policy to be a beneficial use.
Changes to salinity	The action or process of increasing dissolved salt concentrations in groundwater such that conditions become saline such that an existing beneficial use cannot be maintained
Completion of the Projects	The date of handover of the rail infrastructure/asset to the Department of Transport (being the asset owner)
Consultation	Meetings, workshops and exchange of documentation and correspondence between LXRP or its contractors and stakeholders, but would not necessarily require the submission of written documentation or draft plans for formal comment to any particular stakeholder
Contaminated groundwater transfer	The movement of contaminated groundwater between discrete locations within an aquifer/s, via a preferential flow path such as subsurface infrastructure that allows water to flow with relatively lower resistance and higher velocity in the subsurface areas, as compared to the surrounding groundwater flow conditions.
Fund	Provide money to be placed in reserve to pay for the potential requirement to implement the *Groundwater Quality Mitigation Plan (EPR_CL5)* and any potential mitigation required through implementing that Plan during project operation but not project construction.
Groundwater quality	The physical, chemical and biological characteristics of water and the measure of its condition relative to the requirements for one or more biotic species or to any human need or purpose.
Implementation	Execute/put into effect the *Groundwater Quality Mitigation Plan (EPR_CL5)*
Land manager	The person/entity that can exercise power over the land. For example, a person/entity that holds a legal interest in the land, such as an owner, leaseholder or committee of management, or a person/entity that has access to the land, or use of the land.
Maintain	Cause or enable (a condition or situation) to continue.
Manage	To maintain control over any potential project induced impacts to groundwater quality so that the existing beneficial uses of groundwater are maintained.

Term	Description
Measure	A plan or course of action implemented to reduce or eliminate project induced risks to the existing beneficial use of groundwater.
Mitigate	Reduce the severity of any project induced negative impacts to groundwater quality through implementing measures in order to maintain the existing beneficial uses of groundwater.
Negative impacts	Changes to groundwater quality resulting in pollution (as defined in Section 39(1) of the *Environment Protection Act 1970*) above background levels.
Phase (of this Plan)	One of three broad phases (Define, Design and implement, Finalise) that form the basis for this Plan's implementation framework.
Plume migration	The mobilisation (either lateral or vertical) through an aquifer of chemicals introduced by waste or contaminants due to general anthropogenic activity.
Prepare	Development of a management plan outlining measures to be undertaken in response to triggers met.
Projects	The Edithvale and Bonbeach level crossing removal projects.
Result or Attributable	Is caused or produced by, a consequence or outcome of.
Responsible entity	The entity responsible for implementation of the *Groundwater Quality Mitigation Plan (EPR_CL5)* during project construction: Southern Program Alliance (being the asset construction contractor) The entity responsible for implementation of the *Groundwater Quality Mitigation Plan (EPR_CL5)* during project operation: Department of Transport (being the asset manager after project completion)
Stage (of this Plan)	One of six broad stages (Impact verification, Risk analysis, Develop management goals, Mitigation options assessment, Mitigation option implementation, Mitigation option validation) that form logical milestones in this Plan's implementation framework.
Step (of this Plan)	One of several specific tasks/activities that form a logical sequence in carrying out each Stage in this Plan's implementation framework.
Trigger	A metric prescribed through the *Groundwater Monitoring and Management Plan (EPR_GW2)* relating to changes in groundwater level and/or quality. If met, the metric sets an action or process in motion.

1 Introduction

1.1 Background

The Victorian Government is removing 75 level crossings across Melbourne by 2025. At Edithvale and Bonbeach, the level crossings will be removed by lowering the rail line into a trench. An Environment Effects Statement (EES) was undertaken to assess potential impacts from the Edithvale and Bonbeach Projects (the 'projects') to groundwater levels, groundwater quality and the Edithvale-Seaford Wetlands Ramsar Site.

An Environmental Management Framework (EMF) has been prepared for the projects in accordance with the project's planning approval under the Victorian *Planning and Environment Act 1987*. The EMF contains Environmental Performance Requirements (EPRs) developed through the EES process (**Appendix A: EPR requirements**), which have been approved by the Victorian Minister for Planning and include (but are not limited to) the following in relation to groundwater:

- An overarching *Groundwater Monitoring and Management Plan (EPR_GW2)* (LXRP, 2020a), which requires the monitoring of groundwater levels and quality at the trench during project construction and operation, against triggers in order to identify whether the engineering controls incorporated into the design are effective and whether mitigation is required
- Mitigation Plans, including the:
    - *Groundwater Quality Mitigation Plan (EPR_CL5)* – this Plan, which has been prepared to address the requirements of EPR_CL5
    - *Edithvale Wetlands Monitoring and Mitigation Plan (EPR_FF7)* (LXRP, 2020b), which relates specifically to Edithvale Wetland and is not discussed further here

Figure 1 outlines the EPR hierarchy with respect to groundwater management. Aspects relating to this *Groundwater Quality Mitigation Plan (EPR_CL5)* are outlined in red in Figure 1, for both project construction and operation phases. The key stakeholders relevant to this Plan are outlined further in Section 10 and **Appendix A: EPR requirements.**

Figure 1: EPR Hierarchy – Monitor potential to impact groundwater

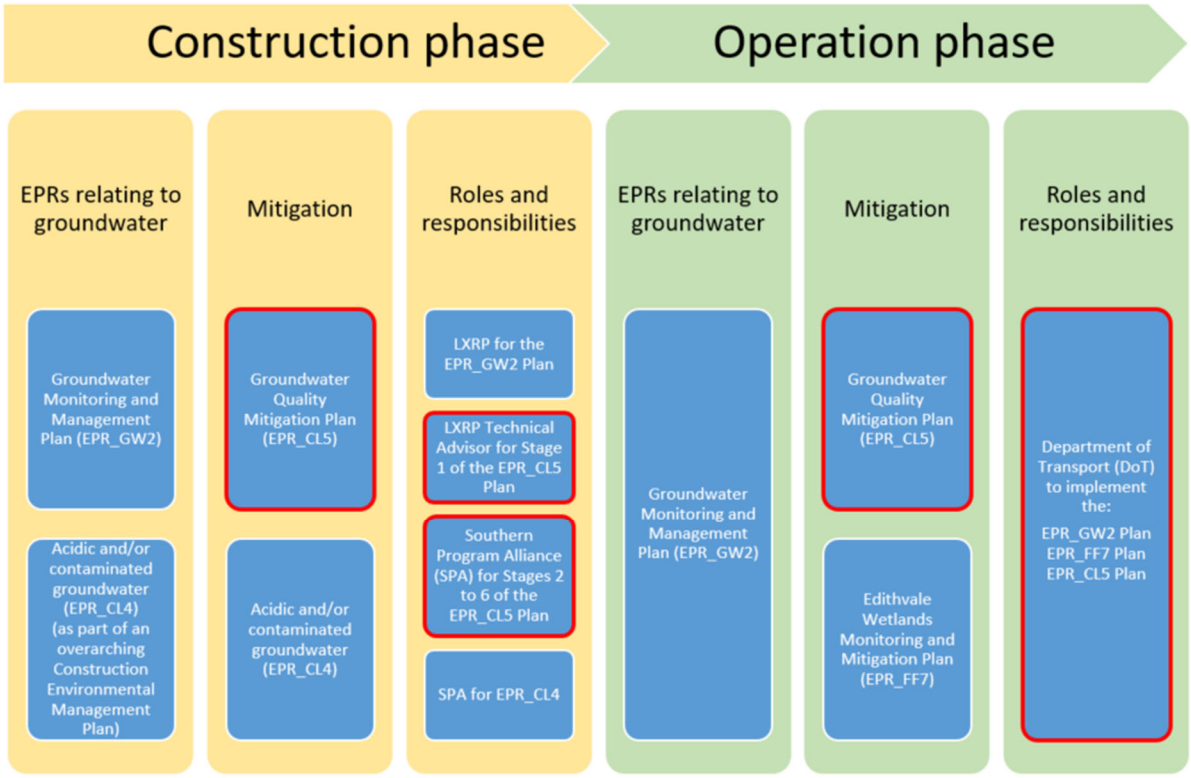


Figure 1 shows that **during project construction**, groundwater quality is to be managed through:

- An overarching *Groundwater Monitoring and Management Plan (EPR_GW2)*, which stipulates trigger events or levels that determine the requirement to implement this *Groundwater Quality Mitigation Plan (EPR_CL5)*

- Documentation that addresses the requirements of EPR_CL4: *Acidic and/or contaminated groundwater (construction)*, which stipulates procedures for the management of groundwater (to maintain existing beneficial uses), waste (including plumes and vapours) and runoff, as they relate to construction activities. Some aspects of EPR_CL4 reference trigger events or levels stipulated in the *Groundwater Monitoring and Management Plan (EPR_GW2)*.

Figure 1 shows that **during project operation**, groundwater quality is to be managed through:

- An overarching *Groundwater Monitoring and Management Plan (EPR_GW2)*, which stipulates trigger events or levels that determine the requirement to implement this *Groundwater Quality Mitigation Plan (EPR_CL5)*

Figure 1 shows that the entity responsible to implement this Plan is dependent on the project phase, where:

- **During project construction**: LXRP is the entity responsible for initiating this Plan until the completion of the projects, which may be implemented by the:
    - LXRP Technical Advisor (TA) (AECOM-GHD Joint Venture) for Stage 1 (Section 3) of this Plan
    - Southern Program Alliance (SPA) for Stages 2 to 6 (Sections 4 to 8) of this Plan
- **During project operation**: The office for the head of Transport for Victoria (Head, TfV) within the Department of Transport (DoT) is the entity responsible for initiating this Plan.

Acknowledging the technical nature of this Plan, a suitably qualified and experienced environmental professional must be engaged by the responsible entity to facilitate Plan implementation. The environmental practitioner must undertake all works in accordance with the requirements of DoT. Guidance on engaging a suitable practitioner is provided by Environment Protection Authority (EPA) Victoria (2018), while guidance on stakeholder participation is provided by the International Association for Public Participation (IAP2) Public Participation Spectrum (2018).

1.2 Purpose of this Plan

The primary purpose of this Plan is to provide a framework that guides verification, management and mitigation of negative impacts from changes to groundwater quality as a result of the projects. This Plan aims to understand whether the trigger that resulted in Plan implementation:

- Is real
- Is project induced
- Has the potential to result in negative impacts from changes to groundwater quality
- Would require mitigation on the basis of risk

1.3 Objectives of this Plan

The primary objective of this Plan is to maintain existing beneficial uses of groundwater, as determined by EPA Victoria through the State Environment Protection Policy (SEPP) – Waters 2018 [1] or any document that supersedes this document[2]. Beneficial uses of groundwater describe the values and uses of water environments to be protected in Victoria and are determined by segments based on the background (naturally occurring) level of total dissolved solids (TDS). Groundwater of higher quality (lower salinity) has more beneficial uses than lower quality (higher salinity) groundwater. Appendix C of the *Groundwater Monitoring and Management Plan (EPR_GW2)* provides a summary of the beneficial uses to be protected for each of the groundwater segments, both generally and as they relate to the project areas, based on Table 2 of SEPP (Waters) 2018.

