

**LEGEND**

- Proposed Development Envelope
  - Development Envelope
  - Development Envelope (tunnelling)
  - Proposed Temporary Construction Footprint
  - Black Cockatoo Foraging Habitat
- Black Cockatoo Potential Breeding Trees
  - Within Development Envelope (3)
  - Outside Development Envelope (175)

**DATA SOURCES**

- ALIGNMENT DATA PROVIDED BY WATER CORPORATION 2016
- BLACK COCKATOO HABITATS SURVEYED BY 360 ENVIRONMENTAL 2016 AND ECOLOGICA 2015
- LOCALITY MAP SOURCED LANDGATE 2006 AERIAL PHOTOGRAPHY SOURCED LANDGATE FEB 2016
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NOTE THAT POSITIONAL ERRORS MAY BE >5M IN SOME AREAS

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**WATER CORPORATION**

CREATED JJ/MH	CHECKED TM	APPROVED SS	REVISION 0	DATE 25/10/2016
HORIZONTAL DATUM GDA 1994 MGA Zone 50		PROJECT NO 1551		

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Meters  
1:8,000 @ A3

**Water Corporation**

**Groundwater Replenishment Scheme (GWRS) Stage 2**

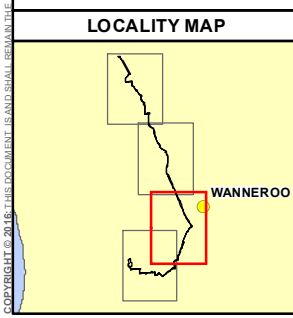
**Referral under Section 38 of the EP Act**

**Figure 7.4 - Map A**  
**Black Cockatoo Habitat**

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MAP C

MAP A



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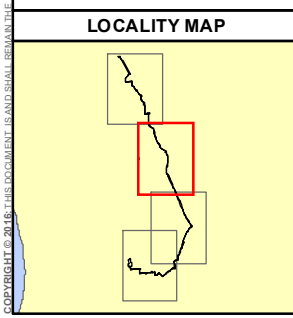
**Water Corporation**

**Groundwater Replenishment Scheme (GWRS) Stage 2**

**Referral under Section 38 of the EP Act**

**Figure 7.5 - Map B**  
**Black Cockatoo Habitat**

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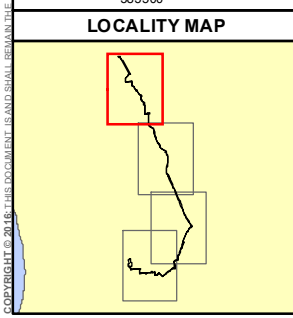
**Water Corporation**

**Groundwater Replenishment Scheme (GWRS) Stage 2**

**Referral under Section 38 of the EP Act**

**Figure 7.6 - Map C**  
**Black Cockatoo Habitat**

K:\Projects\2.0 INF\1551 GWRP\Figures\38 Referral\1551 S38 Figure 5.6C - Black Cockatoo Habitat.mxd



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**Water Corporation**

**Groundwater Replenishment Scheme (GWRs) Stage 2**

**Referral under Section 38 of the EP Act**

**Figure 7.7 - Map D**  
**Black Cockatoo Habitat**

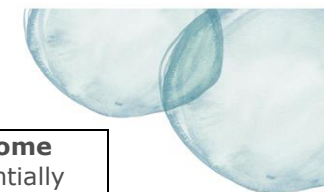
K:\Projects\2.0 INF\1551 GWRP\Figures\S38 Referral\1551 S38 Figure 5.7D - Black Cockatoo Habitat.mxd

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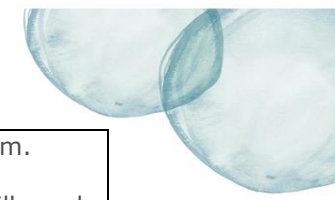


**Table 7.5: Hydrological Processes – Assessment Table**

Inherent Impact	Environmental Aspect	Mitigation actions to address residual impacts	Proposed regulatory mechanisms for ensuring mitigation	Outcome to demonstrate that proposal meets EPA objective
<p><b>EPA Objective: <i>To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.</i></b></p>				
<ul style="list-style-type: none"> <li>• Groundwater replenishment is a sustainable, climate independent long term public water supply option.</li> <li>• A risk assessment on the potential impact of recharge to the Superficial, Leederville and Yarragadee aquifers has indicated that the hydrological regimes of these aquifers will not be impacted by the Proposal. These risk assessments have been endorsed by the DoW and the DoH. A risk assessment summary is provided in <b>Appendix G</b>. Endorsement of this risk assessment process and outcomes has been provided by the DoW and the DoH (Section 3.3).</li> <li>• The presence of a confining layer above the Leederville aquifer in the locations of the proposed recharge sites will prevent recharge influencing the water levels within the Superficial aquifer locally. This confining layer (upper section of the Wanneroo member) consists of consolidated siltstone and mudstone, and occurs between 108 m and 140 m below ground level (bgl) at the proposed northern recharge site (Water Corporation 2016). A confining layer (Kardinya Shale and the Wanneroo Member) is also present at the southern recharge site (DoW 2013).</li> <li>• In order for recharge to influence Superficial aquifer water levels at a regional scale, the pressure in the Leederville aquifer must be greater than the pressure at the base of the Superficial aquifer. Groundwater pressure in the Superficial aquifer exceeds that in the Leederville aquifer. Modelling for the Proposal indicates that the rate of recharge is not great enough to reverse this situation. Therefore it is extremely unlikely that water levels in the Superficial aquifer will be impacted by the Proposal (DoW 2013).</li> <li>• The recharge sites have been located to ensure abstraction does not cause impact to the hydrological regime of the Leederville and the Yarragadee aquifers. The proposed recharge locations have been selected in consultation with the DoW to meet the objectives of the PRCAC study (refer to Section 3.2.5). These locations have been selected to optimise the abstraction of groundwater for public water supply, contributing to the management of the Gngara groundwater system.</li> <li>• Impact to the Leederville and Yarragadee aquifers can also be prevented by managing recharge rates. Modelling and investigations from the GWRT and Stage 1 of the GWRS have informed recharge rates for Stage 2 of the GWRS and will be further refined following site specific investigations in 2017.</li> </ul>				



