## Appendix 14 – Big Brook Crossing Supporting Documents

# Big Brook Causeway

# Construction and Operational Plan

# Version 6 – FOURTH MMPLG SUBMISSION

| | | | | | |
|---|---|---|---|---|---|
| 5 | 03-02-2023 | GHD | | | Version 6, Major Causeway Upgrades, 4th MMPLG Submission |
| 4 | 29-09-2021 | L Gossage | | | Version 5, including September 2021 addendum |
| 3 | 17-10-2013 | J Shuker | | | Version 4 - 3rd MMPLG Submission |
| 2 | 22-03-2011 | A Curnow | | | Version 3 – 2nd MMPLG Submission |
| 1 | 01-02-2011 | A Curnow | | | Version 2 – MMPLG Submission |
| 0 | 20-08-2009 | S. Morley | | | First Revision |
| Rev | Date | Prepared By | Checked By | Approved By | Description |

## Table of Contents

# 1. Executive Summary

## 1.1. Development of a Risk Reduction Solution

Alcoa have undertaken a process of options identification (FEL[1] 1) and options selection (FEL 2) to develop a comprehensive risk reduction solution to mitigate the removal of the 100 m buffer between the Big Brook Causeway and the Serpentine Dam reservoir top water level (TWL).

The FEL 2 options selection study included an Environmental Risk Analysis (ERA) in accordance with the Australian Drinking Water Guidelines (GHD 2022). The ERA expanded on the 2008 risk assessment for the Big Brook Causeway and incorporated consideration of existing and proposed multiple barriers between hazards (e.g. vehicle incidents on the Causeway) and the receptor of the Serpentine Dam reservoir on Big Brook. The ERA considered the potential for barriers to fail in sequence and the cumulative likelihood upon multiple barrier failure for contaminants to discharge into Big Brook.

The development of the risk reduction solution for Big Brook Causeway considered the barrier performance for each of the contaminant pathways into Big Brook, to ensure that all pathways were sufficiently mitigated for the removal of the 100 m buffer.

## 1.2. Proposed Big Brook Causeway Upgrades

Alcoa propose a program of infrastructure upgrades at the Big Brook Causeway to reduce the risk of contaminant discharges into Big Brook, including:

1. Upgraded sump capacities and connection of sumps.
2. New permanent pumps and associated infrastructure.
3. Upgraded causeway barrier to improve impact resistance.

The combined sump upgrades and pumping infrastructure will accommodate runoff from a 0.05% Annual Exceedance Probability (AEP) or 2,000 year Average Recurrence Interval (ARI) storm event of 7 days duration. The proposed connected sump system will ensure that this level of protection is provided for the entire 17.0 ha catchment and 17 sumps that drain into the Big Brook Causeway.

The increased runoff retention capacity provided by the sump upgrades and pumping infrastructure represents a 40 to 24,000 fold reduction in the likelihood of sump overflows occurring into Big Brook, compared to the current individual sump network at the Big Brook Causeway. The pumping system will have standby/duty pumps and

[1] FEL = Front End Loading

generators with a telemetered alert system to provide a high redundancy and reliability of function.

Alcoa propose to upgrade the causeway barrier to provide further resistance to prevent a heavy vehicle exiting off the causeway and into Big Brook. This will provide sufficient energy absorption capacity to match that of *Recognised standard 19. Design and construction of mine roads* (Queensland Government 2019), which is for the protection of human life. The proposed upgrade to the causeway barrier will enable an approximate doubling of the energy absorption capacity of the barrier.

Alcoa propose to construct the infrastructure upgrades in accordance with a preventative risk framework and multiple barriers, to prevent contaminant discharges during construction and discharges from construction areas entering Big Brook.

## 1.3. Risk Elimination for Sewage Tankers

Alcoa have identified the highest consequence hazard for the Big Brook Causeway as being a vehicle crash involving a sewage tanker. This has potential to result in discharge of raw sewage including high loads of pathogens, which are expected to pose the greatest consequence in terms of risk to drinking water consumers. Although sewage tankers comprise a very small proportion of traffic on the Big Brook Causeway and a vehicle crash / spill is highly unlikely, Alcoa have proposed a risk elimination measure given the high consequence of a discharge event.

## 1.4. Outcome

The combined outcome of the substantial reduction in sump overflow likelihood, increased crash resistance of the causeway barrier and elimination of raw sewage transport is considered a net reduction in the risk of contamination to Serpentine Dam from the Big Brook Causeway operations, compared to the existing approved operations. This reduction in risk is expected to mitigate the removal of the preventative barrier provided by the 100 m buffer.

## 2. Document Purpose

This Operating Strategy was originally developed in consultation with the Huntly Production Asset Owner and other stakeholders for the purpose of the Execution Phase for Project MD0442 – Relocation of Huntly Operations to Myara.

The purpose of Version 6 Big Brook Causeway Construction and Operational Plan is to provide all the necessary information for the Mining and Management Program Liaison Group (MMPLG) to review the Big Brook Causeway engineering upgrades, provide comment and ultimately provide approval.

This plan was developed to complement existing procedures in place for environmental aspects directly associated with the management of a haul road causeway, such as spill response and turbidity management. For further detail on the extensive environmental management programs already in place, please refer to WA Mining Operations Environmental Management Manual (Appendix A).

The operating procedures outlined in this document will be transferred to Alcoa's Controlled Document System and form a part of standard operating procedures for the site.

### 2.1. Document Versions

This section summarizes key changes in the document from previous revision to this revision. Changes are also shown with vertical line on right margin of the page.

| Rev | Description |
|---|---|
| **0** | First revision. |
| **1** | Update to Version 2 for MMPLG Submission (Jan 2011 – A Curnow) |
| **2** | Update to Version 3 (2nd Submission for MMPLG) (Mar 2011 – A Curnow)<br><br>Version 3 summarised the risk assessment process undertaken for identifying the causeway location and the subsequent engineering and administration controls to be put in place to mitigate the identified risks.<br><br>MMPLG approval for the construction of Serpentine Causeway was received April 2011, pending further discussions on water quality sampling for hydrocarbons prior to discharge into the reservoir, and application of Alcoa's Red Alert process to the sump operations. |
| **3** | Update to Version 4<br><br>Water quality sampling conditions were resolved in June 2012, and the outcomes included into Version 4 of the plan. Version 4 also requests |

| | |
|---|---|
| | approval for additional construction works on the western side of the causeway (see Section 1.2.1). |
| **4** | Updated to Version 5<br><br>Updated to include 2021 Addendum |
| **5** | Update to Version 6<br><br>Version 6 of this document presents engineering upgrades to the causeway to reduce the likelihood of contaminant discharge occurring into the Big Brook. The engineering upgrades have been subject to an Environmental Risk Analysis in accordance with the Australian Drinking Water Guidelines, demonstrating a net reduction in likelihood of contaminant discharge occurring from haul road sumps. |

# 3. Introduction

## 3.1. Background

The Huntly Mine is the world's second largest bauxite mine and supplies Pinjarra and Kwinana alumina refineries. The Huntly Mine operations are currently within the Myara region, which will continue until to 2023 at which point mining will transition into the proposed Myara North region (Figure 1). Alcoa's Mineral Lease (1 SA) extends to 2045. The Huntly Mine currently produces approximately 28.5 million tonnes per year (Mtpa) of bauxite and is forecast to produce up to approximately 29.6 Mtpa over the next decade.

The Myara region lies within the catchment of the Serpentine Dam, a Priority 1 Public Drinking Water Source Area (PDWSA). The Myara region is bisected by Big Brook, a primary tributary of Serpentine Dam, which flows into the southern arm of the reservoir (Figure 1).