In accordance with the EMF, the implementation of this Plan either during project construction or operation, represents project contingency. The process for assessing triggers that have been met, events that may occur and the potential requirement for mitigation measures to reduce risk is outlined through this Plan. For the purpose of implementing this Plan, these terms are defined as:

[1] While the SEPP *Groundwaters of Victoria 1997* is referenced within Version B of the Edithvale and Bonbeach Level Crossing Removal Projects Environmental Management Framework (December 2018), it is acknowledged that during preparation of this Plan, this policy has been superseded by SEPP (Waters) 2018.

[2] The SEPP (Waters) 2018 is scheduled to be replaced by the Environmental Reference Standard as specified under the *Environment Protection Act 2017* as of 1 July 2021.

- **Trigger**: A metric prescribed through the *Groundwater Monitoring and Management Plan (EPR_GW2)* relating to changes in groundwater level and/or quality that could result in negative impacts to existing groundwater beneficial uses. If such a trigger is met, this Plan must be implemented
- **Event**: A measurable outcome, consequence or scenario that could occur during project construction or operation, if a specific environmental condition or an established trigger is met
- **Measure**: a plan or course of action taken to mitigate or manage risks to the existing beneficial use of groundwater attributable to the projects. Measures are implemented to reduce or eliminate project induced risks to existing beneficial uses of groundwater

1.4 Potential changes to groundwater quality

The EES identified that project infrastructure such as rail trenches and pile walls, could affect groundwater levels and flow through groundwater mounding and drawdown, on the eastern and western sides of the Projects respectively. These terms and processes are described further in Sections 1.2 and 1.3 of EES Technical Report A *Groundwater Impact Assessment* (AECOM-GHD Joint Venture, 2018). The EES identified numerous risks relating to groundwater, which could occur during the construction and/or operation phases of the projects.

The risks that are relevant to this Plan include those relating to the potential to negatively impact groundwater quality and groundwater beneficial uses as defined by the SEPP (Waters) 2018, specifically through:

a. Acidification that is attributable to the project(s), through activation of Coastal Acid Sulfate Soil (CASS)
b. Contaminated groundwater transfer or migration that is attributable to the project(s)
c. Changes to salinity that are attributable to the project(s), which could be caused by saltwater intrusion

The occurrence of groundwater acidification, contaminant migration or salinisation could cause pollution as defined in the SEPP (Waters) 2018. Specifically, Clause 42 of the SEPP requires persons responsible for construction activities to ensure those activities: minimise the risks to beneficial uses; do not cause mobilisation of existing groundwater contamination, and to implement effective management practices consistent with relevant guidelines.

1.5 Project risks, events and potential negative impacts

If implementation of this Plan is required, it would be assumed that potential exists for 'negative impacts due to changes in groundwater quality as a result of the projects', which have been described previously in Section 1.2 of the *Groundwater Monitoring and Management Plan (EPR_GW2)*. For consistency, this Plan adopts the same definitions of impact.

Appendix B: Risks and potential events relevant to this Plan aims to contextualise the risks relevant to this Plan, by outlining potential project induced events that could feasibly occur during project construction or operation, if these risks were realised. The background information included in **Appendix B: Risks and potential events relevant to this Plan** has been summarised from previous project studies referenced in Section 11 of this Plan, with the aim of establishing background context for the Projects. This background is considered invaluable in summarising the key relevant risks for the user of this Plan, prior to undertaking risk analysis.

Appendix C: Risk assessment framework provides a suggested risk assessment framework that the user of this Plan could adopt to:

- Identify the events that could occur in relation to each risk
- Understand the relevance of each potential event in relation to the project phases (i.e. construction and operation)
- Process the relevant information collated through previous project risk assessments undertaken as part of, and since, the EES
- Appreciate the various timeframes to consider in implementing mitigation measures, depending on the trigger and the event

Appendix D: Mitigation Measure Examples provides examples of mitigation measures that could be considered as part of implementation Stage 4: Mitigation options assessment (Section 6 of this Plan).

1.6 Commencement and duration

Implementation of this Plan will commence immediately on the identification of groundwater triggers established in Section 5 of *Groundwater Monitoring and Management Plan (EPR_GW2)* being met, during project construction or operation.

Implementation of this Plan will cease when the period for monitoring within the *Groundwater Monitoring and Management Plan (EPR_GW2)* is completed or whenever implementation of mitigation measures is deemed satisfactory by the appropriate responsible authority; whichever is later.

2 Implementation of this Plan

2.1 Summary

This Plan has been prepared for the benefit of those who may not be technical specialists. Implementation of this Plan can be guided by the flow charts throughout this Plan. The chart below outlines the aspects to be considered for each stage or task required in implementing this Plan.

An implementation framework is provided in Section 2.2 of this Plan; this aims to guide the user through a staged process that is to be undertaken in accordance with applicable industry practices and quality standards. Each of the stages are detailed further in Sections 3 to 8 of this Plan.

While the stages in the implementation framework are sequential, not all stages would require completion in all instances. The start and end points of Plan implementation would be guided by the framework on the basis of impact verification, initial risk and residual risk. Similarly, the sequencing and timing of the stages outlined in this Plan may also be varied and iterative, depending on the source – pathway – receptor and the related risk of negative impacts from changes to groundwater quality.

2.2 Implementation framework

The implementation framework aligns with the Plan objectives outlined in Section 1.3 and comprises the three broad phases outlined in Figure 2. The framework is presented in Figure 3.

Figure 2 Phases of the Plan implementation framework

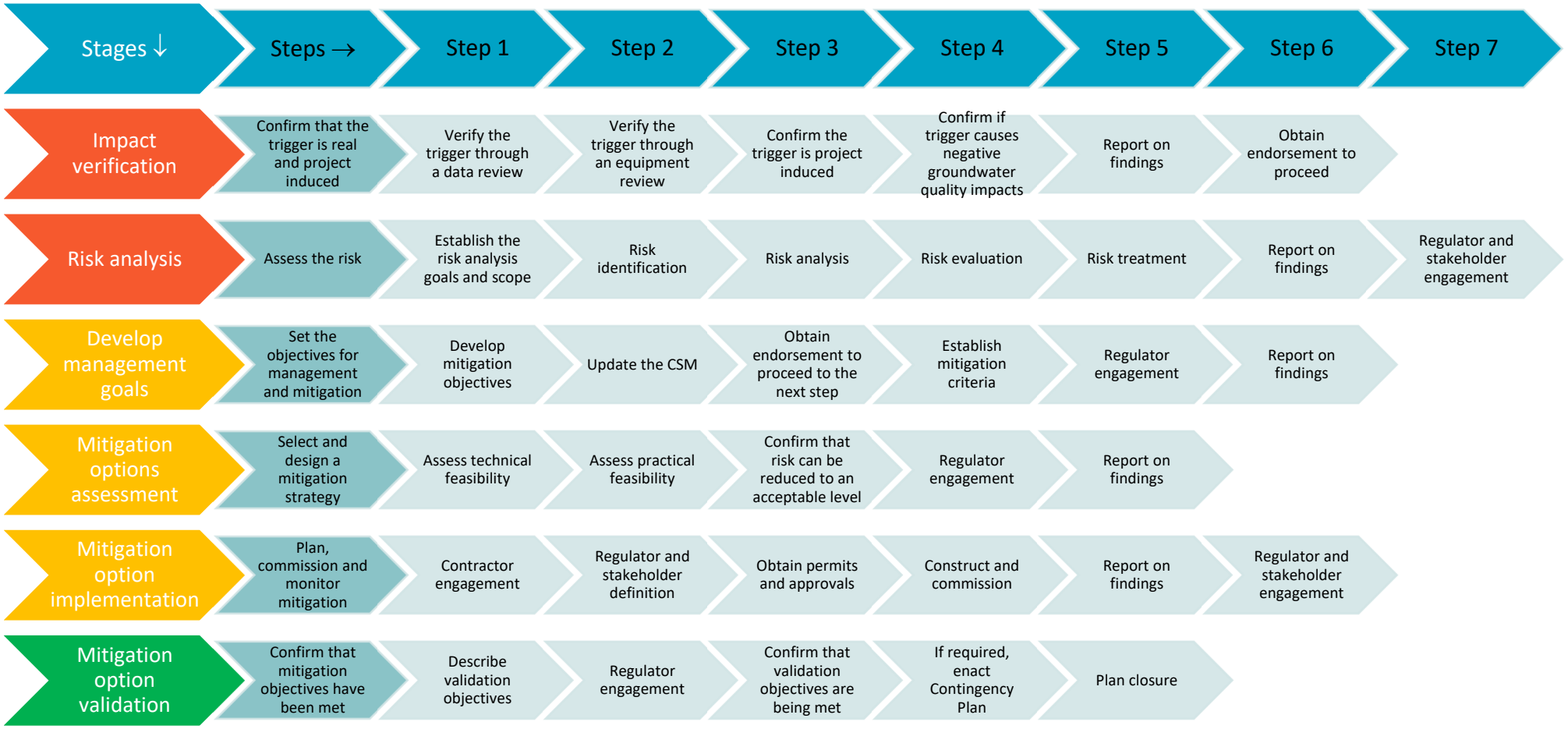
The framework designates a multi-stage approach that guides the Plan user through an appropriate process to confirm, assess, manage, mitigate and close out any negative impact from changes to groundwater quality, as described in Figure 3. These stages form the basis of the implementation framework detailed in subsequent sections of this Plan.

This Plan's implementation framework has been adapted from the National Remediation Framework (NRF) developed by the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE, 2019)[3]. The NRF, or its successors, should be consulted in implementing this Plan to provide strategic guidance and oversight in the practicalities of mitigating and managing changes to groundwater quality, through the involvement of industry practitioners, government representatives and other relevant parties.

For the purpose of implementing this Plan, the term 'remediation' as mentioned in the NRF should be considered synonymous with the term 'mitigation' as used in this Plan and the *Groundwater Monitoring and Management Plan (EPR_GW2)*.

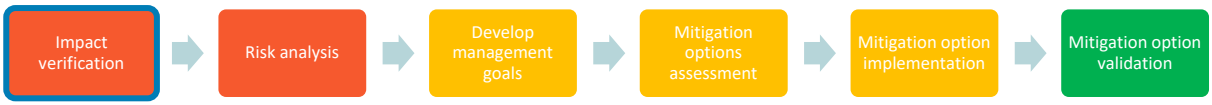
[3] The NRF complements the National Environment Protection Council (NEPC) National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM), and aligns with the objectives of the former Council of Australian Governments Standing Council on Environment and Water. The NRF is therefore considered to be a solid platform on which to base the approaches to mitigation outlined in this Plan.

Figure 3 EPR_CL5 Plan implementation framework



3 Stage 1: Impact verification

This stage confirms whether the verified event and trigger are real and are project induced.



The objective of this initial stage is to verify that the event, trigger and impact are real and not a false positive, and that the trigger that has implemented this Plan is project induced.

If verified impacts are identified during the project construction phase, this initial stage escalates the management process by directing the user of this Plan to implement established construction phase mitigation measures defined within EPR_CL4 (**Appendix A: EPR requirements**).

Details on the specific aspects to be considered and key tasks to be undertaken in implementing this stage in the Plan are provided in Table 1.