<p><b>Potential Impact 1</b></p> <ul style="list-style-type: none"> <li>Alteration of surface water flows</li> </ul>	<p><b>Aspect 1</b></p> <p>Construction and physical presence of:</p> <ul style="list-style-type: none"> <li>Recharge pipeline</li> </ul>	<p><b>Management of Aspect 1</b></p> <ul style="list-style-type: none"> <li>Construction of the recharge pipeline will be completed in sections, with the length of sections of open trench kept to a minimum.</li> <li>The recharge pipeline will be installed below ground level, through a combination of open trenching and tunnelling techniques, such that no impact to surface water flows will occur during operations.</li> </ul>	<p><b>Regulation of Aspect 1</b></p> <ul style="list-style-type: none"> <li>CEMF</li> </ul>	<p><b>Environmental Outcome</b></p> <p>The Proposal will potentially result in temporary alteration of surface water and superficial groundwater flows during construction which will be managed through the implementation of a CEMP in line with objectives set out in the CEMP. This is not expected to present significant impacts to surface water flows or groundwater flows within the Superficial aquifer.</p> <p>Given that the proposed recharge sites are located where the Leederville and Yarragadee aquifers are confined, upward flow into the Superficial aquifer will be prevented.</p> <p>Minor alteration of pressure within the Leederville and Yarragadee aquifers is expected as a result of the implementation of the Proposal, however is not expected to result in significant impacts to hydrological processes within</p>
<p><b>Potential Impact 2</b></p> <ul style="list-style-type: none"> <li>Alteration of Superficial aquifer groundwater flows</li> </ul>	<p><b>Aspect 2</b></p> <p>Construction and physical presence of:</p> <ul style="list-style-type: none"> <li>Recharge pipeline</li> </ul>	<p><b>Management of Aspect 2</b></p> <ul style="list-style-type: none"> <li>Construction of the recharge pipeline will be completed in sections, with the length of sections of open trench kept to a minimum.</li> <li>Any required dewatering of the trench will be short term and managed through the implementation of a CEMP in line with objectives as set out in the CEMP.</li> </ul>	<p><b>Regulation of Aspect 2</b></p> <ul style="list-style-type: none"> <li>CEMF</li> </ul>	
<p><b>Potential Impact 3</b></p> <ul style="list-style-type: none"> <li>Altered groundwater levels in Superficial aquifer resulting from increased pressure in the underlying aquifers</li> </ul>	<p><b>Aspect 3</b></p> <p>Operation of:</p> <ul style="list-style-type: none"> <li>Groundwater recharge</li> </ul>	<p><b>Management of Aspect 3</b></p> <ul style="list-style-type: none"> <li>Presence of confining layer will prevent recharge influencing water levels in the Superficial aquifer.</li> </ul>	<p><b>Regulation of Aspect 3</b></p> <ul style="list-style-type: none"> <li>GWR Regulatory Framework</li> <li>RIWI Act</li> </ul>	



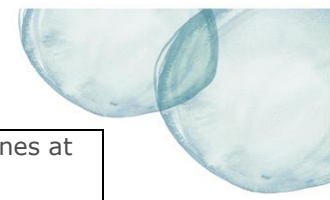
<b>Potential Impact 4</b> <ul style="list-style-type: none"><li>Alteration of pressure within the Leederville and Yarragadee aquifers</li></ul>	<b>Aspect 4</b> <p>Operation of:</p> <ul style="list-style-type: none"><li>Groundwater recharge</li></ul>	<b>Management of Aspect 4</b> <ul style="list-style-type: none"><li>Location of the proposed recharge sites to optimise abstraction</li></ul>	<b>Regulation of Aspect 4</b> <ul style="list-style-type: none"><li>GWR Regulatory Framework</li><li>RIWI Act</li><li>Technical support from the Groundwater TRG</li></ul>	the groundwater system.  Impact to the Leederville and Yarragadee aquifers can also be prevented by managing recharge rates. Site specific investigations will further inform recharge rates.  The predicted increases in pressure in the confined aquifers are not expected to impact the larger-scale hydrological processes within the aquifers.  The Proponent considers that the Proposal does not have a significant impact on hydrological regimes of groundwater and surface water and that the Proposal will meet the EPA's objective for this factor.
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**Table 7.6: Inland Waters Environmental Quality – Assessment Table**

Inherent Impact	Environmental Aspect	Mitigation actions to address residual impacts	Proposed regulatory mechanisms for ensuring mitigation	Outcome to demonstrate that proposal meets EPA objective
<p><b>EPA Objective: <i>To maintain the quality of groundwater and surface water so that environmental values are protected.</i></b></p>				
<ul style="list-style-type: none"> <li>• Numerous investigations have been completed to understand the potential risks associated with recharging the Leederville and Yarragadee aquifer (CyMod Systems 2013, Patterson et al. 2013, Rockwater 2013, Harris 2013).</li> <li>• During the GWRT over 58,200 groundwater samples were collected and compared against 254 water quality guidelines (as set by the DoH). All samples met health and environmental guidelines (Water Corporation 2013).</li> </ul> <p><b>Superficial Aquifer</b></p> <ul style="list-style-type: none"> <li>• The proposed aquifer recharge will not influence water quality within the Superficial aquifer due to the presence of a confining layer above the Leederville aquifer in the locations of the proposed recharge sites.</li> <li>• A confining layer (upper section of the Wanneroo member), consisting of consolidated siltstone, occurs between 108 m and 140 m bgl at the proposed northern recharge site (Water Corporation 2016). A confining layer (Kardinya Shale and the Wanneroo Member) also occurs at the southern recharge site (DoW 2013). These confining layers will prevent the upward movement of recycled water from the Leederville aquifer to the Superficial aquifer in the vicinity of the proposed recharge sites. Recharge of the Leederville aquifer is proposed to occur at a depth of between 140 m and 400 m bgl, below the confining layer.</li> <li>• An analytical model based on data from the GWRT and Stage 1 of the GWRS, and refined data from the study at the northern recharge site assessed the likelihood of vertical flow to the Superficial aquifer and estimated that travel time for recycled water to reach the base of the Superficial aquifer at a recharge rate of 14 GL per annum would be greater than 3,000 years (<b>Appendix H</b>).</li> <li>• For recycled water to enter the Superficial aquifer beyond the horizontal extent of the confining Wanneroo member (i.e. to the north of the proposed northern recharge site) the groundwater pressure (head) in the Leederville aquifer must be greater than the groundwater pressure at the base of the Superficial aquifer. Modelling for the Proposal indicates that the groundwater pressure in the Superficial aquifer exceeds that in the Leederville aquifer, and will continue to do so beyond the recharge sites following the commencement of recharge, such that it is extremely unlikely that recycled water will reach the base of the Superficial aquifer (DoW 2013).</li> <li>• Another confining layer, consisting of mainly siltstone and shales (the South Perth Shale), overlies the Yarragadee aquifer (Davidson &amp; Yu 2008). Recharge of the Yarragadee aquifer is proposed to occur below the South Perth Shale interval.</li> <li>• The presence of the confining layer at the location of the proposed recharge sites prevents any significant impacts to water quality within the Superficial aquifer.</li> </ul> <p><b>Leederville and Yarragadee Aquifers</b></p> <ul style="list-style-type: none"> <li>• The GWR Regulatory Framework requires a definition of the values of the receiving aquifers and the water quality guidelines that protect those values. Four values have been identified for the Leederville and the Yarragadee aquifers at the proposed recharge sites. These values will be protected by 167 water quality parameters set by the DoH. The recycled water is required to meet these guidelines at the point of recharge. Refer to Section 3.3 for further detail on these environmental values and guidelines.</li> <li>• Once recharged into the aquifer, the recycled water continues to mix with groundwater as it moves further away from the recharge bore. A RMZ has been set for each recharge bore at 250 m. The groundwater must meet the water quality guidelines or ambient groundwater quality at the boundary of the RMZ.</li> </ul>				