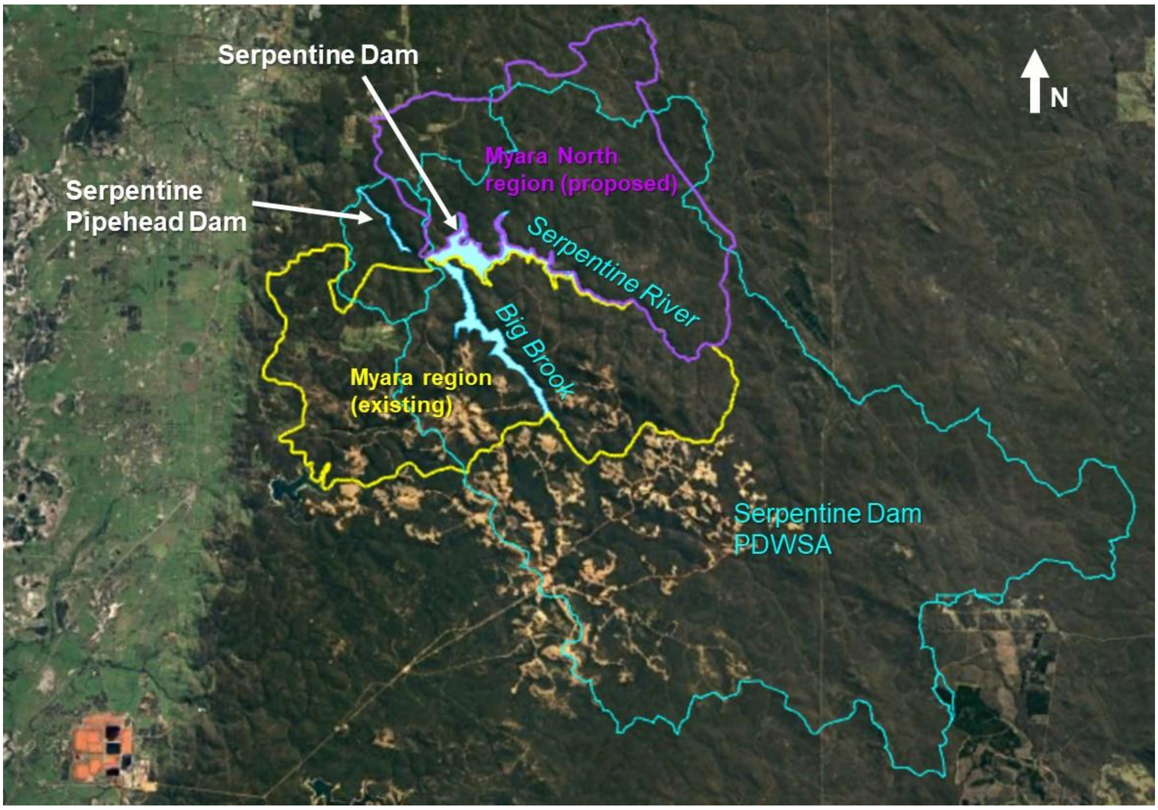



*Figure 1 - Huntly Mine and Serpentine Dam PDWSA locality (imagery: GoogleEarth Pro)*

The Big Brook Causeway is used as a primary haul road Causeway for the Myara region (Figure 2) and will continue to be used for Myara North over 2023-2030. The Causeway was constructed over the summer of 2012/2013 following approval by the MMPLG pursuant to Alcoa's State Agreement. The causeway was approved subject to implementation of the Serpentine Dam Causeway Construction and Operational Plan (Alcoa 2017), which was informed by a risk assessment conducted by Professor Barry Hart (Water Science 2008).

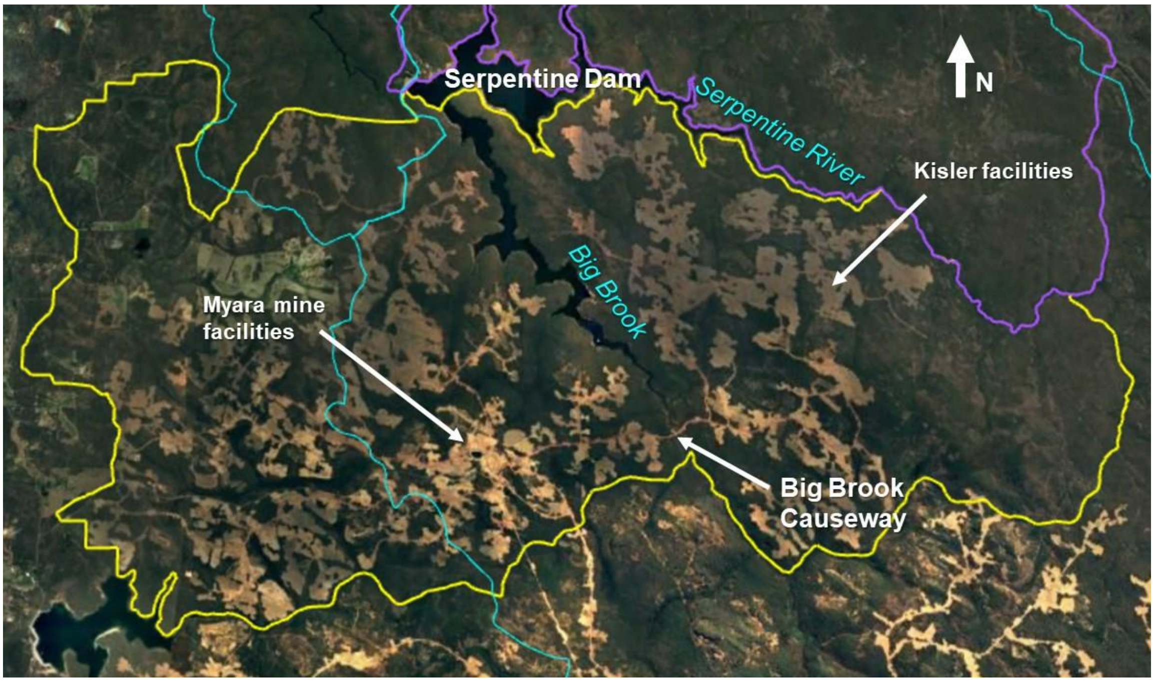



*Figure 2 - Serpentine Dam Big Brook Causeway locality (imagery: GoogleEarth Pro)*

The Big Brook Causeway was constructed in accordance with key performance criteria (Section 4.1.3). In addition, on the recommendation of the Water Corporation, Alcoa committed to maintain a 100 m buffer between the Big Brook Causeway and the Serpentine Dam reservoir top water level (TWL) (Figure 3). In the event the reservoir TWL was to come within 100 m of the causeway, which was defined as a TWL at 207.5 mAHD, then Alcoa was to cease causeway operations (Alcoa 2017).

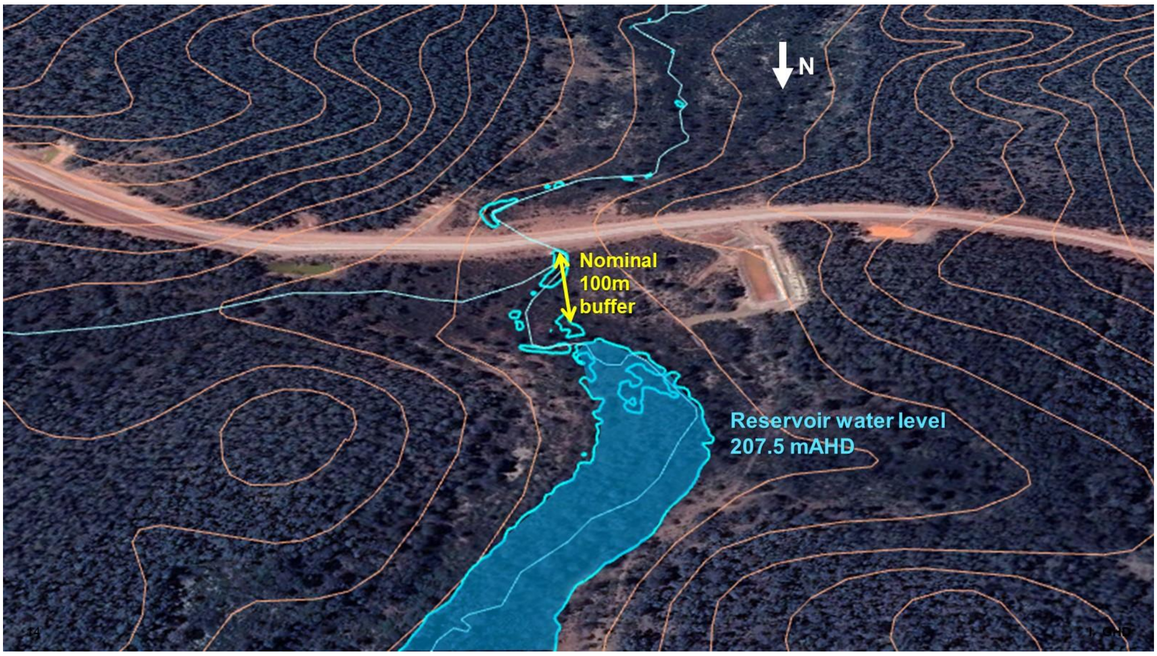



*Figure 3 - Big Brook Causeway 100 m buffer from Serpentine Dam reservoir*

## 3.2. Serpentine Dam Operating Strategy

The Serpentine Dam capacity has been less than 80 GL, averaging about 45 GL, from 2000 to 2020. A combination of high inflows and water banking from 2016 onwards has resulted in the reservoir capacity progressively rising.