Key outcome of this stage:

Once completed, the following outcomes should be achieved:

- The source of groundwater quality changes is identified and understood (i.e. project induced or not)
- The current or potential future impacts of the activated trigger are understood and are represented through a conceptual site model (CSM) and are documented

The next stage in implementing this Plan requires one of the following to be confirmed:

- Groundwater quality changes are not identified as project induced, therefore no further action would be required in terms of mitigation. Cease implementation of the Plan and inform relevant stakeholders of the outcome; or
- Groundwater quality changes are identified as project induced

The next step will be dependent on the project phase:

During project construction:

- If impact is proved to be project induced, the subsequent stages in this Plan must be implemented by SPA, in addition to SPA implementing the relevant construction phase mitigation measures within EPR_CL4
- If impact is verified but is not proved to be project induced, involve the regulator for guidance on how to proceed (EPA)

During project operation:

- If impact is proved to be project induced, the subsequent stages in this Plan must be implemented by the DoT engaged environmental practitioner

Table 1 Impact verification stage – implementation guide

	Step 1 Verify the trigger through a data review	Step 2 Verify the trigger through an equipment review	Step 3 Confirm the trigger is project induced	Step 4 Confirm if trigger causes negative groundwater quality impacts	Step 5 Report on findings	Step 6 Obtain endorsement to proceed to the next step
Objective	Verify that the trigger is real and not relating to a measurement or processing error	Verify that the trigger is not due to an equipment calibration or measurement issue	Verify that the trigger is not part of a broader non-project related issue Escalate EPR_CL4 controls if impact is verified during project construction	Verify that the trigger has not resulted in negative groundwater quality impacts in locations beyond the project groundwater monitoring network Identify affected land parcels	Document findings of this stage	Obtain endorsement to from the relevant regulator and stakeholders Progress Plan implementation
Method / Tasks	Review the groundwater database (data inputs / outputs / transfers)	Confirm that dataloggers are within calibration ranges and that automatic and manual measurements (levels and quality) are consistent	Review potential influences from construction phase activities Review climatic data from the previous 12 months, including comparison of groundwater levels in the QA and UTAF with daily rainfall; comment on correlations Liaise with relevant stakeholders regarding recent issues/maintenance works on water infrastructure assets Develop a CSM to represent the environmental setting, geological, hydrogeological and soil characteristics together with the nature and distribution of negative impacts to groundwater quality	Understand the scale of impact (local and regional) by characterising potential changes to groundwater quality through monitoring data from supplementary locations across the project groundwater monitoring network and better understand the potential for negative impacts Review/update the CSM. Complete a data gap assessment. Delineate impact. Update CSM.	Document information collected and the conclusion reached, data gaps identified and recommendations for further analysis. Clearly state whether groundwater quality changes are confirmed to be project induced.	Inform and involve relevant regulatory agencies and obtain approval to proceed Progress the implementation of the Plan in accordance with regulator advice Notify relevant entity that will progress this Plan

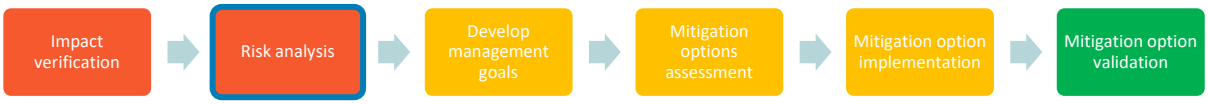
	Step 1 Verify the trigger through a data review	Step 2 Verify the trigger through an equipment review	Step 3 Confirm the trigger is project induced	Step 4 Confirm if trigger causes negative groundwater quality impacts	Step 5 Report on findings	Step 6 Obtain endorsement to proceed to the next step
Specific assessment location / area	All monitoring locations specified in EPR_GW2 where triggers have been met	All monitoring locations specified in EPR_GW2 where triggers have been met (**Appendix E: Bore Locations**)	All areas within or adjacent to the project	All locations specified in EPR_GW2, EPR_FF7, broader monitoring network (**Appendix F: Broader Project Groundwater Monitoring Locations**)	N/A	N/A
Timing of action, from commencement of this Plan	Within 1 week	**During construction:** within 2 weeks **During operation:** Within 1 month		Within 2 months	Within 3 months	Within 4 months
Data/information requirements	Project data portal Project database Defined alarms/triggers in the Project data portal / ESdat	EPR_GW2 monitoring locations Monitoring procedures outlined in Appendix B and C of EPR_GW2 Project data portal EPA Victoria (2000) Publication 669	BoM climate data for Bonbeach gauge Available data from stakeholders EPA Victoria (2006) Publication 668	Monitoring locations defined in **Appendix E: Bore Locations** EPR_FF7 monitoring locations		
Potentially relevant stakeholders[4]	**During construction:** LXRP TA SPA **During operation:** DoT	**During construction:** LXRP TA SPA **During operation:** DoT	**During construction:** LXRP TA SPA	EPA Victoria DoT Land managers of affected land parcels (if engagement is necessary to meet the objectives of this step)	EPA Victoria DoT Southern Rural Water (SRW) Melbourne Water	EPA Victoria

[4] This list is not intended to be exhaustive, but rather it provides the Plan user with a shortlist of potentially relevant stakeholders that could participate as required

	Step 1 Verify the trigger through a data review	Step 2 Verify the trigger through an equipment review	Step 3 Confirm the trigger is project induced	Step 4 Confirm if trigger causes negative groundwater quality impacts	Step 5 Report on findings	Step 6 Obtain endorsement to proceed to the next step
			During operation: EPA Victoria DoT			
Process	If the trigger is confirmed as real, proceed to Step 2. Otherwise, close out Plan (no need to notify responsible authorities).	If monitoring and review confirms the trigger as real, inform the relevant responsible authority and proceed to Step 3. Otherwise, close out Plan (no need to notify responsible authorities).	**During construction:** If project related influences are identified, SPA is to assume responsibility in implementing this Plan from this point forward. TA to hand over all relevant information and data to SPA. SPA to: - enact relevant EPR_CL4 controls identified in the Construction Environmental Management Plan (CEMP); and - skip to Stage 2 (Risk Analysis) **During operation:** If non-project influences are identified, skip to Step 5. Otherwise, continue to Step 4	Complete Step 4 and continue to Step 5	Complete Step 5 and continue to Step 6	Complete Step 6 and either: A) close the Plan and inform relevant stakeholders; or B) Continue to the next stage in Plan implementation (Risk Analysis)

4 Stage 2: Risk analysis

This stage analyses the effect of the verified impact through the source – pathway – receptor model, to understand the level of risk and the need for mitigation to reduce risk.



This stage in Plan implementation outlines a risk-based approach to undertake in the identification of potential pathways and receptors, and to assess the likelihood that the identified receptors will be impacted to an unacceptable level through the verified impact. A risk management approach consistent with the following publications is integral to this stage:

- AS/NZS ISO 31000:2018 Risk Management Process (or more recent version)
- EPA Publication 1695.1 Assessing and controlling risk: A guide for business (outlined further in **Appendix C: Risk assessment framework**)
- The risk framework outlined in **Appendix C: Risk assessment framework**, which presents the risks relevant to this Plan consistent with the risk elements considered in previous risk assessments relating to the Projects

The timing to undertake a specific step outlined in this Plan, and the extent and number of mitigation measures considered, should be proportional to the risk rating. Table 2 defines the risk levels to be adopted in assessing risk as part of this Plan, as well as the actions to be undertaken for each risk level.

Table 2 Description of risk levels

Risk Level	Risk level description	Risk level action
Extreme	Unacceptable level of risk. Take action immediately	Risk is unacceptable. Continue to the next stage in this Plan
High	Unacceptable level of risk. Controls must be put in place to reduce or eliminate risks	Risk is unacceptable. Continue to the next stage in this Plan
Medium	Unacceptable level of risk. Controls must be put in place to reduce or eliminate risks	Risk is unacceptable. Confirm this through Regulator and stakeholder approval; action accordingly
Low	Acceptable level of risk. Attempt to eliminate, but higher risks take priority	Risk is acceptable; action accordingly

Details on the specific aspects to be considered and key tasks to be undertaken in implementing this stage in the Plan are provided in Table 3.

Key outcome of this stage:

Once completed, the following outcomes should be achieved:

- The source – pathway – receptor model is further contextualised in terms of the verified impact and qualitative definitions for acceptability are established
- Negative impacts from changes to groundwater quality as a result of the projects are identified, analysed and evaluated in terms of risk to human health and the environment with reference to the beneficial uses (environmental values) specified in the SEPPs
- The need for risk treatment is considered through a risk evaluation process, and potential mitigation scenarios are considered
- Relevant authorities are consulted and involved in the decision making process

The next stage in implementing this Plan requires one of the following to be confirmed:

- Risk from potential negative groundwater quality impacts is assessed as being acceptable (through criteria defined in Table 2), or, the consequences of mitigation are inferred to introduce unintended consequences that preclude risk reduction. In this case, no further mitigation action is required, other than gaining consensus with relevant stakeholders. This outcome would likely require on-going monitoring to confirm that risk levels remain acceptable, as well as interim compliance reporting as outlined in Section 6 of the *Groundwater Monitoring and Management Plan (EPR_GW2)*
- Risk from potential negative groundwater quality impacts is assessed as posing an unacceptable risk to human health or the environment, therefore the next stage in this Plan (Develop Management Goals) is to be enacted

Table 3 Risk analysis stage – implementation guide

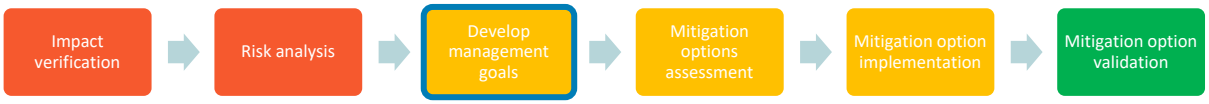
	Step 1 Establish the risk analysis goals and scope	Step 2 Risk identification	Step 3 Risk analysis	Step 4 Risk evaluation	Step 5 Risk treatment	Step 6 Report on findings	Step 7 Regulator and stakeholder engagement
Objective	Establish the goals and scope of the risk analysis process	Identify the relevant risk components	Assess the level of risk posed by the event, the trigger and potential mitigation	Evaluate the level of risk to determine if mitigation is required	Consider risk treatment options for those risks evaluated as requiring additional action	Document findings of this stage	Obtain endorsement to proceed to the next step
Method / Tasks	Define the scope of the risk management process Establish risk criteria and define acceptability	Identify the source (the negative impact resulting in groundwater quality change), risk pathways and risk receptors and their linkages Update the previously developed CSM (AECOM-GHD JV, 2020) if required	Assess risk (likelihood and consequence) for each risk pathway Assess the effectiveness of existing controls; sensitivity and confidence levels	Review the results of the risk analysis for each risk posed by the project Compare with the established risk criteria Evaluate to determine where additional action (in terms of impact assessment or mitigation) is required	Identify additional management and/or potential mitigation scenarios to reduce risk levels Iteratively undertake Step 2 to Step 5	Document the process Provide conclusions on the acceptability of existing (unmitigated) risks Provide recommendations on the inferred acceptability of treated (mitigated) risks	Inform and involve the relevant regulatory agencies and obtain approval to proceed Progress the implementation of the Plan in accordance with regulator advice
Specific assessment location / area	All areas within or adjacent to the project						
Timing of action, from commencement of this stage	Within 1 week	Within 1 week	Within 2 weeks	Within 2 weeks	Within 3 weeks	Within 4 weeks	Within 6 weeks