<ul style="list-style-type: none"> <li>13 Critical Control Points are continuously monitored throughout the treatment process to ensure recycled water quality meets guidelines at the point of recharge.</li> <li>The ability for the treatment plant to meet guidelines and all potential treatment process failures was considered in the Treatment Process risk assessment. The outcome of this risk assessment concluded that the treatment process will produce recycled water that is well below water quality guidelines and that all potential treatment process failures can be managed. Therefore, this demonstrates that there is no significant impact to groundwater quality from the Proposal, and human health is protected. A risk assessment summary is provided in <b>Appendix G</b>. Endorsement of this risk assessment process and outcomes has been provided by the DoW and the DoH (Section 3.3).</li> <li>In the Gnangara Groundwater system the Leederville aquifer contains about 100,000 GL in onshore storage. In the Perth region, storage within the Yarragadee aquifer is approximately 180,000 GL (Davidson 1995). Thus the proposed recharge volumes following the implementation of the Proposal are negligible.</li> </ul>				
<p><b>Potential Impact 1</b></p> <ul style="list-style-type: none"> <li>Change to water quality within the Leederville and Yarragadee aquifers</li> </ul>	<p><b>Aspect 1</b></p> <p>Groundwater recharge</p>	<p><b>Management of Aspect 1</b></p> <ul style="list-style-type: none"> <li>13 Critical Control Points at AWRP</li> <li>Process Control Point at recharge sites</li> <li>Ongoing water quality monitoring within the recharge management zone to ensure quality at the boundary</li> <li>Intensive monitoring to confirm attainment of required water quality prior to and during recharge</li> </ul>	<p><b>Regulation of Aspect 1</b></p> <ul style="list-style-type: none"> <li>GWR Regulatory Framework</li> </ul>	<p><b>Environmental Outcome</b></p> <p>The Corporation considers that the Proposal will meet the EPA objective for this factor, given the following:</p> <ul style="list-style-type: none"> <li>The proposed recharge sites are located where the Leederville and the Yarragadee aquifers are confined, preventing upward flow of water from the Leederville aquifer to the Superficial;</li> <li>There are 13 Critical Control Points at the AWRP and a Process Control Point at the recharge sites which will protect water quality by ensuring water meets guidelines or is diverted from the AWRP process; and</li> <li>The Corporation will undertake water quality monitoring within the Recharge Management Zone to ensure water quality meets guidelines at the boundary.</li> </ul> <p>It is not expected that the implementation of the Proposal will result in any significant impact to groundwater or surface water quality.</p>
<p><b>Potential Impact 2</b></p> <ul style="list-style-type: none"> <li>Change to water quality within the Superficial aquifer and wetlands</li> </ul>	<p><b>Aspect 2</b></p> <p>Groundwater recharge</p>	<p><b>Management of Aspect 2</b></p> <ul style="list-style-type: none"> <li>Presence of a confining layer to prevent recycled water reaching the Superficial aquifer.</li> </ul>	<p><b>Regulation of Aspect 2</b></p> <ul style="list-style-type: none"> <li>GWR Regulatory Framework</li> </ul>	<p>It is not expected that the implementation of the Proposal will result in any significant impact to groundwater or surface water quality.</p>