Water Corporation have advised Alcoa that they propose to undertake maintenance activities over the summer of 2022/23 to enable increased banking of water in Serpentine Dam, such that reservoir water levels are expected to rise from winter 2023 onwards. Modelling by Water Corporation has indicated that reservoir water levels may potentially rise to over 210 mAHD in the second half of 2023 and be sustained, which may allow water levels to encroach on the 100 m buffer to the Big Brook Causeway.

To address this possibility, Alcoa propose to upgrade the environmental protection infrastructure and operations surrounding the Causeway, and once executed, propose the ongoing operation of multiple barriers at the Big Brook Causeway to minimise the risk to drinking water quality.

# 4. Current State

## 4.1. Serpentine Dam

Serpentine Dam is one of the major water supply dams for Perth, Western Australia. The dam is used to store water which is released at a controlled rate to regulate the level in Serpentine Pipehead Dam, which in turn feeds water to the metropolitan trunk main network depending on demand (Figure 1).

The Pipehead Dam, located 7 km upstream of the Serpentine Falls, was opened in 1957. It is 6 km long, has a capacity of 3.14 GL and a surface area of 60.8 ha. The Serpentine Main Dam was finished in 1961, and has a capacity of 138 GL. The surface area of the dam at full capacity is 1067 ha. The Main Dam is supplied by two rivers: the Serpentine River, which enters the northern arm and Big Brook, which enters the southern arm. The total catchment area is 664 $km^2$.

The Serpentine Scheme is an important component in the Water Corporation's Metropolitan Integrated Water Supply System (IWSS), because of its ability to provide a peaking facility. The Metropolitan Water Supply System includes surface reservoirs, groundwater and desalination.

### 4.1.1. Requirement for Big Brook Causeway

The Myara crusher region has a total of around 270 Mt of bauxite, with approximately 97 Mt located in the Lang subregion, east of Big Brook and the southern arm of Serpentine Dam reservoir (Figure 4). Access to the Lang region required the construction and operation of a haul road causeway over the southern arm of the Serpentine Dam to allow bauxite ore to be economically hauled back to the Myara crusher.

Access to the Lang sub-region ore is also important in assisting with the management of noise constrained mining in the Myara region. Without Lang sub-region ore, Myara would have a distribution of 50/50 noise constrained/non-noise constrained ore bodies which is unmanageable without an additional crusher.

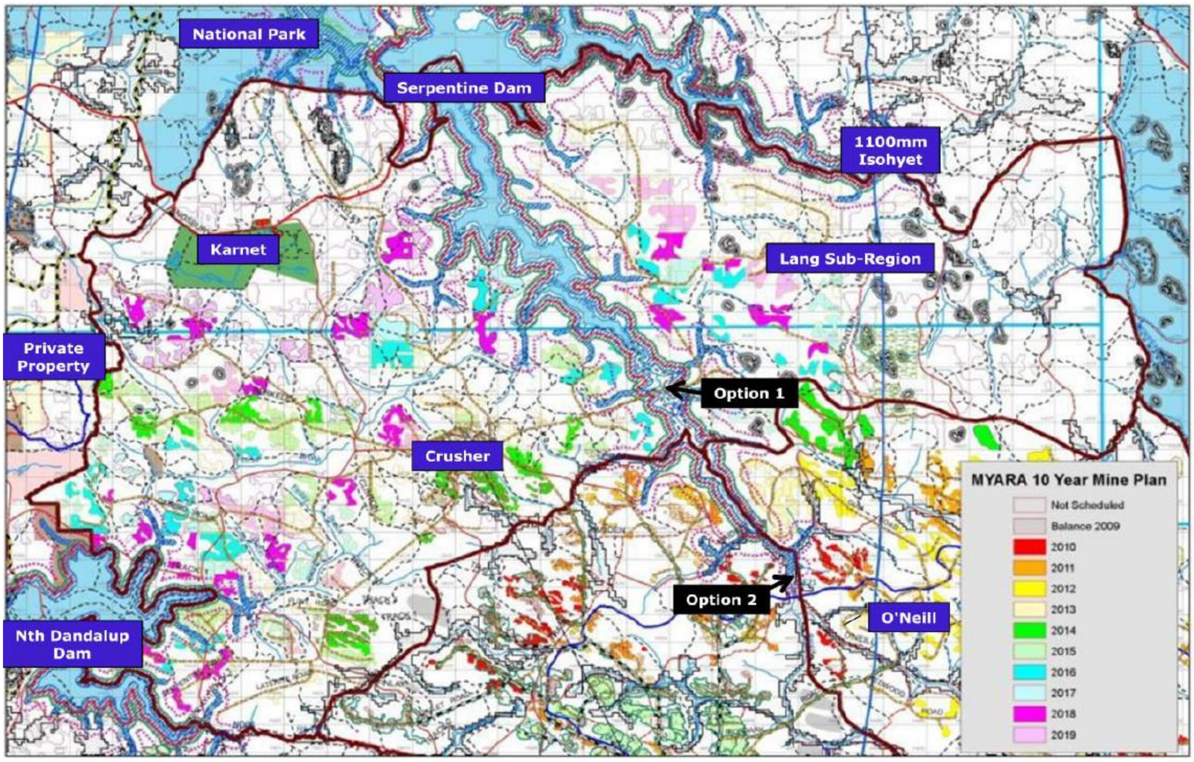



*Figure 4 - Myara Crusher Region including Options 1 and 2 for Big Brook Causeway. Option 1 consists of two potential alignments (Alignment A and Alignment B, 700 m apart).*

#### 4.1.2. Big Brook Causeway Risk Assessment, Selection and Approval

In May 2008, Professor Barry Hart from Water Science Pty Ltd was engaged to undertake an assessment of the risk to water quality in Serpentine Main Dam associated with the construction and operation of both Options 1 or 2 of a haul-road causeway of the southern arm of the dam (Appendix C). The risk assessment identified three key risks as follows:

1. A minor (or major) spill of ore, dust or hydrocarbons on the causeway.

2. A minor (or major) spill of ore, dust or hydrocarbons on the causeway, during or followed by a rain event that washes material off the Causeway and into the sumps.

3. A major accident in which a fully loaded truck goes over the edge of the causeway spilling its entire contents of 190 tonne of ore and 2,000 L of diesel in the dam below.

#### 4.1.3. Big Brook Causeway Design

Alcoa understands that Serpentine Dam is an important part of Perth's ongoing water supply. The construction and operation of Big Brook Causeway within the Serpentine Dam Reservoir Protection Zone (RPZ), and buffers of a P1 reservoir (as outlined in the Working Arrangements Between Alcoa World Alumina Australia, the Department of Water and the Water Corporation Covering Alcoa's Mining Operations in the Darling Range), poses a possible risk to Perth's drinking water. Alcoa committed to design performance criteria and controls to manage the risk to drinking water quality and prevent impact on Water Corporation's normal operation of Serpentine Dam. The performance criteria and controls were agreed and approved by the MMPLG as part of the approval for construction and operation of the causeway.

Big Brook Causeway was constructed over summer 2012/2013, to the following original specifications.