	Step 1 Establish the risk analysis goals and scope	Step 2 Risk identification	Step 3 Risk analysis	Step 4 Risk evaluation	Step 5 Risk treatment	Step 6 Report on findings	Step 7 Regulator and stakeholder engagement
Data/information requirements	AS/NZS ISO 31000:2018 Risk Management Process AECOM-GHD JV (2020, 2018) EPR_GW2 Plan					N/A	N/A
Potentially relevant stakeholders[5]	**During construction:** LXRP, SPA, EPA Victoria, DoT, Land managers of affected land parcels (if engagement is necessary to meet the objectives of this step) **During operation:** EPA Victoria, DoT, Land managers of affected land parcels (if engagement is necessary to meet the objectives of this step)					EPA Victoria DoT	EPA Victoria DoT Melbourne Water Kingston City Council SRW
Process	Complete Step 1 and continue to Step 2	Complete Step 2 and continue to Step 3	Complete Step 3 and continue to Step 4	Complete Step 4 and continue to Step 5	Complete Step 5 and continue to Step 6. If required, repeat Step 2 and 3 to better understand the risk. If required, repeat Step 4 and re-evaluate to determine the need for additional action	Complete Step 6 and continue to Step 7	Complete Step 7 and either A) close the Plan and inform relevant stakeholders; or B) Continue to the next stage in Plan implementation (Develop Management Goals)

[5] This list is not intended to be exhaustive, but rather it provides the Plan user with a shortlist of potentially relevant stakeholders that could participate as required

5 Stage 3: Develop management goals

This stage represents the objective setting phase and provides guidance for establishing key management and mitigation objectives and criteria, as well as regulatory requirements.



The management goals developed in this stage should be used to guide the remaining stages of this Plan, specifically to measure alignment of, and verify compliance with, management and mitigation performance.

Details on the specific aspects to be considered and key tasks to be undertaken in implementing this stage in the Plan are provided in Table 4.

Key outcome of this stage:

Once completed, the following outcomes should be achieved:

- Objectives for the mitigation of impacts are defined and endorsed by relevant regulatory agencies and stakeholders
- Criteria to measure whether objectives have been achieved are defined and endorsed by relevant regulatory agencies and stakeholders

The objectives and criteria established above are used in the next implementation stage to assess feasible potential options for mitigation, in accordance with relevant guidelines and in collaboration with relevant regulatory agencies, stakeholders and industry professionals.

Table 4 Develop management goals stage – implementation guide

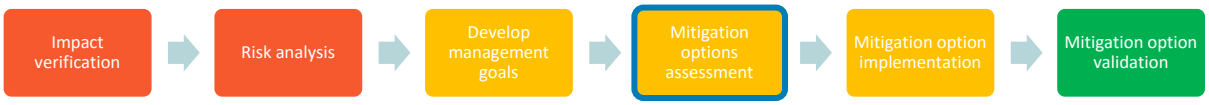
	Step 1 Develop mitigation objectives	Step 2 Update the CSM	Step 3 Obtain endorsement to proceed to the next step	Step 4 Establish mitigation criteria	Step 5 Obtain endorsement to proceed to the next step	Step 6 Report on findings
Objective	Establish realistic and tangible goals of undertaking management or mitigation, specific to the negative impact to groundwater quality Confirm previously defined risk criteria and define acceptability	Represent objectives in Step 1 in a robust CSM that can be used to convey information to regulators and stakeholders	Consult the regulator and stakeholders to obtain endorsement to proceed to the next step	Define the mitigation end points for the specific groundwater quality change being managed	Obtain regulator and stakeholder to endorsement to proceed to the next step	Document findings of this stage
Method / Tasks	Use the CSM to show the relevant source-pathway-receptor linkages Define the decision-making methodology and implementation Develop a validation plan Develop a contingency plan that would be implemented if new or previously unidentified site conditions are encountered, or if mitigation objectives are not (or cannot be) met	Represent objectives in Step 1 in the previously developed CSM. This should sufficiently identify the source, pathway, receptor components in the context of the established mitigation objectives.	Inform and involve the relevant regulatory agencies and relevant stakeholders in the development of mitigation objectives	Define the relevant environmental guidelines and assessment criteria Establish site specific risk-based criteria Define performance-based metrics (e.g. mass flux) to benchmark mitigation performance Develop a multiple lines of evidence approach to measure mitigation compliance / effectiveness	Inform and involve the relevant regulatory agencies in establishing mitigation objectives Inform and gain consensus on mitigation objectives Gain an understanding of community values Collaborate to develop mitigation scenarios	Document the process undertaken
Specific assessment location / area	All areas within or adjacent to the project					

	Step 1 Develop mitigation objectives	Step 2 Update the CSM	Step 3 Obtain endorsement to proceed to the next step	Step 4 Establish mitigation criteria	Step 5 Obtain endorsement to proceed to the next step	Step 6 Report on findings
Timing of action, from commencement of this stage	Within 1 week	Within 2 weeks	Within 4 weeks	Within 6 weeks	Within 8 weeks	Within 8 weeks
Data/information requirements	CRC CARE (2019) ASC NEPM (1999)	CRC CARE (2019) ASC NEPM (1999)	N/A	CRC CARE (2019)	N/A	CRC CARE (2019)
Potentially relevant stakeholders[6]	EPA Victoria DoT SRW Land managers of affected land parcels	EPA Victoria Land managers of affected land parcels	EPA Victoria	EPA Victoria DoT	EPA Victoria	EPA Victoria DoT Melbourne Water Kingston City Council SRW Land managers of affected land parcels
Process	Complete Step 1 and continue to Step 2	Complete Step 2 and continue to Step 3, but return to update this task as required	Complete Step 3 and continue to Step 4	Complete Step 4 and continue to Step 5	Complete Step 5 and continue to Step 6	Complete Step 6 and continue to the next stage in Plan implementation (Mitigation Options Assessment)

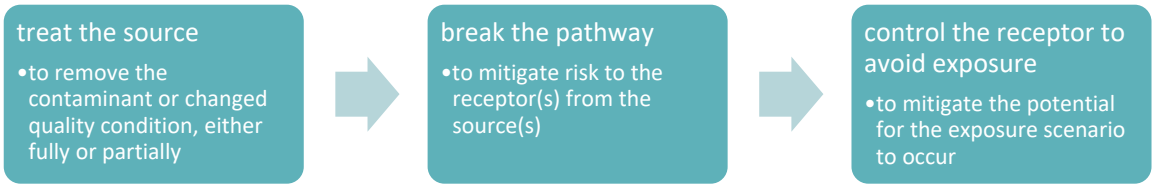
[6] This list is not intended to be exhaustive, but rather it provides the Plan user with a shortlist of potentially relevant stakeholders that could participate as required

6 Stage 4: Mitigation options assessment

This stage provides guidance on the assessment of potential mitigation options and designing a mitigation strategy, including aspects relating to technical applicability, cost effectiveness and risk assessment.



The level of effort and resources expended to risk treatment should be commensurate with the risk, which will have been defined through previous stages. Successful mitigation can be defined as an option (or options) that:



Groundwater level changes (i.e. groundwater mounding and drawdown) could occur during project construction and/or operation, and are the primary mechanisms that could cause negative impacts to groundwater quality due to the project. As outlined in Appendix B: Risks and potential events relevant to this Plan, the relevant risks are dependent on the project phase (i.e. construction or operation).

Because of this, the assessment of potential mitigation measures is suggested to initially focus on minimising groundwater level impact specifically. **Appendix D: Mitigation Measure Examples** provides an overview of the potential engineering options and technologies that could be considered to mitigate project induced groundwater level and quality impacts.

Details on the specific aspects to be considered and key tasks to be undertaken in implementing this stage in the Plan are provided in Table 5.

Key outcome of this stage:

Once completed, the following outcomes should be achieved:

- Potential mitigation measures are assessed in terms of technical feasibility, in accordance with relevant guidelines
- Potential mitigation measures are assessed in terms of cost / benefit / sustainability, in accordance with relevant guidelines
- Residual risk of implementing a mitigation measure is assessed in detail and is considered to be acceptable
- A specific mitigation measure is adopted with the endorsement of relevant regulatory agencies

The next stage requires implementation of the adopted mitigation option, in accordance with relevant guidelines and in collaboration with relevant regulatory agencies, stakeholders and industry professionals.

Table 5 Mitigation options assessment stage – implementation guide

	Step 1 Assess technical feasibility	Step 2 Assess practical feasibility	Step 3 Confirm that risk can be reduced to an acceptable level	Step 4 Report on findings	Step 5 Obtain endorsement to proceed to the next step
Objective	Assess potential mitigation measures	Confirm that cost and sustainability of technically feasible mitigation options is favourable and acceptable	Confirm that the proposed mitigation measure actually reduces the relevant risks, and does not realise unintended consequences	Document findings of this stage	Obtain regulatory endorsement of the specific mitigation measure proposed. Progress Plan implementation
Method / Tasks	• Identify and undertake preliminary screening/evaluation of mitigation options (to treat, remove or contain the groundwater quality impact) • Undertake hydrogeological characterisation (physical, chemical and biological) and understanding of limitations • Undertake treatability studies, including bench tests and pilot trials, to evaluate feasibility and potential effectiveness of preferred mitigation options • Consider institutional controls or restrictions on land or groundwater use (as determined by regulatory agencies) that may permit higher concentrations of the contaminants to remain • Explore groundwater treatment / disposal options • Consider mitigation options that will reduce risk to acceptable levels for a particular use • Assess design requirements and expected cost of the selected mitigation option	Assess cost and sustainability of technically feasible mitigation options through approaches of cost-benefit analysis (CBA) and multi-criteria analysis (MCA).	Assess risk (likelihood and consequence) for each risk pathway Assess the effectiveness of the proposed mitigation measure, sensitivity and confidence levels If required, consideration should be given to the inclusion of additional interim management controls and responses that may need to be taken to reduce the risks to an acceptable level	Document the analysis process Provide conclusions on the effectiveness of proposed mitigation, associated uncertainty and acceptability of risks	Consult with and involve the relevant regulatory agencies and obtain approval to proceed Progress the implementation of the Plan in accordance with regulator advice

	Step 1 Assess technical feasibility	Step 2 Assess practical feasibility	Step 3 Confirm that risk can be reduced to an acceptable level	Step 4 Report on findings	Step 5 Obtain endorsement to proceed to the next step
	• Consider secondary effects of mitigation works, including their risk and sustainability • Undertake preliminary design of the mitigation option including flow rates, capture zone analysis capacity and design concentrations				
Specific assessment location / area	Specific to land parcels affected by any negative impacts from changes to groundwater quality as a result of the projects	Specific to land parcels affected by any negative impacts from changes to groundwater quality as a result of the projects	Specific to land parcels affected by any negative impacts from changes to groundwater quality as a result of the projects	N/A	N/A
Timing of action, from commencement of this stage	Within 3 months	Within 3 months	Within 4 months	Within 4 months	Within 5 months
Data/information requirements	CRC CARE (2019)	CRC CARE (2019) *Guideline on performing remediation options assessment* United Nations (UN) Sustainable Development Goals (SDGs) Goal 9: *Build resilient infrastructure, promote sustainable*	AS/NZS ISO 31000:2018 Risk Management Process CRC CARE (2019)	All information and data compiled in enacting Stage 4 of this Plan	

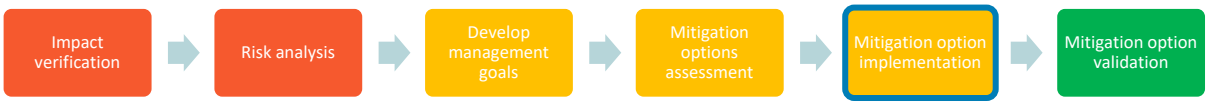
	Step 1 Assess technical feasibility	Step 2 Assess practical feasibility	Step 3 Confirm that risk can be reduced to an acceptable level	Step 4 Report on findings	Step 5 Obtain endorsement to proceed to the next step
		industrialization and foster innovation[7]			
Potentially relevant stakeholders[8]				DoT Melbourne Water Kingston City Council Land managers of affected land parcels	EPA Victoria DoT
Process	Complete Step 1 and if mitigation option is technically feasible, continue to Step 2. If not reconsider mitigation option.	Complete Step 2 and if mitigation option is practically feasible, continue to Step 3. If not reconsider mitigation option and return to Step 1.	Complete Step 3 iteratively, applying additional controls as required to reduce risk. Once residual risks are acceptable, continue to Step 4.	Complete Step 4 and continue to Step 5	Complete Step 5 and once regulatory endorsement is obtained, continue to the next stage in Plan implementation (Mitigation Options Implementation).