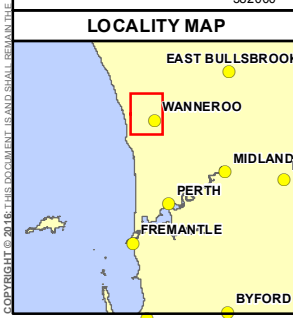


**Table 7.7: Social Surroundings – Assessment Table**

Inherent Impact	Environmental Aspect	Mitigation actions to address residual impacts	Proposed regulatory mechanisms for ensuring mitigation	Outcome to demonstrate that proposal meets EPA objective
<p><b>EPA Objective: <i>To protect social surroundings from significant harm.</i></b></p> <p><b>Aboriginal Heritage</b>            The Development Envelope intersects one Known Aboriginal Heritage Site:  <ul style="list-style-type: none"> <li>• Lake Joondalup South-West (Place ID 3640)</li> </ul>           An Aboriginal Heritage survey was completed for the Proposal in accordance with the <i>Aboriginal Heritage Act 1972</i>. No impacts to Aboriginal Heritage have been identified. The report is attached as <b>Appendix E</b>.</p> <p><b>European Heritage</b>            The Development Envelope intersects two Known European Heritage Sites (<b>Figure 7.8</b>):  <ul style="list-style-type: none"> <li>• Cockman House</li> <li>• Perry’s Paddock Cottage and Stables</li> </ul>           The Proposal was referred to the State Heritage Council on 9 September 2016 for an assessment of archaeological significance of the area within the Development Envelope and any associated impacts from the Proposal. The State Heritage Office responded to the Corporation on 21 September 2016 and has no objections to the Proposal (<b>Appendix L</b>).</p> <p><b>Amenity</b>  <ul style="list-style-type: none"> <li>• AWRP (Stage 2) site located within 270 m of sensitive receptors.</li> <li>• Northern recharge site is adjacent to Wanneroo Road (significant noise source) and located approximately 120 m away from nearest sensitive receptors.</li> <li>• Southern recharge site is surrounded by pine trees and native bushland and is located approximately 290 m away from nearest sensitive receptors.</li> </ul> </p>				
<p><b>Potential Impact 1</b></p> <ul style="list-style-type: none"> <li>• Disturbance to Aboriginal Heritage site</li> </ul>	<p><b>Aspect 1</b></p> <ul style="list-style-type: none"> <li>• Construction and physical presence of recharge pipeline</li> </ul>	<p><b>Management of Aspect 1</b></p> <ul style="list-style-type: none"> <li>• Design of the Proposal has minimised planned disturbance within Aboriginal Heritage site.</li> <li>• Construction will be carried out in accordance with the Corporation’s CEMF and CEMP.</li> <li>• Disturbance will only occur within approved boundaries and will be minimised as far as reasonably practicable.</li> </ul>	<p><b>Regulation of Aspect 1</b></p> <ul style="list-style-type: none"> <li>• <i>Aboriginal Heritage Act 1972</i></li> </ul>	<p><b>Environmental Outcome</b></p> <p>The implementation of the Proposal will result in a minor residual impact given the presence of the proposed Recharge Pipeline in areas of European Heritage and Aboriginal Heritage value. Temporary disturbance to the surface will be reinstated and</p>
<p><b>Potential Impact 2</b></p> <ul style="list-style-type: none"> <li>• Disturbance to</li> </ul>	<p><b>Aspect 2</b></p> <ul style="list-style-type: none"> <li>• Construction</li> </ul>	<p><b>Management of Aspect 2</b></p> <ul style="list-style-type: none"> <li>• Design of the Proposal has</li> </ul>	<p><b>Regulation of Aspect 2</b></p>	



<p>European Heritage site</p>	<p>and physical presence of recharge pipeline</p>	<p>minimised planned disturbance within European Heritage site.</p> <ul style="list-style-type: none"> <li>• Construction will be carried out in accordance with the Corporation's CEMF and CEMP.</li> <li>• Disturbance will only occur within approved boundaries and will be minimised as far as reasonably practicable.</li> <li>• Recommendations from the State Heritage Council will be adopted to ensure no significant impacts from the Proposal to European Heritage.</li> </ul>	<ul style="list-style-type: none"> <li>• Development approval under the Metropolitan Region Scheme (decision is made by a Development Assessment Panel on advice from the City of Joondalup/City of Wanneroo/ Department of Planning/WAPC).</li> </ul>	<p>rehabilitated following construction.</p> <p>The State Heritage Office has advised that it has no objections to the Proposal given that the Corporation retains all construction within the proposed Development Envelope.</p> <p>Impacts to amenity are not likely to be significant given the low level of impact and the mitigation measures that the Corporation will implement.</p>
<p><b>Potential Impact 3</b></p> <ul style="list-style-type: none"> <li>• Elevated levels of noise, light and vibration at nearby sensitive receptors during construction of the AWRP, recharge pipeline and bores</li> </ul>	<p><b>Aspect 3</b> Construction of recharge pipeline and bores</p>	<p><b>Management of Aspect 3</b></p> <ul style="list-style-type: none"> <li>• Light management and noise attenuation measures to be employed at all construction sites in accordance with objectives as set out in the CEMF, and procedures specified in the CEMP.</li> <li>• Stakeholder engagement and complaints register to be maintained.</li> </ul>	<p><b>Regulation of Aspect 3</b></p> <ul style="list-style-type: none"> <li>• CEMF</li> </ul>	<p>The Proponent considers that the Proposal will meet the EPA's objective for the Heritage factor given that there are no significant impacts to Aboriginal or European heritage sites.</p>
<p><b>Potential Impact 4</b></p> <ul style="list-style-type: none"> <li>• Ongoing impact to visual amenity within Yellagonga Regional Park due to presence of recharge bores and associated infrastructure</li> </ul>	<p><b>Aspect 4</b> Groundwater recharge</p>	<p><b>Management of Aspect 4</b></p> <ul style="list-style-type: none"> <li>• Recharge infrastructure to be designed to minimise impact to visual amenity.</li> <li>• Design of pump station and fencing to be determined in consultation with DPaW.</li> </ul>	<p><b>Regulation of Aspect 4</b></p> <ul style="list-style-type: none"> <li>• Detailed design to incorporate appropriate mitigation measures.</li> </ul>	



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- Aboriginal Heritage Sites
  - Registered Site
  - Lodged
  - Stored Data/Not a Site
- European Heritage Sites
  - Conservation Orders
  - State Register of Heritage Places
  - Heritage Agreements

**ABORIGINAL HERITAGE SITES DESCRIPTION**  
 Registered Site Has been assessed as meeting Section 5 of the AH Act  
 Stored Data Has been assessed as not meeting Section 5 of the AH Act  
 Lodged information on site has been received, but an assessment against Section 5 of the AH Act has not been completed

**DATA SOURCES**  
 - ALIGNMENT DATA PROVIDED BY WATER CORPORATION 2016  
 - ABORIGINAL HERITAGE SITES SOURCED DAA NOV 2015 STATE HERITAGE SOURCED HERITAGE OFFICE 2016  
 - LOCALITY MAP SOURCED LANDGATE 2006 AERIAL PHOTOGRAPHY SOURCED LANDGATE FEB 2016  
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**WATER CORPORATION**

CREATED JJ/MH	CHECKED TM	APPROVED SS	REVISION 0	DATE 25/10/2016
HORIZONTAL DATUM GDA 1994 MGA Zone 50		PROJECT NO 1551		

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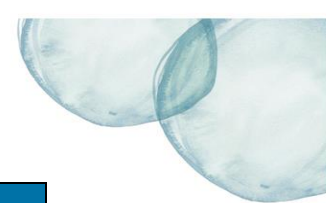
**Water Corporation**