- Single concrete arch culvert with 12 m span to accommodate 1:200 year rainfall event;
- Wing walls installed on archway to protect the causeway embankment;
- Rock pitching from stream entry to exit (including within arch) for stream bank protection;
- Eastern sump was constructed with a holding capacity of less than a 63% AEP (1 yr ARI) for a 7 day duration storm;
- Western sump was constructed with a holding capacity of a 5% AEP (20 yr ARI) for a 7 day duration storm;
- Sumps are three-stage sumps to ensure no release of hydrocarbon-contaminated water into the stream channel;
- Multistage inverted culverts are installed between each stage:
    - Small diameter "T-joint" galvanised invert pipes installed between all stages (5 x 100nb stage 1 to 2; 5 x 65nb stage 2 to 3) to restrict the movement of hydrocarbons should they enter the first stage sump whilst allowing sufficient retention time in the first stage for sediment to settle from the water and ability to lower the water level in that stage providing for surge capacity for the next storm event. Following the first winter in operation, several of the small invert pipes were blocked off, leaving only two open small invert pipes between each stage. This was undertaken to further encourage sediment settling by increasing the retention time in the first and second stages;
    - Large diameter "T-joint" galvanised invert pipes installed between all stages (5 x 200nb) and between the sump and the dam at a higher level. There are no valves on these pipes ensuring flow is not restricted between stages while still retaining hydrocarbons in the first stage;
- Small diameter "T-joint" invert pipes installed between the sump and the stream channel. The system is operated as a closed system, in which discharge from the small pipes of water into the stream channel is controlled with valves and a manual discharge procedure (similar to Samson Dam). This ensures water quality is tested and meets requirements prior to discharge. Refer to Section 5.2.1 for details on this process;

- Emergency overflows constructed above the 1 in 200 year reservoir level (RL 212.39 m) in the third stage of the sumps which are rock pitched to slow water velocity preventing turbidity;

- Stages 1 and 2 are lined with a high density polyethylene liner to prevent infiltration;

- Visual marker installed within the sump to indicate the sediment level at which clean out should be initiated and the level to which sediment should be removed to ensure the liner is not compromised;

- Bitumen sealed road surface to reduce generation of sediment and turbidity. The bitumen was extended from chainage 4200 to 4700 during summer 2013/2014;

- Minimum cross fall on the causeway of 3% with a maximum of 5% to reduce wear on the sealed surface and accommodate smooth transition zones;

- 1.75 m bunding along sides of Big Brook Causeway (1.5 m high precast concrete retaining wall sections along the roadway edges, backfilled with earth to 1.75 m and providing additional stability for the retaining wall sections);

- Earth embankment fill on the outer sides forms the shape of the rock protected embankment batters from the bund to the dam floor;

- Rock pitching from top of Big Brook Causeway embankment to dam floor with rock obtained from selected sources approved by Alcoa. Maximum rock size is generally between 300 and 400mm; and

- A facility for long term storage of hydrocarbon response equipment is in place at the Causeway, Refer to Appendix B for operational procedures which include equipment details relating to this facility.

Provision has been made for access to forest tracks intersecting the causeway on the western side of the dam (Figure 3). As agreed in consultation with the Department of Parks and Wildlife (DPaW) and Water Corporation, provision of access to the eastern forest track is not required. It is important that the causeway does not become a conduit for public access to the reservoir. Therefore, gating and signage was installed restricting access to the long term forest access from the causeway on the northern side. No gating is required on access to the southern side of the causeway.

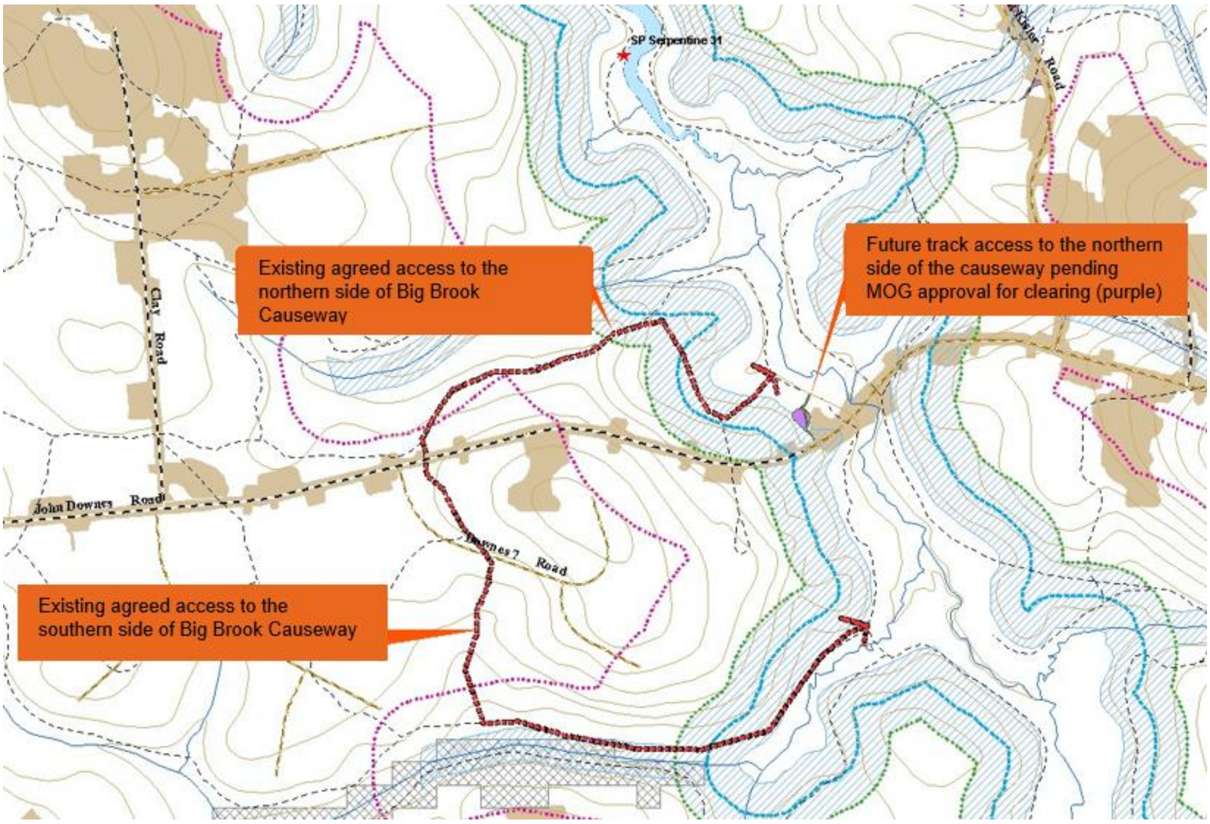



*Figure 5 – Access will be maintained to forest tracks on the western side of the Big Brook Causeway*

## 4.2. Sumps

### 4.2.1. Sump Configuration

The Big Brook Causeway has a system of sumps to capture spills and/or contaminated runoff following spills on the causeway, as two of the key risks identified by the 2008 risk assessment (Section 4.1.2).

The Big Brook Causeway has a total of 17 sumps within the Big Brook catchment, as presented in Figure 6 (Advisian 2021). Seven sumps (ID 23 to 28) lie west of Big Brook and 10 sumps (ID 29 to 39) lie east of Big Brook. Sumps 28 and 29 lie adjacent to the causeway and are three stage sumps with the first two stages being HDPE lined and the third stage being unlined. The other 15 sumps upslope of the causeway are single cell, unlined sumps. The current sumps are not connected by drains, have very low infiltration rates and have potential to overflow into the adjacent Jarrah forest or, in the case of sumps 28 and 29, into the Big Brook floodplain. The current sumps are effectively hydraulically disconnected from each other.

Table 2 presents the capacity of the existing sumps, assuming negligible infiltration and pumping. The sump catchments and volumes have been determined through LiDAR analysis (Advisian 2021). The equivalent Annual Exceedance Probability (AEP) storm that would result in overtopping of the sumps is estimated based on design rainfall depths generated by Bureau of Meteorology[2] for the Big Brook Causeway location. A seven day storm event is selected as the longest duration for which design rainfall depths are available.

#### 4.2.2. Sump Discharge

In 2017, Alcoa agreed to a water quality regime for the western and eastern three stage sumps whereby the sumps are tested for hydrocarbons (BTEX, PAH and TPH) and reported to the Water Corporation representative of the Mining Operations Group for approval prior to discharge of sump water into Big Brook. Where water quality exceeds the agreed standards for hydrocarbons the water will be disposed or reused of elsewhere (e.g. mine site dust control) rather than discharge into Big Brook (Alcoa 2017).