[7] The **Sustainable Development Goals** are the blueprint to achieve a better and more sustainable future for all. Goal 9 of the Sustainable Development Goals requires inclusive and sustainable industrialization, together with innovation and infrastructure, through introducing and promoting new technologies and enabling the efficient use of resources. https://www.un.org/sustainabledevelopment/infrastructure-industrialization/

[8] This list is not intended to be exhaustive, but rather it provides the Plan user with a shortlist of potentially relevant stakeholders that could participate as required

7 Stage 5: Mitigation option implementation

This stage provides guidance on the implementation of the adopted mitigation option(s), focussing on planning aspects, as well as monitoring and evaluation during mitigation commissioning.



Details on the specific aspects to be considered and key tasks to be undertaken in implementing this stage in the Plan are provided in Table 6.

Key outcome of this stage:

Once completed, the following outcomes should be achieved:

- A suitably experienced and qualified environmental contractor is engaged to implement construction aspects of the mitigation measure
- Each stakeholder responsible for an aspect of mitigation implementation is identified, and their roles and responsibilities are well defined
- All required permits and planning approvals are identified and obtained, including health, safety and environment planning, and stakeholders are notified accordingly
- Construction of mitigation implementation works is undertaken and completed in coordination with construction phase monitoring and evaluation of the adopted management goals (refer to Section 5; Stage 3) and to the satisfaction of regulatory agencies

The next stage in implementing this Plan requires validation of the implemented mitigation option in terms of the developed management goals, in accordance with relevant guidelines and in collaboration with relevant regulatory agencies, stakeholders and industry professionals.

Table 6 Mitigation option implementation stage – implementation guide

	Step 1 Identify, engage and collaborate with relevant contractors	Step 2 Identify, consult and collaborate with relevant stakeholders	Step 3 Obtain permits and approvals	Step 4 Construct and commission	Step 5 Report on findings	Step 6 Regulator and stakeholder engagement
Objective	Identify, engage and collaborate with relevant contractors	Involve relevant stakeholders to guide the mitigation option implementation process	Identify and obtain the relevant health, safety and environmental permits and any administrative approvals to undertake mitigation option implementation	Implement the mitigation option in accordance with regulatory requirements and health, safety and environment best practice	Document findings of this stage	Inform the regulator and relevant stakeholders that the mitigation option has been implemented
Method / Tasks	Engage a suitably experienced and qualified contractor and collaborate on mitigation construction	Identify relevant stakeholders and confirm their respective roles and responsibilities in implementing mitigating actions. This should include the: • Proponent • Environmental Practitioner • Contractor • Health and Safety Regulator • Environmental Regulator	Liaise with DoT, Kingston City Council, SRW and EPA Victoria to identify relevant permits to obtain and conditions to adhere to. Undertake health, safety and environmental planning through development of necessary plans, including: • Job safety and environmental analyses (JSEAs) • Emergency plans • Safe work procedures • Materials safety data sheets (MSDS) • Procedures for construction phase environmental management • Plan for unexpected finds	Contractor to perform mitigation implementation under appropriate supervision Undertake construction phase monitoring and evaluation in accordance with regulatory requirements	Document the process undertaken	Inform the relevant regulatory agencies and relevant stakeholder of outcomes, and advise on next steps Progress the implementation of the Plan in accordance with regulator advice

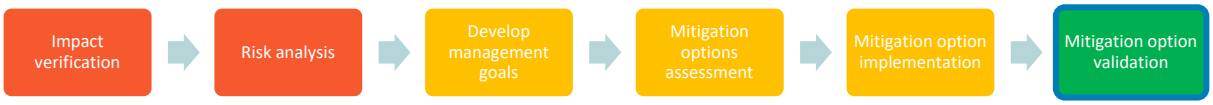
	Step 1 Identify, engage and collaborate with relevant contractors	Step 2 Identify, consult and collaborate with relevant stakeholders	Step 3 Obtain permits and approvals	Step 4 Construct and commission	Step 5 Report on findings	Step 6 Regulator and stakeholder engagement
Specific assessment location / area	Specific to land parcels affected by any negative impacts from changes to groundwater quality as a result of the projects	N/A	N/A	Specific to land parcels affected by any negative impacts from changes to groundwater quality as a result of the projects	N/A	Specific to land parcels affected by any negative impacts from changes to groundwater quality as a result of the projects
Timing of action, from commencement of this stage	Within 2 months	Within 2 months	Within 3 months	Up to 12 months, depending on the option to be implemented	Within 12 months	Within 12 months
Data/information requirements	N/A	International Association for Public Participation Australasia (IAP2) Spectrum	*Occupational Health and Safety Act 2004* Guideline on health and safety (CRC CARE, 2019) Safe Work Australia – relevant codes of practice	*Occupational Health and Safety Act 2004* Guideline on health and safety (CRC CARE, 2019) Safe Work Australia – relevant codes of practice Worksafe Victoria (2005)	All information and data compiled in enacting Stage 5 of this Plan	IAP2 Spectrum
Potentially relevant stakeholders[9]	DoT	EPA Victoria DoT	EPA Victoria DoT Melbourne Water	DoT EPA Victoria	DoT EPA Victoria Kingston City Council	EPA Victoria Kingston City Council

[9] This list is not intended to be exhaustive, but rather it provides the Plan user with a shortlist of potentially relevant stakeholders that could participate as required

	Step 1 Identify, engage and collaborate with relevant contractors	Step 2 Identify, consult and collaborate with relevant stakeholders	Step 3 Obtain permits and approvals	Step 4 Construct and commission	Step 5 Report on findings	Step 6 Regulator and stakeholder engagement
		Land managers of affected land parcels	Kingston City Council SRW WorkSafe Victoria	Kingston City Council WorkSafe Victoria	Land managers of affected land parcels	Land managers of affected land parcels
Process	Complete Step 1 and continue to Step 2	Complete Step 2 and continue to Step 3	Complete Step 3 and continue to Step 4	Complete Step 4 and continue to Step 5	Complete Step 5 and continue to Step 6	Complete Step 6 and continue to the next stage in Plan implementation (Mitigation Option Validation)

8 Stage 6: Mitigation option validation

This stage confirms whether the management goals established have been met and confirms whether negative impacts from changes to groundwater quality as a result of the projects have been appropriately managed and mitigated and no longer present an unacceptable risk.



Details on the specific aspects to be considered and key tasks to be undertaken in implementing this stage in the Plan are provided in Table 7.

Key outcome of this stage:

Once completed, the following outcomes should be achieved:

- A strategy is developed to demonstrate that mitigation objectives have been met
- Mitigation performance against established validation criteria is assessed, and the level of compliance with regulatory requirements is understood
- Regulators and stakeholders understand how the mitigation measure has performed, and if satisfied, provide consent / facilitation of mitigation close out
- Regulators and stakeholders facilitate the implementation of a Contingency Plan, if it is considered that mitigation performance, or residual risks, are unacceptable

This Plan is either terminated if mitigation performance and residual risk is acceptable, or continued if mitigation performance and residual risk is considered unacceptable.

Table 7 Mitigation option validation stage – implementation guide

	Step 1 Describe the objectives of the validation	Step 2 Obtain endorsement of the validation strategy	Step 3 Confirm that validation objectives are being met	Step 4 If required, enact a Contingency Plan	Step 5 Plan closure
Objective	To describe the overall goals of the validation, including the criteria that must be validated against, and the lines of evidence that will be used to demonstrate that the mitigation objectives have been met	Obtain endorsement of the drafted validation strategy Obtain agreement on the suggested validation monitoring endpoint	To confirm that validation criteria and mitigation objectives are being met	To determine and implement an agreed course of action in the event that mitigation does not reduce residual risk to human health and environmental receptors, to acceptable levels	To terminate this Plan if mitigation performance and residual risk is acceptable To identify any on-going aspects to be managed
Method / Tasks	Develop a validation strategy (plan): • Consider mitigation objectives • Consider developed Management Goals • Establish validation criteria, which should include: -Trend analysis (chemical concentrations, mass flux) - Mitigation end points • Develop a decision framework to confirm that the groundwater quality change has been resolved and that implementation of this Plan can be terminated (i.e. suggest a validation monitoring end-point) • Develop the framework of a Contingency Plan	Collaborate with the relevant regulatory agencies in developing an acceptable validation strategy Progress the implementation of the Plan in accordance with regulator advice	Undertake monitoring and evaluation of groundwater conditions (levels and specific quality parameters) through a 'multiple lines of evidence' approach Evaluate data against mitigation end points Update the CSM Verify compliance with regulatory requirements Regulator and stakeholder notification	Enact the preliminary Contingency Plan developed in Step 1 Develop the Contingency Plan further in collaboration with regulatory agencies and relevant stakeholders Determine the need to: • Revise the Mitigation Options Assessment (Stage 4 in this Plan) • Revise mitigation objectives or developed management goals • Introduce ongoing management • Impose institutional controls Enact the Contingency Plan developed in this Step	Document the findings of this stage, outlining the course of action taken, with evidence to support the recommendation for Plan closure Identify new infrastructure / assets introduced through enacting this Plan, and define the roles and responsibilities of responsible stakeholders Close out any planning tools that were required (licenses, approvals and development consents set by regulatory agencies)
Specific assessment location / area	All monitoring locations specified in EPR_GW2	All monitoring locations specified in EPR_GW2	All monitoring locations specified in EPR_GW2	Specific to land parcels affected by any negative impacts from changes to groundwater quality as a result of the projects	All areas within or adjacent to the project