**Groundwater Replenishment Scheme (GWRS) Stage 2**

**Referral under Section 38 of the EP Act**

**Figure 7.8**  
**Heritage Sites within the Development Envelope**

K:\Projects\2.0 INF\1551 GWRS\Figures\38 Referral\1551 S38 Figure 5.8 - Heritage Sites.mxd



**Table 7.8: Human Health – Assessment Table**

Potential Impact	Aspect	Mitigation actions to address residual impacts	Proponent’s proposed mechanism for ensuring mitigation	Outcome to demonstrate that proposal meets EPA objective
<b>Human Health - to protect human health from significant harm..</b>				
<ul style="list-style-type: none"> <li>The AWRP treats water using a multi-stage process including ultra-filtration, reverse osmosis, ultra violet disinfection, and other processes to produce water that is as safe as drinking water.</li> <li>The DoH has set performance requirements for the treatment process and water quality guidelines for recycled water under the MoU.</li> <li>The Corporation ensures that the recycled water quality always meets the water quality guidelines by continuously monitoring the performance of the treatment process at 13 Critical Control Points located throughout the WWTP and AWRP and automatically applying a controlling action (divert water from treatment process or cease production) if performance varies from specification.</li> <li>During the GWRT over 58,200 groundwater samples were collected and compared against 254 water quality guidelines (as set by the DoH). All samples met health and environmental guidelines (Water Corporation 2013).</li> <li>Numerous investigations have been completed to understand the potential risks associated with recharging the Leederville and Yarragadee aquifer (CyMod Systems 2013, Patterson et al. 2013, Rockwater 2013, Harris 2013).</li> <li>The presence of the confining layers (as described in <b>Table 7.5, Table 7.6</b> and Section 3.3) will prevent the upward movement of recycled water from the Leederville aquifer to the Superficial aquifer in the vicinity of the proposed recharge sites. For recycled water to enter the Superficial aquifer beyond the horizontal extent of the confining Wanneroo member (i.e. to the north of the proposed northern recharge site) the groundwater pressure (head) in the Leederville aquifer must be greater than the groundwater pressure at the base of the Superficial aquifer. Modelling indicates that the groundwater pressure in the Superficial aquifer exceeds that in the Leederville aquifer, and will continue to do so beyond the recharge sites following the commencement of recharge, such that it is extremely unlikely that recycled water will reach the base of the Superficial aquifer (DoW 2013).</li> <li>Another confining layer, consisting of mainly siltstone and shales (the South Perth Shale), overlies the Yarragadee aquifer (Davidson &amp; Yu 2008). Recharge of the Yarragadee aquifer is proposed to occur below the South Perth Shale interval.</li> <li>The hazard risk assessment process considered 167 Recycled Water Quality Parameters that protect 123 guidelines set by the DoH and defined in the MoU. An additional four water quality parameters were identified as part of the environment scan process and brought the number of hazards assessed in the risk assessment to a total of 171. The Hazard risk assessment considered 170 out of 171 inherent risks as low. The barrier risk assessment resulted in 47 out of 52 residual (or mitigated) risks rated as Low and five as moderate. The five moderate residual risks were associated with the Beenyup Ocean Outlet capacity and possible operational risks which can be mitigated through design, commissioning and application of the defined operational procedures. The DoH has endorsed the risk assessment process under the GWR Regulatory Framework (<b>Appendix N</b>). Refer to <b>Appendix G</b> for further detail on the risk assessment process and outcomes.</li> </ul>				
<b>Potential Impact 1</b> <ul style="list-style-type: none"> <li>Impact to Superficial aquifer water quality</li> </ul>	<b>Aspect 1</b> Groundwater recharge	<b>Management of Aspect 1</b> <ul style="list-style-type: none"> <li>Aquifer and AWRP Risk Assessment</li> <li>DoH endorsed Water Quality Guidelines</li> <li>Critical Control Points at AWRP</li> <li>Process Control Point at recharge sites</li> <li>Ongoing water quality monitoring</li> </ul>	<b>Regulation of Aspect 1</b> <ul style="list-style-type: none"> <li>GWR Regulatory Framework</li> <li>Recycled Water Quality Management Plan (DoH approval required)</li> </ul>	<b>Environmental Outcome</b> Given that the IAWG has endorsed the AWRP risk assessment as part of the GWR Regulatory



Potential Impact	Aspect	Mitigation actions to address residual impacts	Proponent's proposed mechanism for ensuring mitigation	Outcome to demonstrate that proposal meets EPA objective
<ul style="list-style-type: none"> <li>Impact to surface water quality</li> </ul>	Groundwater recharge	<ul style="list-style-type: none"> <li>Aquifer and AWRP Risk Assessment</li> <li>DoH endorsed Water Quality Guidelines</li> <li>Critical Control Points at AWRP</li> <li>Process Control Point at recharge sites</li> <li>Presence of confining layers to minimise likelihood of recycled water reaching the Superficial aquifer.</li> </ul>	<ul style="list-style-type: none"> <li>GWR Regulatory Framework</li> <li>Recycled Water Quality Management Plan (DoH approval required)</li> </ul>	<p>Framework, that the Corporation will operate the AWRP and water quality monitoring in accordance the Recycled Water Quality Management Plan, and the presence of a confining layer at the location of the recharge sites, the Corporation does not consider that there will be any significant impacts to human health from the Proposal.</p> <p>The Corporation considers that the Proposal will meet the EPA's objective for the Human Health Factor.</p>



## 8. Other Environmental Factors

The EPA Scoping Guideline identifies 'other' environmental factors that are not considered key factors, but have the potential to be affected by the Proposal. For this Proposal, these include:

- Landforms;
- Subterranean Fauna;
- Amenity;
- Offsets; and
- Rehabilitation and Decommissioning.

These factors are not expected to be required for assessment by the EPA due to the very low likelihood of impact, the low level of impact and the mitigation measures that the Corporation will implement to manage any impacts. **Table 8.1** outlines the consideration of these factors relevant to the Proposal, and also addresses the remaining environmental factors (Landforms, Offsets and Rehabilitation and Decommissioning).