From 2020, Alcoa now prevents discharges from the western and eastern three stage sumps (as per the agreed water quality regime) due to the presence of PFAS detected in this sump water. Alcoa has since managed water from within these sumps so that no discharge from these sumps has been required.

[2] http://www.bom.gov.au/water/designRainfalls/ifd/

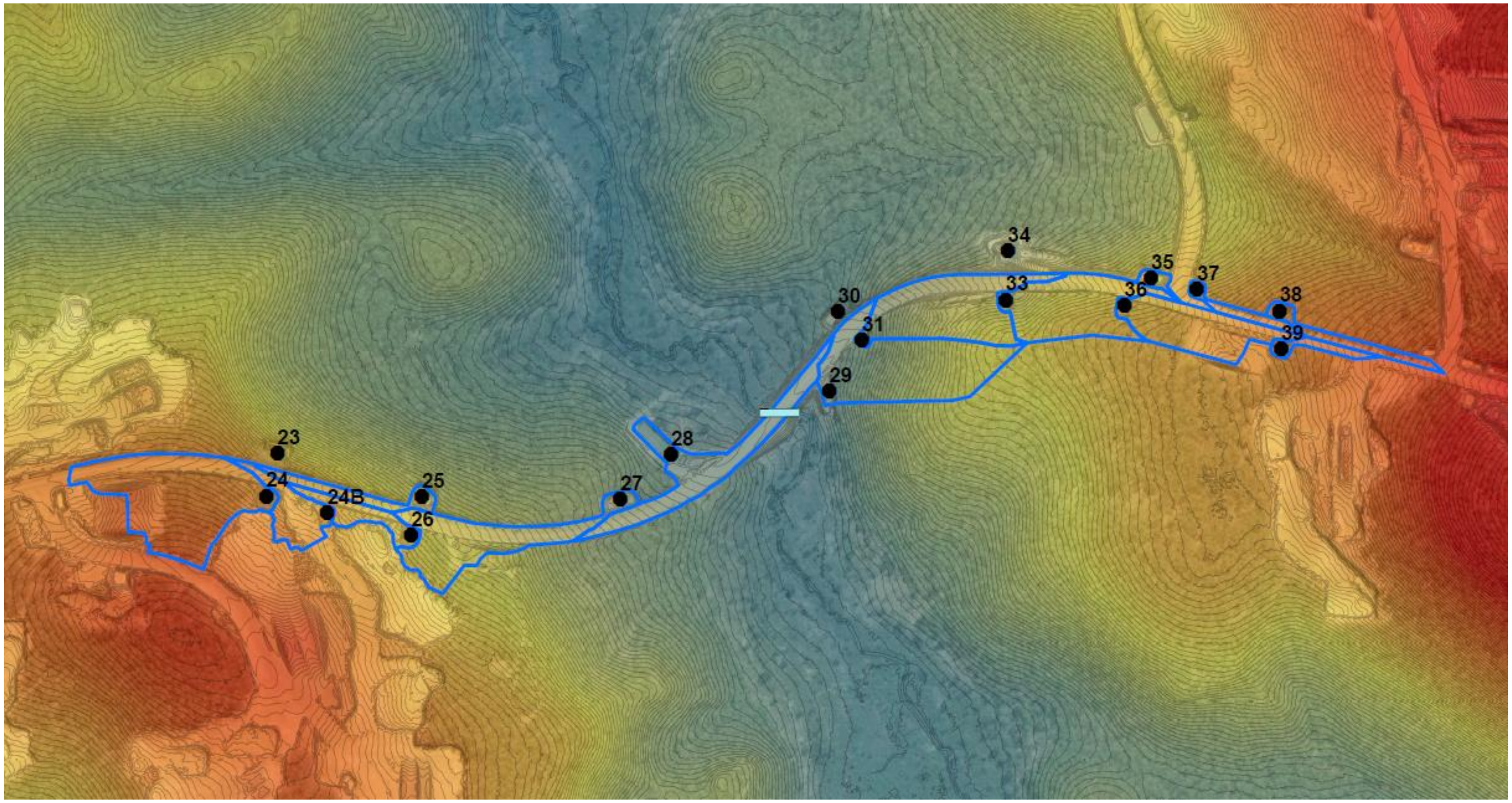



*Figure 6 - Big Brook Causeway haul road sumps discharging into Big Brook*

**Table 2: Capacity of current sumps at Big Brook Causeway**

| Causeway Side | Sump ID | Catchment Area ($m^2$) | Total Runoff Coeff. | Available Sump Volume ($m^3$) | Event Depth (mm) to Overtop Sump | Equivalent AEP** of 7 day duration storm event to overtop Sump |
|---|---|---|---|---|---|---|
| East | 39 | 2300 | 0.76 | 773 | 441 | Rarer than 0.05% |
| | 38 | 4080 | 0.81 | 651 | 198 | 2% |
| | 35, 36 and 37* | 18,150 | 0.49 | 1089 | 123 | 50% |
| | 33 and 34* | 17,590 | 0.43 | 2841 | 379 | Rarer than 0.05% |
| | 30 and 31* | 20,810 | 0.46 | 776 | 81 | 3EY*** |
| | 29 | 26,060 | 0.28 | 386 | 53 | 12EY |
| West | 23 and 24* | 30,130 | 0.40 | 716 | 59 | 6EY |
| | 24B | 7300 | 0.36 | 273 | 104 | 1EY |
| | 25 | 4390 | 0.78 | 451 | 131 | 50% |
| | 26 | 5180 | 0.54 | 444 | 159 | 10% |
| | 27 | 17,540 | 0.56 | 631 | 64 | 4EY |
| | 28 | 16,100 | 1.00 | 2855 | 177 | 5% |

*Sumps are considered together where drop boxes have been utilised to place a sump in a location that is more favourable to the local topography. These sumps are connected by culverts.

** AEP = Annual Exceedance Probability. 1% AEP is equivalent to 100 yr ARI. 10% AEP is equivalent to 10 yr ARI. 63% AEP is equivalent to 1 yr ARI.

*** EY = annual number of exceedances per year, for storms more frequent than 63% AEP / 1 yr ARI.

## 4.3. Big Brook Causeway Barrier

The Big Brook Causeway has a barrier to prevent a heavy vehicle exiting off the causeway and into Big Brook, as the third key risk identified by the 2008 risk assessment (Section 4.1.2).

The existing barrier along the Big Brook Causeway is constructed of precast concrete L-panelling with rock fill providing support to the wall. The current barrier is constructed approximately 1.5m high along the roadway. Figure 7 shows the extent of this barrier and Figure 8 shows a typical cross section.

The Australian Standards for road barrier designs do not consider vehicles as large as off-highway haul trucks such as the Cat 789D used at the Huntly Mine. However, the size of the wall and material behind will provide a substantial barrier to prevent vehicles crashing off the causeway and into Big Brook.