	Step 1 Describe the objectives of the validation	Step 2 Obtain endorsement of the validation strategy	Step 3 Confirm that validation objectives are being met	Step 4 If required, enact a Contingency Plan	Step 5 Plan closure
Timing of action, from commencement of this stage	Within 1 month	Within 1 month	Within 6 months, or as agreed with regulatory agency in Step 2	Within 12 months, or as agreed with regulatory agency in Step 2	Within 8 months (if Step 4 is not required)
Data/information requirements	Guideline on validation and closure (CRC CARE, 2019) EPR_GW2 monitoring locations	Guideline on validation and closure (CRC CARE, 2019) EPR_GW2 monitoring locations IAP2 Spectrum	Monitoring procedures outlined in Appendix B and C of EPR_GW2 Project data portal Project database Defined alarms/triggers in Project data portal / ESdat EPA Victoria (2000) Publication 669	Section 6 of this Plan (Mitigation options assessment)	All information and data compiled in enacting this Plan
Potentially relevant stakeholders[10]		EPA Victoria Land managers of affected land parcels	EPA Victoria Land managers of affected land parcels	EPA Victoria Kingston City Council Land managers of affected land parcels DoT	EPA Victoria DoT Land managers of affected land parcels
Process	Complete Step 1 and continue to Step 2	Complete Step 2 and continue to Step 3	Complete Step 3. If residual risks are unacceptable, continue to Step 4 If residual risks are acceptable, skip to Step 5	Complete Step 4. Depending on the outcome, either: • Return to Step 3 (e.g. if an administrative solution is agreed to be suitable) • Return to the Mitigation options assessment stage (e.g. if an alternative technical solution is agreed to be suitable)	Complete Step 5 and close out this Plan

[10] This list is not intended to be exhaustive, but rather it provides the Plan user with a shortlist of potentially relevant stakeholders that could participate as required

9 Reporting, notification and audit

9.1 Reporting

If this Plan is implemented, the reporting requirements outlined in Table 8 must be completed by the entity implementing this Plan, in accordance with relevant guidelines and to the requirements of relevant regulatory agencies and stakeholders.

Table 8 Reporting requirements

Reporting requirement	Timing for completion	Entity to notify
Develop progress reports confirming compliance with the framework outlined in this Plan. **Progress reports may outline relevant compliance measures in summary, and append the relevant report required at the conclusion of each stage in this Plan.**	Upon completion of each stage in the implementation framework outlined in this Plan	LXRP (construction phase only) DoT (operation phase only) Kingston City Council
Interim report to inform EPR_GW2 Annual Compliance Reporting	Prior to submission of EPR_GW2 Annual Compliance Reporting	LXRP (construction phase only) DoT (operation phase only)

9.2 Data management

If this Plan is implemented, groundwater level and quality data collected as part of its implementation should be stored within the data management arrangements in place as part of the *Groundwater Monitoring and Management Plan (EPR_GW2)*, with data delivered in coordination with interim reporting outlined in Table 8.

Any groundwater level or quality data that is to be collected following closure of this *Groundwater Quality Mitigation Plan (EPR_CL5)*, must be incorporated within the monitoring requirements stipulated in the *Groundwater Monitoring and Management Plan (EPR_GW2)*. This is to be actioned through revision of the *Groundwater Monitoring and Management Plan (EPR_GW2)* upon its next scheduled revision, and may be instigated through the interim reporting outlined in Table 8.

10 Roles and responsibilities

Roles and responsibilities associated with this Plan are set out in Table 9. Where responsibilities and/or funding arrangements change depending on the project phase, this is outlined in Table 9.

Table 9 Roles and responsibilities – Groundwater Quality Mitigation Plan

Role	Responsibility	Funding	Additional details
Implementation of the Groundwater Quality Mitigation Plan (EPR_CL5)	**During construction**: LXRP **During operation**: The Head, TfV (DoT) or its delegate	**During construction**: Funds for implementation provided by the Head, TfV (DoT) if project related influences are not identified in Stage 1 of this Plan. If project related influences are identified in Stage 1 of this Plan, funds for implementation would be provided by SPA from that point forward. **During operation**: Funds for implementation provided by LXRP and reserved. Unspent funds returned to DoT after 10-year period.	Guidance / approval / endorsement of proposed mitigation approaches and designs to be provided by relevant stakeholders.
Closure of the Groundwater Quality Mitigation Plan (EPR_CL5) and cessation of environmental monitoring	**If closure is required during construction**: A suitably qualified and experienced environmental consultant on behalf of SPA **If closure is required during operation**: A suitably qualified and experienced environmental consultant on behalf of DoT	The Head, TfV (DoT)	Plan closure would require EPA Victoria approval. If environmental monitoring is required beyond closure of the EPR_CL5 Plan, this would be managed through incorporation in the EPR_GW2 Plan.
Management and maintenance of assets (mitigation and monitoring infrastructure) introduced by the Groundwater Quality Mitigation Plan (EPR_CL5)	The Head, TfV (DoT) delegated to Rail franchisee	The Head, TfV (DoT)	This includes: • Monitoring assets • Maintenance inspections • Maintenance repairs and/or replacements

11 References

AECOM-GHD Joint Venture (2020) *Southern Package 00 – Multiple Sites, Baseline Groundwater Quality Assessment Edithvale (ID18) & Bonbeach (ID46)*, LXRA-LX31-00-HZ-RPT-0013. Revision A. Level Crossing Removal Project, Melbourne.

AECOM-GHD Joint Venture (2018) *Edithvale and Bonbeach Level Crossing Removal Projects Environment Effects Statement Technical Report A Groundwater Impact Assessment*, LXRA-LX31-00-GE-EES-0001. Revision: 1. Level Crossing Removal Authority, Melbourne. Available at: https://levelcrossings.vic.gov.au/media/publications/ees/read-the-ees

AECOM-GHD Joint Venture (2018b) *Edithvale and Bonbeach Level Crossing Removal Projects Environment Effects Statement Technical Report C – Acid Sulfate Soils and Contamination* LXRA-LX31-00-HZ-EES-0001. Revision: 1. Level Crossing Removal Authority, Melbourne. Available at: https://levelcrossings.vic.gov.au/media/publications/ees/read-the-ees

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) (2019) *National Remediation Framework (NRF)*

EPA Victoria (2000) EPA Publication 669 – *Groundwater Sampling Guidelines*

EPA Victoria (2019) EPA Publication 1695.1 *Assessing and controlling risk: A guide for business*

EPA Victoria (2018) EPA Publication 1702 – *Fact sheet: Engaging consultants*

EPA Victoria (2006) EPA Publication 668 – *Hydrogeological Assessment (Groundwater Quality) Guidelines*. ISBN 0 7306 7658 7

International Association for Public Participation (IAP2) International Federation (2018) *IAP2 Spectrum of Public Participation*. https://iap2.org.au/wp-content/uploads/2020/01/2018_IAP2_Spectrum.pdf

Level Crossing Removal Project (2020a) *Edithvale and Bonbeach Groundwater Monitoring and Management Plan*. Version 3. 21/08/2020

Level Crossing Removal Project (2020b) *Edithvale Wetland Monitoring and Mitigation Plan*, Edithvale and Bonbeach Level Crossing Removal Projects. Version 2. 17/06/2020

Level Crossing Removal Project (2018) *Edithvale and Bonbeach Level Crossing Removal Projects, Environmental Management Framework*

National Environment Protection Council (NEPC) (1999) Na*tional Environment Protection (Assessment of Site Contamination) Measure (NEPM)*, Amended 11 April 2013

Southern Program Alliance (2019) *AWP2 Groundwater Impact Assessment Report*, STP-000-C-SPA-REP-00-MMN-CGT-0002, Rev A, 11 December 2019

Southern Program Alliance (2019b) *AWP2 Groundwater Modelling Report*, STP-000-C-SPA-REP-00-MMN-CGT-0003, Rev A, 11 December 2019

Worksafe Victoria (2005) *Industry standard: Contaminated construction sites – construction and utilities*, Victorian Workcover Authority, Melbourne, Australia

Appendix A: EPR requirements

EPR_CL5 requirements

EPR_CL5 states:

Prior to the completion of the Projects, prepare and fund the implementation of a Groundwater Quality Mitigation Plan in consultation with the land manager of any affected land parcels to manage and mitigate any negative impacts from changes to groundwater quality as a result of the projects.

The Plan shall be implemented following the completion of the projects if the relevant trigger level within the Groundwater Monitoring and Mitigation Plan (EPR_GW2) is met.

The Plan must include:

a. measures to manage any negative impacts on the beneficial use of groundwater caused by acidification that is attributable to the project(s) so as to maintain existing beneficial use of groundwater

b. measures to manage any negative impacts on the beneficial use of groundwater caused by contaminated groundwater transfer or plume migration that is attributable to the project(s) so as to maintain existing beneficial use of groundwater

c. measures to manage any negative impacts on the beneficial use of groundwater caused by changes to salinity that is attributable to the project(s) so as to maintain existing beneficial use of groundwater

d. the entity or entities responsible for implementation of any management and mitigation measures.

The plan must meet the requirements outlined in Table 10.

Table 10 EPR_CL5 requirements and location (document/section) where this requirement is addressed

	EPR_CL5 requirements	Location in this Plan
a	Must include measures to manage any negative impacts on the beneficial use of groundwater caused by acidification that is attributable to the project(s) so as to maintain existing beneficial use of groundwater	Overall management framework outlined in Section 2.2. Detailed approach in Sections 3 to 8.
b	Must include measures to manage any negative impacts on the beneficial use of groundwater caused by contaminated groundwater transfer or plume migration that is attributable to the project(s) so as to maintain existing beneficial use of groundwater	Overall management framework outlined in Section 2. Detailed approach in Sections 3 to 8.
c	Must include measures to manage any negative impacts on the beneficial use of groundwater caused by changes to salinity that is attributable to the project(s) so as to maintain existing beneficial use of groundwater	Overall management framework outlined in Section 2. Detailed approach in Sections 3 to 8.
d	Must include the entity or entities responsible for implementation of any management and mitigation measures.	Section 10 – Roles and Responsibilities

EPRs relating to groundwater quality

Several EPRs relate to groundwater quality monitoring, management and mitigation, depending on the project phase. Table 11 outlines the relevance of each Plan relating to groundwater quality in the context of project phase.

Table 11 EPRs relating to the groundwater quality

EMF EPR	Relevant during project construction	Relevant during project operation
Groundwater Monitoring and Management Plan (EPR_GW2)	√	√
Groundwater Quality Mitigation Plan (EPR_CL5)	√	√
Edithvale Wetlands Monitoring and Mitigation Plan (EPR_FF7)		√
Construction Environmental Management Plan (EPR_EMF2)	√	
Acidic and/or contaminated groundwater (construction) (EPR_CL4)	√	

Groundwater Monitoring and Management Plan (EPR_GW2)
Prior to construction (excluding preparatory works), prepare and fund the implementation of a Groundwater Monitoring and Management Plan in consultation with Southern Rural Water, EPA Victoria, Melbourne Water, Kingston Council, DELWP to monitor and manage predicted and potential impacts to groundwater as a result of the projects.