**Table 8.1: Other Environmental Factors**

Potential Impact	Aspect	Mitigation actions to address residual impacts	Proponent's proposed mechanism for ensuring mitigation
<p><b>Landforms – to maintain the variety and integrity of distinctive physical landforms so that environmental values are protected.</b></p>			
<p>For the purpose of EIA, the EPA defines a landform as “a distinctive, recognisable physical feature of the earth’s surface having a characteristic shape produced by natural processes.” A landform can be a small scale feature, such as a cliff or dune, or of larger scale, such as a dune field. It should be noted that the EPA considers the defining feature of a landform to be the combination of its geology (composition) and morphology (form).</p> <p>There are no significant landforms within the Development Envelope.</p>			
<ul style="list-style-type: none"> <li>Change to landforms</li> </ul>	<p>Construction of the recharge pipeline</p>	<ul style="list-style-type: none"> <li>The recharge pipeline will be installed below ground level, through a combination of open trenching and tunnelling techniques, such that no impact to landforms will occur.</li> <li>The proposed recharge sites are located within flat, cleared, areas and no impact to landforms are expected.</li> </ul>	<p>Not applicable.</p>

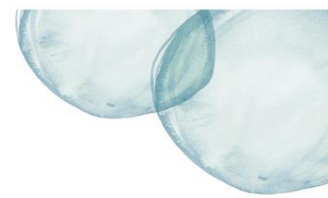




Potential Impact	Aspect	Mitigation actions to address residual impacts	Proponent's proposed mechanism for ensuring mitigation
<b>Subterranean Fauna – to protect subterranean fauna so that biological diversity and ecological integrity are maintained.</b>			
<ul style="list-style-type: none"> <li>• A desktop subterranean fauna assessment was commissioned by the Corporation to determine the potential impacts to stygofauna from aquifer recharge. Following the outcome of the desktop assessment, it was considered that a subterranean fauna survey was not required.</li> <li>• A confining layer (upper section of the Wanneroo member), consisting of consolidated siltstone, occurs between 108 m and 140 m bgl at the proposed northern recharge site (Water Corporation 2016). A confining layer (Kardinya Shale) similarly occurs at the southern recharge site (DoW 2013). These confining layers will prevent the upward movement of recycled water from the Leederville aquifer to the Superficial aquifer in the vicinity of the proposed recharge sites. Recharge of the Leederville aquifer is proposed to occur at a depth of between 140 m and 400 m bgl, below the confining layer.</li> <li>• Another confining layer, consisting of mainly siltstone and shales (the South Perth Shale), overlies the Yarragadee aquifer (Davidson &amp; Yu 2008). Recharge of the Yarragadee aquifer is proposed to occur below the South Perth Shale interval.</li> <li>• Thus the recharge of the Leederville and Yarragadee aquifers is proposed to occur significantly below the Superficial aquifer (i.e. the watertable).</li> <li>• Few stygofauna species are expected to occur at large depths below the watertable because of the attenuation of carbon and nutrient inputs with depth, so that productivity is reliant on chemosynthesis (<b>Appendix D</b>).</li> <li>• For recycled water to enter the Superficial aquifer beyond the horizontal extent of the confining Wanneroo member (i.e. to the north of the proposed northern recharge site) the groundwater pressure (head) in the Leederville aquifer must be greater than the groundwater pressure at the base of the Superficial aquifer. Modelling indicates that the groundwater pressure in the Superficial aquifer exceeds that in the Leederville aquifer, and will continue to do so beyond the recharge sites following the commencement of recharge, such that it is extremely unlikely that recycled water will reach the base of the Superficial aquifer (DoW 2013).</li> <li>• The salinity of groundwater in all aquifers and the recharge water has similar magnitude ( total dissolved solids (TDS) of approximately 250 – 500 mg/L in the Superficial aquifer on the Gnangara Mound, &lt;500 in the Leederville aquifer and &lt;500 in the Yarragadee aquifer) (Davidson 1995) compared to &lt;600 for the recycled water. Aquatic invertebrate species in south-western Australia, including stygofauna species, have evolved in a relatively saline landscape and have relatively high salinity tolerances. The differences in salinity levels in the different aquifers and recharge water are unlikely to be ecologically meaningful below 600 mg/L (<b>Appendix D</b>). Thus even in the event of recycled water reaching the Superficial aquifer impacts to stygofauna are not expected.</li> <li>• Based on the characteristics of the aquifer and the outcome of the desktop assessment (<b>Appendix D</b>), it is not considered that the Proposal will result in impact to subterranean fauna. Further, the IAWG does not consider that the Proposal represents a risk to aquatic ecosystems (including stygofauna) (<b>Appendix H</b>).</li> </ul>			
<ul style="list-style-type: none"> <li>• Change to water quality within aquifers</li> </ul>	Groundwater recharge	<ul style="list-style-type: none"> <li>• Critical Control Points at AWRP</li> <li>• Process Control Point at recharge sites</li> <li>• Ongoing water quality monitoring at the boundary of the recharge management zone</li> <li>• Presence of 30 m confining layer above the Leederville aquifer</li> </ul>	Intensive monitoring to confirm attainment of required water quality prior to recharge.



Potential Impact	Aspect	Mitigation actions to address residual impacts	Proponent's proposed mechanism for ensuring mitigation
<b>Offsets</b> – <i>To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.</i>			
No significant residual impacts from the Proposal therefore offsets are not considered to be a factor requiring assessment.			
<b>Rehabilitation and Decommissioning</b> – <i>To ensure that premises are decommissioned and rehabilitated in an ecologically sustainable manner.</i>			
All temporary disturbance areas within the Development Envelope will be rehabilitated. The recharge pipeline will have a design life of at least 80 years. The recharge bores will have a design life of at least 100 years. Maintenance and 'redevelopment' of the bores may be required approximately every 5 years.			



## 9. Principles of the Environmental Protection Act

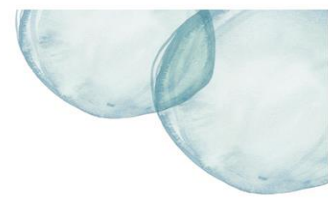
Section 4A of the EP Act outlines the objective of the Act and the principles of environmental protection. In accordance with EAG14 (EPA 2015) this section describes how the five principles of the EP Act have been addressed by the Corporation in the consideration and design of the Proposal. A description of these principles and how they have been considered by the Corporation is provided below in **Table 9.1**.