*Figure 7 - Approximate extent of existing Causeway barrier*

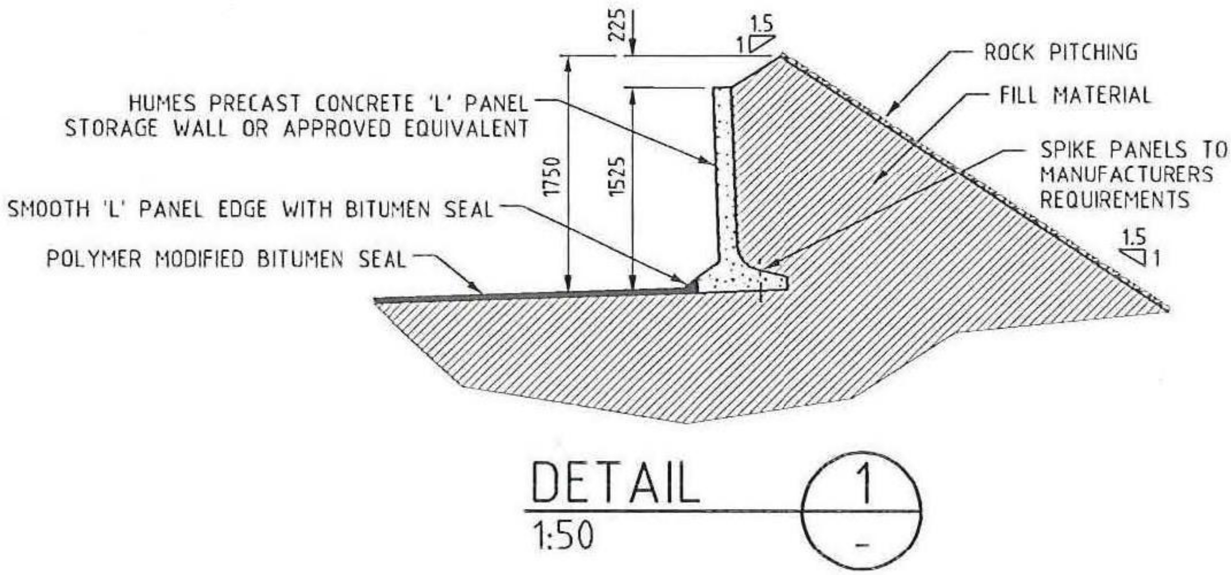



*Figure 8 - Typical sections through Causeway barrier*

# 5. Proposed Upgrades

## 5.1. Upgrade Development

Alcoa have undertaken a process of options identification (FEL[3] 1) and options selection (FEL 2) to develop a comprehensive risk reduction solution to mitigate the removal of the 100 m buffer for the Big Brook Causeway.

The FEL 2 options selection study included an Environmental Risk Analysis (ERA) in accordance with the Australian Drinking Water Guidelines (GHD 2022) (see Appendix E). The ERA expanded on the 2008 risk assessment for the Big Brook Causeway and incorporated a consideration of existing and proposed multiple barriers between hazards (e.g. vehicle incidents on the causeway) and the receptor of the Serpentine Dam reservoir on Big Brook. The ERA considered the potential for barriers to fail in sequence and the cumulative likelihood upon multiple barrier failure for contaminants to discharge into Big Brook.

The ERA expanded on the 2008 risk assessment to identify the following contaminants that could arise from credible hazards associated with the Big Brook Causeway operations:

- Hydrocarbons from spillage of diesel fuel, hydraulic or engine oils, or oily residue from tyre fires
- Surfactants from aqueous film forming foams (AFFF) during fire response
- Perfluoroalkyl and polyfluoroalkyl substances (PFAS) from residual contamination of pavements and mobilised by stormwater runoff
- Sediment from stormwater runoff or spillage of ore
- Heavy metals from oily residue from tyre fires
- Pathogens and nutrients from spillage of sewage tanker contents

Details of the identified hazards, pathways and barrier performance are presented in Appendix E.

The development of the risk reduction solution for Big Brook Causeway considered the barrier performance for each of the potential contaminant pathways into Big Brook, to ensure that all pathways were sufficiently mitigated for the loss of the 100 m buffer.

---

[3] FEL = Front End Loading

## 5.2. Sumps

Alcoa propose to upgrade the capacities of the 17 sumps that currently drain into Big Brook to retain runoff from higher intensity, more infrequent storm events, thereby reducing the likelihood of the sumps overflowing and discharging sediment or hydrocarbons into Big Brook.

Alcoa propose to increase the capacity of the three stage sumps adjacent to Big Brook (28 and 29) to accommodate a 0.2% AEP (500 yr ARI), 7 day storm event. The upslope sumps will be upgraded to accommodate a 1% AEP (100 yr ARI), 7 day storm event. The sump volumes will incorporate capacity for 2 years of sediment loading, assuming a high level of sediment loading (class D roadway condition based on Alcoa's Drainage Design Manual).

Table 3 presents the capacities of the proposed upgraded sumps based on design storm events in the individual catchments of the sumps.

The sumps have also been designed to overflow back onto the road. This allows for the additional capacity in the three stage sumps 28 and 29 to be utilised in the event of rarer / more intense storm events. Storm events rarer / more intense than 1% AEP (100 yr ARI), 7 day storms that cause upslope sumps to overflow will result in discharge into sumps 28 and 29. This results in a cascade effect.

Table 4 presents the combined capacity of the east and west sump systems compared to the rare storm events of the combined catchment of each sump system. As presented, the combined water holding volume of each sump system can accommodate runoff from the 1% AEP (100 yr ARI) 7 day storm event over the combined catchment. If the storm event occurs when the sumps have recently been cleaned, that is the Sediment Holding Volume has not been filled, then each sump system can accommodate runoff from the 0.2% AEP (500 yr ARI) 7 day storm event.

Table 4 indicates the minimum performance of the upgraded sumps in the absence of pumping. As presented in Section 5.3, the proposed pumping infrastructure is expected to increase the capacity of the east and west sump systems to accommodate runoff from at least a 0.05% AEP (1 in 2000 yr ARI) 7 day storm event.

**Table 3: Capacity of proposed upgraded sumps at Big Brook Causeway – individual catchments, no pumping**

| Causeway Side | Basin ID | Design AEP | Design Basin Water Holding Volume ($m^3$) | Existing Basin Volume ($m^3$) | Increase in Water Holding Volume | Sediment Holding Volume ($m^3$) | Total Sump Volume ($m^3$) |
|---|---|---|---|---|---|---|---|
| East | 39 | 1% | 418 | 773 | retain existing | 96 | 773 – retain existing |
| | 38 | 1% | 787 | 651 | 21% | 170 | 957 |
| | 35, 36 and 37 | 1% | 2115 | 1089 | 94% | 755 | 2870 |
| | 33 and 34 | 1% | 1790 | 2841 | retain existing | 732 | 2841 – retain existing |
| | 30 and 31 | 1% | 2297 | 776 | 196% | 812 | 3108 |
| | 29 | 0.2% | 2144 | 386 | 455% | 271 | 2415 |
| | **East – total capacity** | | **9551** | | | | **12,964** |
| West | 23 and 24 | 1% | 2906 | 716 | 306% | 1097 | 4003 |
| | 24B | 1% | 630 | 273 | 131% | 285 | 914 |
| | 25 | 1% | 823 | 451 | 82% | 171 | 994 |
| | 26 | 1% | 666 | 444 | 50% | 202 | 868 |
| | 27 | 1% | 2364 | 631 | 275% | 730 | 3094 |
| | 28 | 0.2% | 4766 | 2855 | 67% | 167 | 4933 |
| | **West – total capacity** | | **12,155** | | | | **14,806** |

**Table 4: Capacity of proposed upgraded sumps at Big Brook Causeway – connected catchments, no pumping**

**East sump network (ID 29 to 39)**

| Capacity and Runoff Volumes | | Volume ($m^3$) |
|---|---|---|
| Total Water Storage Capacity | | 9,551 |
| Total Sump Volume (including Sediment Holding) | | 12,964 |
| Runoff Volumes from combined sump catchments east of Big Brook (seven day storm duration) | 1% AEP | 9,138 |
| | 0.5% AEP | 10,094 |
| | 0.2% AEP | 11,318 |

**West sump network (ID 23 to 28)**

| Capacity and Runoff Volumes | | Volume ($m^3$) |
|---|---|---|
| Total Water Storage Capacity | | 12,155 |
| Total Sump Volume (including Sediment Holding) | | 14,806 |
| Runoff Volumes from combined sump catchments west of Big Brook (seven day storm duration) | 1% AEP | 11,237 |
| | 0.5% AEP | 12,412 |
| | 0.2% AEP | 13,917 |

## 5.3. Pumping Infrastructure

Alcoa propose to develop permanent pumps and associated infrastructure at sumps 28 and 29 to manage the water levels in these sumps. Pipes will connect upslope sumps into 28 and 29 to enable the upslope sumps to be emptied through the use of valves. This will restore the maximum capacity of the upslope following a major storm event, preventing the upslope sumps from overflowing into and thereby reducing the capacity of sumps 28 and 29 during major storm events.

The pumping infrastructure has been designed to allow all connected sumps to be emptied within 24 hours after a 1% AEP (100 yr ARI) storm event. The critical flowrate for a 1% AEP event was used to size the pumps at sumps 28 and 29 to ensure suitable management of the sumps.