The Groundwater Monitoring and Management Plan must include:

a. detailed groundwater level monitoring parameters with timing and location of monitoring bores

b. parameters and timing for monitoring groundwater quality to identify any changes to contaminant transfer or plume migration (if present) caused by the projects

c. duration of the groundwater monitoring program for at least 10 years, (components of the plan may cease earlier if considered appropriate following periodic reviews (refer point d)

d. provision for periodic review as required, and not less than every second year, to consider the adequacy of the groundwater monitoring program and the need for future groundwater monitoring

e. the entity responsible for the implementation of the plan

f. the entity responsible for the ownership and management of monitoring network assets

g. clear trigger events or levels for changes in groundwater level or quality that require one or more of the following actions:

i. implementation of the Groundwater Quality Mitigation Plan (EPR_CL5)

ii. implementation of the mitigation component of the Edithvale Wetlands Monitoring and Mitigation Plan (EPR_FF7)

The Groundwater Monitoring and Management Plan must be publicly available and results from the monitoring program must be reported to the public annually or as otherwise required by the Commonwealth EPBC Approval 2017/7906.

Acidic and/or contaminated groundwater (construction) (EPR_CL4)
Develop and implement measures within the Construction Environmental Management Plan (EPR EMF2) to manage acidic and/or contaminated groundwater, in accordance with the State Environment Protection Policy (Groundwaters of Victoria) 1997, State Environment Protection Policy (Waters of Victoria) 2004, State Environment Protection Policy (Prevention and

Management of Contamination of Land) 2002, Water Industry Regulations 2006, and relevant EPA Victoria regulations, standards and best practice guidance.

Measures must include:

a) a baseline groundwater quality assessment (taking into account site history) at least three months prior to commencement of construction works

b) a system to manage and/or dispose of intercepted groundwater (if required) which may be a trade waste agreement with South East Water or other measures in accordance with relevant guidelines and legislation (if a trade waste agreement is not granted)

c) procedures for collection, treatment, disposal and handling of contaminated groundwater and/or slurries, including vapours

d) water quality monitoring of intercepted groundwater and run-off containment areas during construction

e) contamination plume management procedures (if required)

Appendix B: Risks and potential events relevant to this Plan

Risks and potential events relevant to this Plan

Introduction

Following on from the project related groundwater risks identified and assessed as part of the EES, this section provides an outline of previously identified risks that could result in negative impacts from changes to groundwater quality as a result of the projects, and are therefore relevant to this Plan.

This summary is provided for information purposes only and as an indicative summary of the understanding of project risks to groundwater quality and beneficial uses as they were understood prior to the commencement of project construction. The aim here is to contextualise these risks in terms of the likely requirement to implement this Plan and the potential events that could occur for these risks to be realised.

Background

This high level overview of relevant project induced risks to groundwater quality considers the following studies undertaken prior to the commencement of project construction:

- Risk of project induced saltwater intrusion potentially affecting beneficial uses identified in the EES (AECOM-GHD JV, 2018)
- Risk of project induced CASS activation potentially affecting beneficial uses identified in the EES (AECOM-GHD JV, 2018b)
- The potential sources of contamination (PSOCs) identified as part of the EES (AECOM-GHD JV, 2018b)
- The potential groundwater impacts predicted through the November 2019 update of the EES numerical groundwater model
- The updated Edithvale and Bonbeach project designs (August 2019)
- The findings of the Baseline Groundwater Quality Assessment (AECOM-GHD JV, 2020)
- The Groundwater Monitoring and Management Plan (EPR_GW2) (LXRP, 2020a)

Potential project induced risks

The key risks to groundwater quality and potential events that could occur are outlined in Table 12 and Table 13 for the project construction phase and operation phase, respectively.

An outline of risk management controls that should be in place under the EMF (LXRP, 2018), along with relevant aspects to consider (as identified through previous studies), are provided for information purposes in Table 12 and Table 13 for the project construction phase and operation phase, respectively.

The need for mitigation of specific events would depend on the risk ratings, which would be analysed through implementing this Plan (specifically through Stage 2: Risk analysis).

Table 12 Potential project induced risks and events that could affect groundwater quality – project construction phase

Risk	Potential risk event (Construction phase)	Assumed controls [1]	Relevant aspects to consider in assessing risk	Reference
Groundwater acidification	Disturbance of acid sulfate soils results in the acidification of groundwater	Spoil Management Plan (EPR_CL1) Acid Sulfate Soil Management Plan (EPR_CL2) Construction Environment Management Plan (EPR_EMF2)	Potential area of impact confined within the trench (i.e. between the pile walls). Identified CASS is not spatially widespread. [Sheet] piling process is unlikely to introduce oxygen below the water table.	AECOM-GHD JV (2018, 2018b) SPA (2019b)
	Drawdown leads to the activation of acid sulfate soils which results in the acidification of groundwater	Groundwater performance outcomes (EPR_GW1)	Drawdown not predicted to be significant in spatial extent or magnitude. Identified CASS is not spatially widespread. Numerous groundwater users, including unregistered bores.	SPA (2019b) AECOM-GHD JV (2018, 2018b)
	Dewatering leads to the activation of acid sulfate soils which results in the acidification of groundwater	Construction Environment Management Plan (EPR_EMF2)	Potential area of impact confined within the trench (i.e. between the pile walls), but could spread beyond the trench. Construction method is likely to require dewatering in locations where a base slab is required. Identified CASS is not spatially widespread. Dewatering process likely to introduce oxygen below the water table.	AECOM-GHD JV (2018, 2018b) Construction Environmental Management Plan (EPR EMF2)
Contaminated groundwater migration	Drawdown/mounding results in the migration of hydrocarbon contaminated groundwater (including LNAPL) causing pollution	Groundwater performance outcomes (EPR_GW1) Acidic and/or contaminated groundwater (EPR_CL4)	Construction method is likely to require dewatering in locations where a base slab is required. If contamination is migrated into the trench, this water would be managed appropriately	Construction Environmental Management Plan (EPR EMF2)
	Drawdown/mounding results in the migration of chlorinated hydrocarbon (i.e. trichloroethylene/vinyl	Groundwater performance outcomes (EPR_GW1)	Construction method is likely to require dewatering in locations where a base slab is required. If contamination is migrated into the trench, this water would be managed appropriately Potential human health risk to workers due to vapours in trench	Construction Environmental Management Plan (EPR EMF2)

Risk	Potential risk event (Construction phase)	Assumed controls [1]	Relevant aspects to consider in assessing risk	Reference
	chloride) contaminated groundwater (including DNAPL) causing pollution			
	Drawdown/mounding results in the migration of PFAS contaminated groundwater causing pollution	Groundwater performance outcomes (EPR_GW1)	Construction method is likely to require dewatering in locations where a base slab is required. If contamination is migrated into the trench, this water would be managed appropriately	Construction Environmental Management Plan (EPR EMF2)
	Dewatering leads to the migration of contaminated groundwater causing pollution	Construction Environment Management Plan (EPR_EMF2)	Potential area of impact confined within the trench (i.e. between the pile walls), but could spread beyond the trench. If contamination is migrated into the trench, this water would be managed appropriately	Construction Environmental Management Plan (EPR EMF2)
Groundwater salinisation	N/A	N/A	N/A	N/A

[1]: Assumed implementation of relevant controls in the Environmental Management Framework (EMF) (LXRP, 2018).

Table 13 Potential project induced risks and events that could affect groundwater quality – project operation phase

Risk	Potential risk event (Operation phase)	Assumed controls [1]	Relevant aspects to consider in assessing risk	Reference
Groundwater acidification	Drawdown leads to the activation of acid sulfate soils which results in the acidification of groundwater	Groundwater performance outcomes (EPR_GW1)	Drawdown not predicted to be significant in spatial extent or magnitude. Identified CASS is not spatially widespread. Numerous groundwater users, including unregistered bores.	AECOM-GHD JV (2018, 2018b) SPA (2019, 2019b)
Contaminated groundwater migration	Drawdown/mounding results in the migration of hydrocarbon contaminated groundwater (including LNAPL) causing pollution	Groundwater performance outcomes (EPR_GW1)	Trench design should minimise magnitude and spatial extent of mounding and drawdown in locations where potential contamination sources have been identified	SPA (2019, 2019b)
	Drawdown/mounding results in the migration of chlorinated hydrocarbon (i.e. trichloroethylene/vinyl chloride) contaminated groundwater (including DNAPL) causing pollution	Groundwater performance outcomes (EPR_GW1)	Several potential contamination sites, but mostly on the western side of the trench. Contaminant concentrations likely to be low (several small sources)	AECOM-GHD JV (2018b, 2020)
	Drawdown/mounding results in the migration of PFAS contaminated groundwater causing pollution	Groundwater performance outcomes (EPR_GW1)	Exceedances of drinking water criteria have been measured in numerous (but not all) bores across the predicted area of groundwater impact The most significant likely contamination source is in vicinity of the intermediate pile wall system, and potential for project induced migration along the pile wall may occur	AECOM-GHD JV (2018b, 2020)
Groundwater salinisation	Drawdown and upconing results in the increase in Total Dissolved Solids causing pollution.	Groundwater performance outcomes (EPR_GW1)	Impact predicted to occur over several decades and predicted impact to beneficial uses predicted to occur after 100 years (end of project design life). Predicted drawdown is not likely to be sustained for prolonged periods. Predicted drawdown is not expected to occur to the extent and magnitude that upconing would occur	Appendix F of AECOM-GHD JV (2018)

Appendix C: Risk assessment framework

Suggested risk framework

Introduction

Following on from the project related groundwater risks identified previously in **Appendix B: Risks and potential events relevant to this Plan**, this section outlines a suggested qualitative risk assessment framework to adopt in the implementation of this Plan. It focusses on the key risks that relate to this Plan as they are understood prior to commencement of project construction.

The aim here is to provide an industry leading approach to the assessment of risks, events and potential for mitigation, that is consistent with the assessment of risks in previous studies related to the Projects.

Method

This qualitative risk framework was developed in general accordance with the method and descriptors presented in EPA Victoria's Assessing and Controlling Risk: A guide for business (EPA Publication 1695.1). The risk management approach outlined is based on the framework in the *Australian Standard AS/NZS ISO 31000:2009 Risk management — Principles and guidelines*.

Assessing likelihood

The likelihood of each risk occurring should be assessed using likelihood descriptors provided in Table 14.

Table 14 Suggested likelihood descriptors

	Likelihood	Descriptor
A	Certain	Expected to happen regularly under normal circumstances
B	Likely	Expected to happen at some time
C	Possible	May happen at some time
D	Unlikely	Not likely to happen in normal circumstances
E	Rare	Could happen but probably never will

Assessing consequence

The consequence descriptors shown in Table 15 should be used to describe the impact of a risk occurring. The consequence description provides an indication of the impact in the event that the trigger is met and it is demonstrated that impacts have been realised (i.e. likelihood is no longer relevant as the event has occurred).