**Table 9.1: Environmental Principles of the EP Act**

Principle	Consideration of Principle in Proposal
<p><i>1. The Precautionary Principle</i></p> <p>Where there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.</p> <p>In the application of the precautionary principle, decision should be guided by:</p> <ul style="list-style-type: none"> <li>a) Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and</li> <li>b) An assessment of the risk-weighted consequences of various options.</li> </ul>	<ul style="list-style-type: none"> <li>• The Corporation has undertaken comprehensive baseline environmental studies on aspects of the Proposal that may impact the environment including flora and fauna surveys and a subterranean fauna assessment. The Corporation has also commissioned a baseline wetland vegetation health assessment of wetlands in the vicinity of the Proposal to obtain data on vegetation health prior to recharge under GWRS Stage 2.</li> <li>• The Proposal, particularly the alignment of the recharge pipeline following the analysis of alternative options, has been designed to avoid impact to native vegetation and fauna habitat which has involved significant consideration of multiple factors including engineering, constructability and environmental impacts to inform a best outcome approach.</li> <li>• A pilot study was undertaken by the Corporation to define the characteristics of the Leederville aquifer to determine risk of upward flow of recycled water into the Superficial aquifer.</li> <li>• Multiple engineering and construction methods have been adopted in the design of the Proposal to avoid the unnecessary clearing of native vegetation.</li> <li>• A comprehensive multi-agency Risk Assessment process has been completed in accordance with the GWR Regulatory Framework which has been endorsed by the DoW and the DoH as part of the IAWG.</li> <li>• Management and mitigation measures to minimise potential environmental impacts during construction will be addressed in a CEMF.</li> </ul>



Principle	Consideration of Principle in Proposal
<p><b>2. <i>The Principle of Intergenerational Equity</i></b></p> <p>The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.</p>	<ul style="list-style-type: none"> <li>• The Corporation has embarked on a ten year plan to investigate climate resilience sources for Perth by 2022 so that sufficient water supplies are maintained, in response to the drying climate. As inflow to Perth’s dams continues to decline, the Corporation remains focused on making way for a new range of water sources including seawater desalination and GWR.</li> <li>• By implementing GWR, the Corporation is safely replenishing the deep Yarragadee and Leederville aquifers with highly treated recycled water, enabling water to be abstracted without affecting the natural environment.</li> <li>• In its advice under section 16(e) of the EP Act to the Minister for Environment on the Perth and Peel @ 3.5 Million draft planning framework, the EPA recommended that the State Government continue to implement measures to reduce water use, increase water recycling and develop alternative fit-for-purpose water sources. Recommendation 6 also outlined the recommendation for the State Government to support the Water Corporation’s continued development of managed aquifer recharge into confined aquifers of the Gnampting Mound. This Proposal represents the continued work of the Corporation in identifying and developing new and sustainable water sources for the future of Western Australia (EPA 2015c).</li> <li>• The locations of the proposed recharge sites have been chosen in collaboration with the DoW following the results of the PRCAC project. The recharge of highly treated recycled water at the proposed recharge sites into the Leederville and Yarragadee aquifers is expected to contribute to the recovery of groundwater levels which will potentially benefit wetlands across the Gnampting Mound.</li> </ul>
<p><b>3. <i>The Principle of the Conservation of Biological Diversity and Ecological Integrity</i></b></p> <p>Conservation of biological diversity and ecological integrity should be a fundamental consideration.</p>	<ul style="list-style-type: none"> <li>• Areas of conservation significance were identified during baseline flora and fauna surveys undertaken for the Proposal.</li> <li>• The proposed recharge pipeline alignment has been designed to minimise impact to areas of conservation significance with clearing of native vegetation minimised. No significant impact to</li> </ul>



Principle	Consideration of Principle in Proposal
	<p>biological diversity is expected.</p> <ul style="list-style-type: none"> <li>Any disturbed areas will be rehabilitated in line with the Corporation's CEMF.</li> <li>The Corporation is also undertaking other environmental studies including vegetation health assessment of fringing vegetation around some of the wetlands in the region of the Gngara Mound, complementing existing studies undertaken by Edith Cowan University and the DoW.</li> </ul>
<p>4. <i>Principles relating to improved valuation, pricing and incentive mechanisms</i></p> <p>a) Environmental factors should be included in the valuation of assets and services.</p> <p>b) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement.</p> <p>c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of wastes.</p> <p>d) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.</p>	<ul style="list-style-type: none"> <li>Environmental factors were considered in the design of the Proposal including the alignment of the recharge pipeline and the location of the proposed recharge sites.</li> <li>GWR represents a sustainable, climate independent and energy efficient (compared to desalination) water supply.</li> </ul>
<p>5. <i>The Principle of Waste Minimisation</i></p> <p>All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.</p>	<ul style="list-style-type: none"> <li>Waste will be minimised through the implementation of the hierarchy of waste controls; avoid, re-use, recycle, recover and dispose.</li> <li>Waste avoidance and minimisation management objectives will be outlined in the Corporation's CEMF, and specific management procedures will be outlined in the CEMP.</li> </ul>



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## 10. Conclusions

### 10.1 Proponent's Conclusion

The Corporation is proposing to develop Stage 2 of the Groundwater Replenishment Scheme (the Proposal). The Proposal represents an expansion to the GWRS, which involves the duplication of the existing AWRP at the Beenyup facility, and recharge of an additional 14 GL per annum of recycled water into the Leederville and Yarragadee aquifers at two offsite locations.

Following completion of the GWRT in December 2012, the Corporation was able to demonstrate that advanced water treatment processes can successfully deliver a safe, reliable and sustainable water source option that adequately protects human health and the environment.

In its advice under section 16(e) of the EP Act to the Minister for Environment on the Perth and Peel @ 3.5 Million draft planning framework, the EPA recommended that the State Government continue to implement measures to reduce water use, increase water recycling and develop alternative fit-for-purpose water sources. Recommendation 6 also outlined the recommendation for the State Government to support the Water Corporation's continued development of managed aquifer recharge into confined aquifers of the Gnamptara Mound. This Proposal represents the continued work of the Corporation in identifying and developing new and sustainable water sources for the future of Western Australia (EPA 2015c).

Significant community and stakeholder consultation has been undertaken for the Proposal to date and since the inception of the GWRT. Stakeholder consultation will be progressed throughout the detailed design, construction and operational phases of the GWRS.