A duty/standby arrangement for both pumps and LPG fuelled generator sets have been proposed to provide a level of redundancy to the system to allow for continued operation in the event of equipment failure. The system is intended to operate automatically with activation points occurring on a determined sump level. Selected system parameters are to be telemetered back to Alcoa operations to provide warning of any potential malfunctions in the system. The likelihood of the pumping system failing coincident with a major storm event rarer than 1% AEP is considered extremely remote and not a credible risk.

Piping from the upstream sumps will be intended to flow into sumps 28 and 29 respectively with automatic control valves placed near the causeway side sumps. The upstream sumps are intended to have level sensing to actuate the downstream valves to allow management of each sump level. The pump discharge pipework is to utilise suitable valving to prevent backflow into the three stage sumps when pumping is stopped. The piping has been selected to be of a suitable material and pressure rating to provide a suitable margin above the hydraulic head generated during pumping from the sumps. All materials used in the piping and pumping infrastructure to be risk assessed against the requirements for drinking water.

Figure 9 presents the combined performance of the upgraded sumps and proposed pumping infrastructure during a 0.05% (2000 yr ARI) storm event. As presented, the combined upgraded sump capacity and pumping is expected to limit water volumes in the sumps to less than 80% of the sump capacity. This indicates that the upgraded sumps and pumping infrastructure will accommodate runoff from more than a 0.05% storm event of 7 days duration.

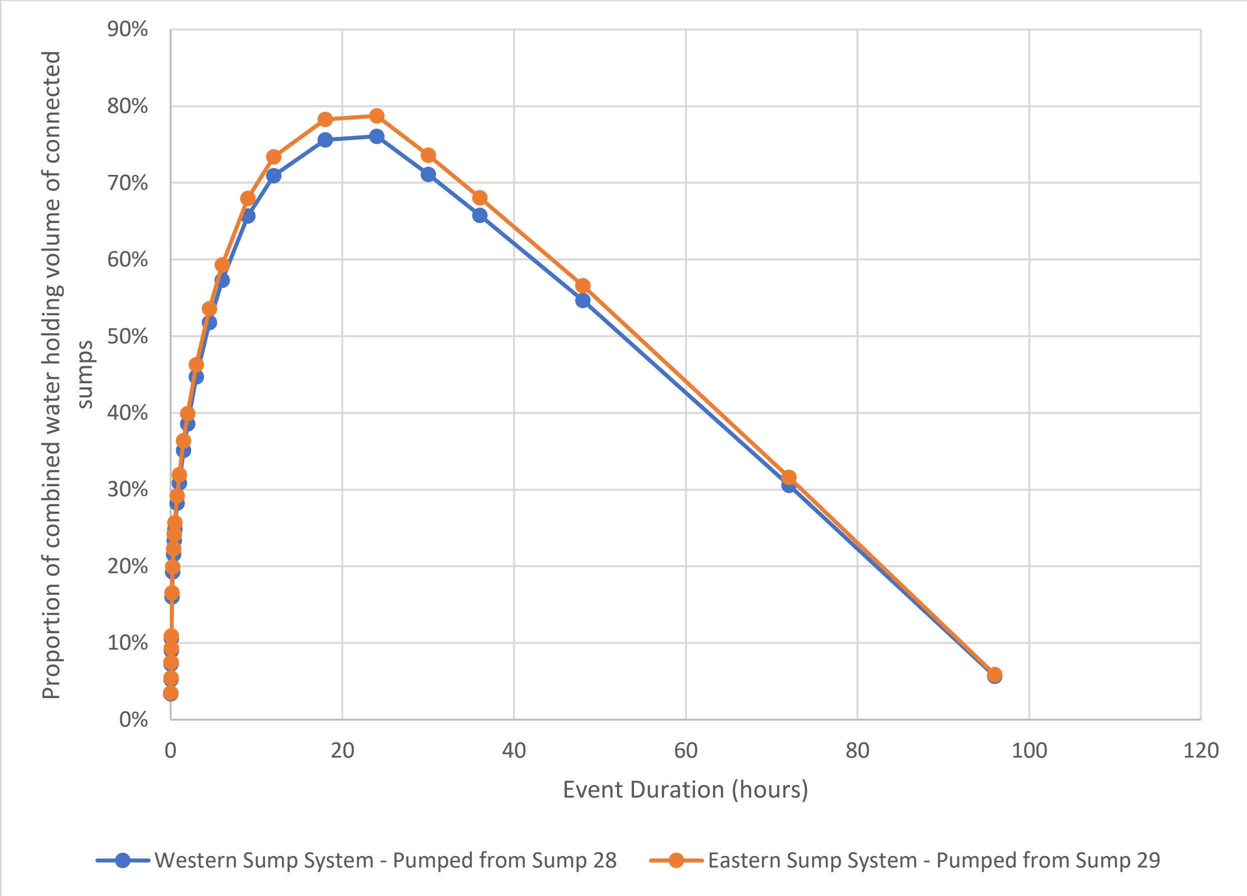



*Figure 9 - Combined performance of upgraded sumps and pumping infrastructure - maximum sump volume reached during a 0.05% AEP storm event*

## 5.4. Barrier Upgrade

Alcoa propose to upgrade the causeway barrier to provide further resistance to prevent a heavy vehicle exiting off the causeway and into Big Brook. This will provide sufficient energy absorption capacity to match that of *Recognised standard 19. Design and construction of mine roads* (Queensland Government 2019), which is for the protection of human life.

The impact energy absorption of the existing system retaining wall has been estimated and compared to the estimated impact energy absorption for a windrow to *Recognised standard 19. Design and construction of mine roads* (Queensland Government 2019). It is noted that this standard is used by large mining companies in Western Australia for the design of windrows as barriers to prevent haul trucks crashing into open cut mine pits and thereby protect human life.

The estimates indicate that the existing causeway barrier has an energy absorption capacity of approximately 54% of the windrow specified in Recognised standard 19.

Adding fill material behind the wall for a horizontal length of 2.5m before battering to the existing levels matches the energy absorption capacity of a windrow specified in Recognised standard 19.

The proposed upgrade to the causeway barrier will enable an approximate doubling of the energy absorption capacity of the barrier.

Figure 10 presents a typical cross section and Figure 11 the approximate extent of the proposed causeway barrier upgrade. As presented in Figure 10, the barrier presents a substantial physical obstacle as well as energy absorption capacity for a typical sewage tanker (e.g. 26t rigid truck) compared to the much larger haul truck (over two times the height and over 10 times the mass) for which the barrier is designed.