Table 15 Suggested qualitative measures of consequence

Qualitative descriptor	5. Negligible	4. Minor	3. Moderate	2. Major	1. Extreme
Consequence description	**Minimal, if any impact locally. Potentially some impact for a small number (<10) of individuals**	**Low level impact locally, or high impact for a small number (<10) of individuals**	**High level of impact locally, or moderate impact for the broader area**	**High level of impact for the broader area**	**High level of impact for the broader area**
ENVIRONMENT Groundwater	Changes to groundwater quality have no detectable impact.	Changes to groundwater quality within range of typical variation and does not result in loss of one or more beneficial uses of groundwater.	Changes to groundwater quality results in temporary and reversible loss of one or more beneficial uses of groundwater.	Changes to groundwater quality results in permanent loss of one or more beneficial uses of groundwater in a local area.	Changes to groundwater quality results in permanent loss of one or more beneficial uses of groundwater over a widespread area.
PUBLIC HEALTH AND SAFETY Illness / Injury / Fatality	Potential impact to less than 10 individuals.	Potential impact to more than 10 individuals. Minor injury or illness to less than 10 individuals.	Minor injury or illness to between 10 and 100 individuals. Major injury or illness to 1 individual.	Minor injury or illness to between 100 and 1000 individuals. Major injury or illness to between 1 and 10 individuals. 1 fatality or serious injury.	Major injury or illness to greater than 10 individuals. Numerous fatalities or serious injuries.
ECONOMIC Mitigation Cost	Mitigation of off-site impact not required	Off-site impact involving minor rectification costs (<$1,000,000)	Off-site impact requiring moderate rectification costs ($1,000,000 - $5,000,000)	Offsite impact (e.g. groundwater contamination) resulting in requirement for substantial rectification works (e.g. $5 – $10 million).	Offsite impact (e.g. groundwater contamination) resulting in requirement for substantial rectification works (e.g. >$10 million).

Assessing the level of risk

As outlined in EPA Publication 1695.1, the level of risk is a combination of the likelihood of a risk occurring and the consequence of it occurring. A suggested risk register is shown in Table 16, and the suggested descriptions of risk ratings are shown in Table 17.

Table 16 Qualitative risk analysis matrix – Level of risk

Consequence		Likelihood				
		A	B	C	D	E
		Certain	Likely	Possible	Unlikely	Rare
1	Extreme	E	E	H	H	M
2	Major	E	H	H	M	M
3	Moderate	H	H	M	M	L
4	Minor	M	M	M	L	L
5	Negligible	M	L	L	L	L

Table 17 Description of risk ratings

Risk Level	Risk level description
Extreme	Unacceptable level of risk. Take action immediately
High	Unacceptable level of risk. Controls must be put in place to reduce or eliminate risks
Medium	Unacceptable level of risk. Controls must be put in place to reduce or eliminate risks
Low	Acceptable level of risk. Attempt to eliminate, but higher risks take priority

Risk analysis framework

An assessment of project induced risks to groundwater beneficial uses as defined by SEPP (Waters) 2018 should be undertaken in accordance with the risk framework described in this section. The likelihood, consequence and residual risk ratings applied during the risk assessment process should be analysed for the project construction phase and for the project operation phase.

Appendix D: Mitigation Measure Examples

This section provides an overview of potential mitigation measures that could be considered as part of implementation Stage 4: Mitigation options assessment (Section 6 of this Plan).

A selection of potential technology options that could be considered in Stage 4: Mitigation options assessment to mitigate risks relevant to this Plan are summarised in Table 18 and Table 19, for groundwater level mitigation options and groundwater quality mitigation options, respectively.

A comprehensive list of potential mitigation options is provided within the NRF (CRC CARE, 2019). The NRF[11] or its successors should be consulted in considering current, industry accepted mitigation technologies/options, and strategic guidance and oversight in their implementation.

[11] https://www.crccare.com/knowledge-sharing/national-remediation-framework

Table 18 Examples of groundwater level impact mitigation measures

Mitigation measure	Description	Suitability of implementation		Focus of mitigation measure		Relevant groundwater quality risk		
		Project construction	*Project operation*	*Reducing project induced groundwater drawdown*	*Reducing project induced groundwater mounding*	*Groundwater acidification*	*Contaminated groundwater migration*	*Groundwater salinisation*
Revised dewatering program	This would involve the cessation or modification of any construction phase dewatering being undertaken by SPA, with the aim to reduce drawdown effects caused by construction dewatering.	✓		✓		✓	✓	
Groundwater equalisation (Passive horizontal drain)	This would involve the installation of linear, horizontal subsurface infrastructure to reduce groundwater hydraulic head differences across the projects, thus maintaining groundwater flow from east to west and minimising the magnitude and spatial area affected by groundwater mounding and drawdown.	✓	✓	✓	✓	✓	✓	✓
Groundwater equalisation (Relief bores)	This would involve the installation of subsurface infrastructure to reduce groundwater hydraulic head differences across the projects, thus maintaining groundwater flow from east to west and minimising the magnitude and spatial area affected by groundwater mounding and drawdown.	✓	✓	✓	✓	✓	✓	✓
Managed Aquifer Recharge (MAR)	This would involve aquifer storage, transfer and recovery techniques to extract groundwater through active pumping from bores in areas of mounding, transfer extracted water via a pipeline	✓	✓	✓	✓	✓		✓

Mitigation measure	Description	Suitability of implementation		Focus of mitigation measure		Relevant groundwater quality risk		
		Project construction	*Project operation*	*Reducing project induced groundwater drawdown*	*Reducing project induced groundwater mounding*	*Groundwater acidification*	*Contaminated groundwater migration*	*Groundwater salinisation*
	network, and inject transferred water into recovery bores in areas of drawdown. This could involve fresh water injection from areas of shallow mounding, and abstraction of saltwater from deeper intervals targeting the saltwater wedge.							
MAR: Groundwater recharge only (injection bores)	This would involve actively injecting or infiltrating fresh (low salinity) water into the subsurface to displace denser, saltier groundwater.	✓	✓	✓		✓	✓	✓
MAR: Groundwater recharge only (passive infiltration)	This would involve passively infiltrating fresh (low salinity) water into the subsurface to displace denser, saltier groundwater. Infiltration methods include bank filtration, infiltration ponds (recharge basins) and infiltration trenches. For example, raingardens for stormwater infiltration and focused groundwater recharge.	✓	✓	✓		✓		✓
Groundwater abstraction only (abstraction bores)	Numerous groundwater pumping options could be considered. For example, spear-points or conventional electrical submersible systems.	✓	✓		✓		✓	

Table 19 Examples of groundwater quality impact mitigation measures

Mitigation measure	Description	Suitability of implementation		Focus of mitigation measure			Potential application / relevant groundwater quality risk		
		Project construction	*Project operation*	*Source*	*Pathway*	*Receptor*	*Groundwater acidification*	*Contaminated groundwater migration*	*Groundwater salinisation*
Groundwater abstraction and treatment	This would involve targeted installation of groundwater extraction bores, from which groundwater could be extracted from the affected aquifer, treating the groundwater (e.g. through a desalination process), then injecting the same water into the same aquifer. Options for both ex-situ and in-situ treatment could be explored.	✓	✓	✓	✓		✓	✓	✓
MAR: Groundwater recharge only (injection bores)	This would involve actively injecting or infiltrating fresh (low salinity) water into the subsurface to displace denser, saltier groundwater.	✓	✓		✓	✓	✓	✓	✓
MAR: Groundwater recharge only (passive infiltration)	This would involve passively infiltrating fresh (low salinity) water into the subsurface to displace denser, saltier groundwater.	✓	✓		✓	✓	✓	✓	✓
MAR: injection and abstraction	This would involve fresh water injection from areas of shallow mounding, and abstraction of saltwater from deeper intervals targeting the saltwater wedge	✓	✓	✓			✓		✓
Physical barriers (deep soil mixing)	This would involve installation of physical barriers to prevent seawater from moving into fresh groundwater		✓		✓			✓	✓

Mitigation measure	Description	Suitability of implementation		Focus of mitigation measure			Potential application / relevant groundwater quality risk		
		Project construction	*Project operation*	*Source*	*Pathway*	*Receptor*	*Groundwater acidification*	*Contaminated groundwater migration*	*Groundwater salinisation*
In-situ air sparging	This would involve the injection of air below the water table to assist in breaking down contaminants through volatilisation and biodegradation.		✓	✓				✓	
Chemical oxidation or reduction	This would involve in-situ chemical oxidation (and surfactant enhanced in-situ chemical oxidation) to break down chemicals into less hazardous forms		✓	✓				✓	
Monitored natural attenuation	A variety of physical, chemical or biological processes that, under favourable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. This is typically applicable only if the primary source has been controlled, and risks are demonstrated to be, or can be controlled to be, low and acceptable.		✓		✓			✓	
Barrier systems (permeable reactive barriers and cut off walls)	This would involve interception of groundwater through the installation of a permeable reactive barrier across the flow path of the groundwater contaminant plume, allowing the plume to passively pass through the wall, but the reactive media either sorbs, degrades or transforms contaminants. Common reactive media include zero valent iron, natural zeolites and organic substrates.		✓		✓		✓	✓	

Appendix E: Bore Locations

The bore locations presented in this Plan show the bore locations at the time of reporting and are subject to change and/or modification as per the *Groundwater Monitoring and Management Plan (EPR_GW2)* (LXRP, 2020a). For updated bore locations, please refer to the *Groundwater Monitoring and Management Plan (EPR_GW2)* (LXRP, 2020a).

Appendix F: Broader Project Groundwater Monitoring Locations

Bore ID	Bore location
CHEL-BH04	1A Newington Parade, Chelsea
ID121-BH01	1 Barnes Grove, Chelsea
ID121-BH02	Embankment Grove (Cnr Embankment Grove/Station Street), Chelsea
ID121-BH04	2 Glenola Road, Chelsea
ID121-BH05	Cross Road (Cnr Cross Road/Ella Grove), Chelsea
ID121-BH07	17 Foy Avenue, Chelsea
ID121-BH08	17 Foy Avenue, Chelsea
ID121-BH09	3 Drinan Road, Chelsea
ID121-BH10	5 Showers Avenue, Chelsea
ID121-BH11	The Beachway (Cnr The Beachway/Nepean Highway), Chelsea
ID121-BH13	43 Glenola Road, Chelsea
ID121-BH15	2 Argyle Avenue, Chelsea
ID18-BH10	Edithvale-Seaford Wetlands Environmental Area, Chelsea Heights
ID18-BH11	117 Edithvale Road, Edithvale
ID18-BH12	Edithvale-Seaford Wetlands Environmental Area, Chelsea Heights
ID18-BH13	Edithvale-Seaford Wetlands Environmental Area, Chelsea Heights
ID18-BH14	Edithvale-Seaford Wetlands Environmental Area, Chelsea Heights
ID18-BH15	Edithvale-Seaford Wetlands Environmental Area, Edithvale
ID18-BH16	Edithvale-Seaford Wetlands Environmental Area, Chelsea Heights
ID18-BH17	Edithvale-Seaford Wetlands Environmental Area, Chelsea Heights

Bore ID	Bore location
ID18-BH18	Edithvale-Seaford Wetlands Environmental Area, Edithvale
ID18-BH24	Bristol Lane, Edithvale
ID18-BH36	3 Northcliffe Road, Edithvale
ID18-BH37	15 Bayside Avenue, Edithvale
ID46-BH11	1A Newberry Avenue, Bonbeach
ID46-BH14	1A Williams Grove, Bonbeach
ID46-BH15	319 Station Street, Chelsea
ID46-GWBH01	2 Harding Avenue, Bonbeach
ID46-GWBH05	2 Zephyr Place, Bonbeach
ID46-GWBH06	2 Zephyr Place, Bonbeach