The IAWG has been reformed following Stage 1 of the GWRS to evaluate the relevant environmental values associated with the Leederville and the Yarragadee aquifers. Four environmental values were defined, management objectives and water quality guidelines have been agreed for each value. A rigorous risk assessment process has been completed to assess the potential risks of GWR on the receiving aquifers based on extensive aquifer characterisation and modelling. The DoW and DoH have formally endorsed the risk assessment (**Appendix M; Appendix N**) under the GWR Regulatory Framework.

An Environmental Impact Assessment has been completed on the following preliminary key environmental factors relevant to the physical and operational elements of the Proposal;

- Flora and Vegetation;
- Terrestrial Environmental Quality;
- Terrestrial Fauna;
- Inland Waters Environmental Quality;
- Hydrological Processes;
- Heritage; and
- Human Health.



The preliminary key environmental factors have been assessed against EPA's objectives and guidelines and it is considered that the Proposal will meet the EPA's objectives for these factors given the following:

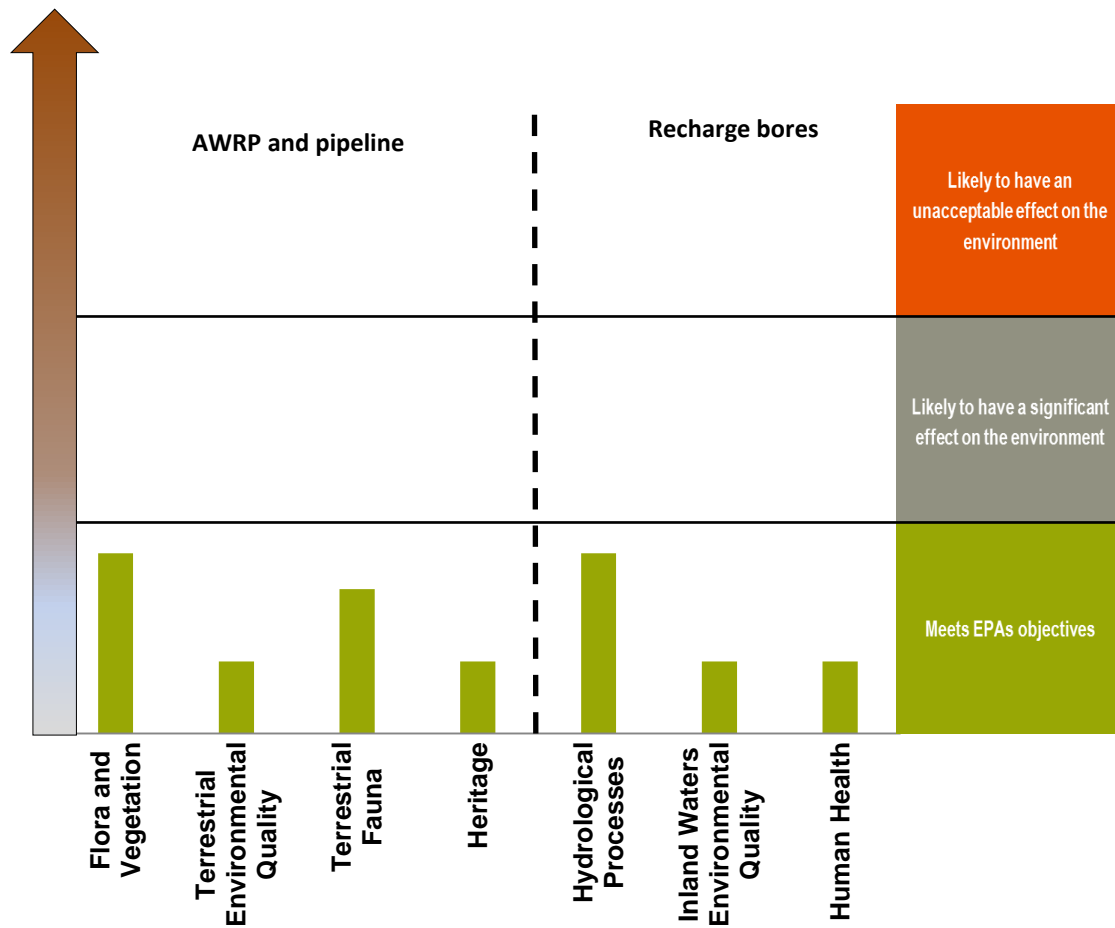
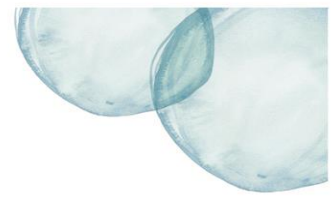
- The Proposal has been designed to avoid and minimise the clearing of native vegetation, particularly through route selection and the employment of trenchless technology;
- The GWR Regulatory Framework has been applied and the IAWG (DoH and DoW) have endorsed the risk assessment process for Stage 2 of the GWRS (the Proposal); and
- The Corporation has adequate construction management procedures that will be implemented for the construction of the Proposal through an overarching CEMF that will define management objectives to be addressed in a CEMP.

The Corporation considers that the Proposal is not likely to result in any significant impacts on the environment. The application of the significance framework is addressed in Section 10.2.

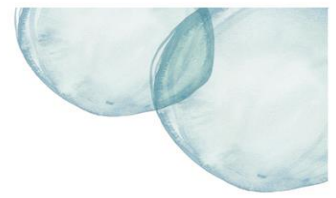
## **10.2 Application of the Significance Framework**

An overview of the environmental assessment information provided in the Assessment Tables (**Table 7.2** to **Table 7.8**) has been provided in a conceptual diagram illustrating the Corporation's consideration of the level of uncertainty remaining and the mitigation measures to be adopted to provide confidence to the EPA that its objective for each of the key environmental factors will be met (**Figure 10.1**).





**Table 10.1: Proponent’s conceptual application of the EPA’s Significance Framework**



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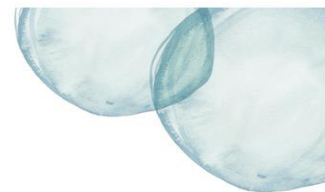
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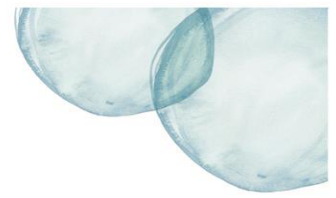
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## 12. Appendices