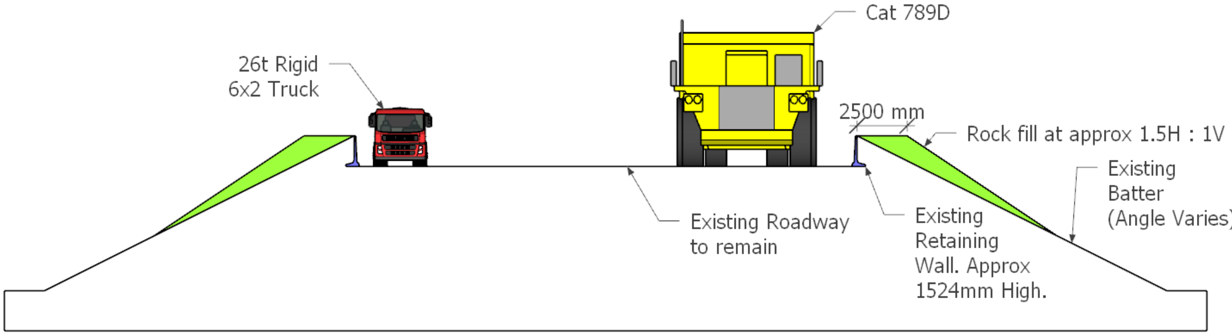



*Figure 10 - Typical cross section of proposed causeway barrier upgrade*

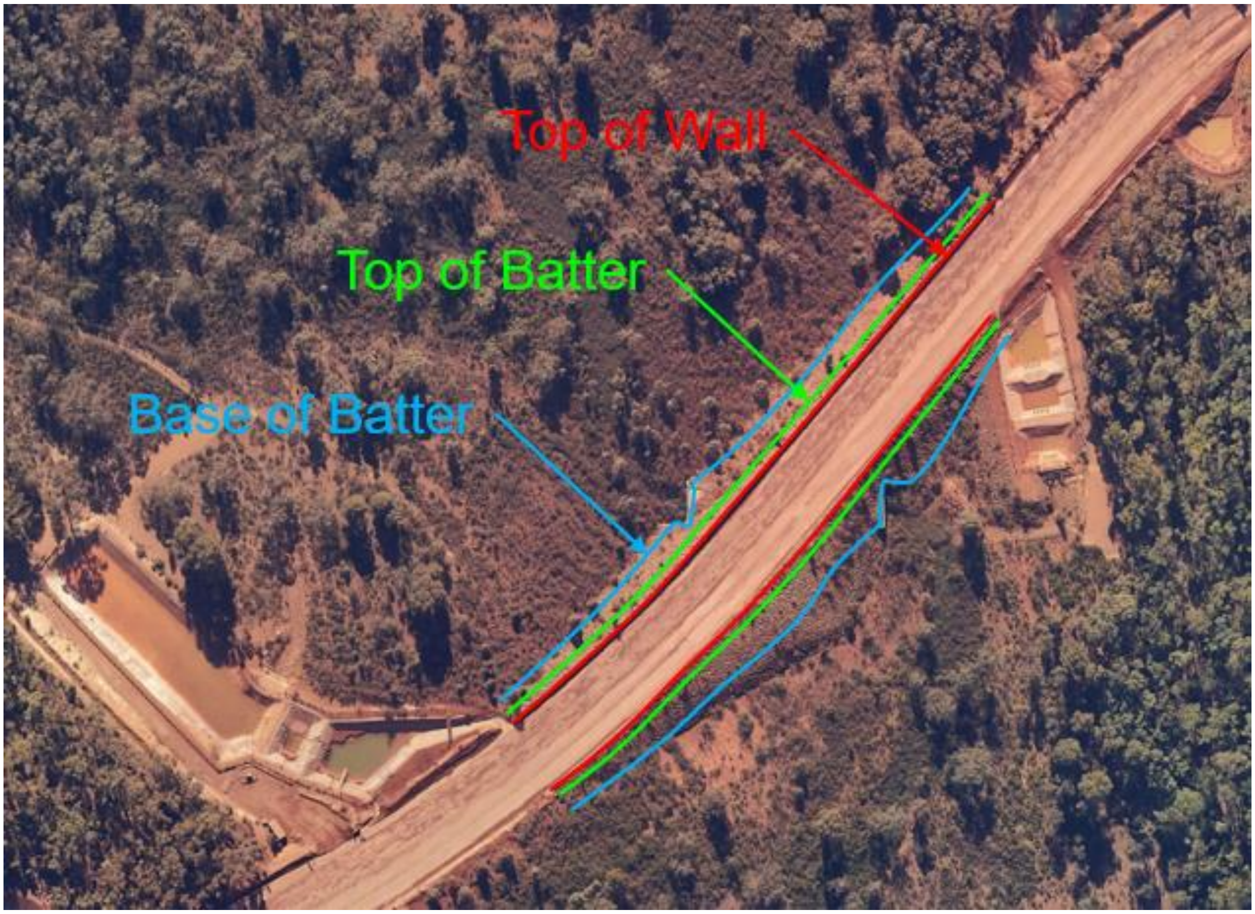



*Figure 11 - Approximate extent of proposed causeway barrier upgrade*

## 5.5. Kisler Ablution Facilities Sewage Disposal Upgrade

In addition to the risks identified in the 2008 risk assessment, GHD (2022) have identified the potential for a vehicle crash to involve a sewage tanker. This has potential to result in discharge of raw sewage including high loads of pathogens, which are expected to pose the greatest consequence in terms of risk to drinking water consumers. Although sewage tankers comprise a very small proportion of traffic on the Big Brook Causeway and a vehicle crash / spill is highly unlikely, Alcoa have proposed a risk elimination measure given the high consequence of a discharge event.

Alcoa propose to develop a Sewage Treatment Plant (Biomax) at the existing Kisler ablution facilities east of the Big Brook Causeway. The STP will incorporate primary treatment, aeration and disinfection via chlorination. Alcoa propose for the treated effluent to be irrigated in the vicinity of the existing Kisler ablution facilities, subject to agreed location and design criteria.

Development of the STP and effluent irrigation system will eliminate the requirement for regular transport of raw sewage via tanker from the Kisler ablution facilities west across the Big Brook Causeway.

# 6. Construction Management of Upgrades

Alcoa propose to construct the upgraded sumps, pumping infrastructure and upgrade causeway barrier in a manner that prevents discharge of contaminants from construction areas into Big Brook. Alcoa will adopt a preventative risk framework incorporating multiple barriers during construction, including the following:

- Construction will be staged to occur from November to April to reduce the likelihood of a major storm event or Big Brook stream flow occurring during construction.
- A 100 m buffer will be maintained at all times between construction areas and the Serpentine Dam reservoir water body.
- No ground disturbance will be undertaken in the immediate vicinity of the Big Brook channel. All earthworks will be in cut to fill with imported fill sourced from outside the Big Brook Causeway catchment and Big Brook floodway.
- The expansion of three stage sumps 28 and 29 will be scheduled when the ground is dry, as far as practicable. Construction will be suspended in the event of forecast rainfall expected to exceed 10 mm in a day.
- The expansion of three stage sumps 28 and 29 will be undertaken in a staged manner such that the new sump embankments will be completed prior to the removal of the existing sump embankments, to maintain the sump containment function for Big Brook Causeway throughout the construction period.
- All temporary construction areas will be located adjacent to the proposed infrastructure. No access roads or areas will be constructed into the Big Brook flood plain.
- Temporary erosion and sediment controls will be installed and maintained in all construction areas that are not captured by the existing or upgraded sump system.
- Water used for hydrostatic testing of pipework will be either discharged into sumps 28 or 29 and tested prior to discharge into a mine void located outside of the Big Brook Causeway catchment.
- Construction compounds, including vehicle parking, fuel and waste storage, will be located outside of the OCA2 boundary within an existing cleared area
- Fuel storage within construction compounds will be limited to diesel generators. The quantity of fuel stored will be limited to the amount required for power supply.

- Refuelling of construction vehicles will occur at the construction compound which will be located outside of OCA2. Refuelling of earthmoving equipment will be undertaken using spill prevention equipment and procedures.

- Emergency spill response equipment will be maintained at the construction areas. Excavation equipment will be present in the vicinity to remove contaminated soil in the event of a spill occurring in a construction area.

- Alcoa will ensure that the Water Corporation and Department of Water and Environmental Regulation are notified in writing prior to commencement of construction and will allow time for site inspection prior to and during construction.

# 7. Operational Management

## 7.1. Big Brook Causeway Operation

As Serpentine Dam provides drinking water to Perth and surrounding areas, it is essential that the water is not contaminated by either hydrocarbons or turbid water as a result of Big Brook Causeway operation.

To ensure the risk is minimised, Alcoa has agreed to the following operational strategies for Big Brook Causeway.

- Speed limit of 35 km/hr. over Big Brook Causeway at all times. This is clearly signed at the causeway;
- Limit of 15,000L of total hydrocarbon volume (per vehicle) to be transported across Big Brook Causeway. This is clearly signed prior to entry points on either side of the causeway;
- The sumps are to be regularly checked and maintained in a “Storm Ready State”, where water is always below a pre-determined marked level (refer to Section 5.3);
- Specific spill response procedures, a standby agreement with a contractor and an annual spill response drill (refer to Section 5.5), similar to that currently carried out for the Samson Dam Causeway at Willowdale Mine will be implemented; and
- A program to maintain the sealed surface will be implemented to keep turbidity to a minimum (refer to Section 5.2.2).

Due to the potential rise in reservoir water levels following dam maintenance works, it is expected that the 100 m buffer may not be maintained at all times. Alcoa have proposed infrastructure upgrades to reduce the likelihood of sump overflows or a vehicle exiting the causeway into Big Brook, to mitigate the removal of the 100 m buffer.

## 7.2. Sump Operation

The following operational strategies for sump management at the causeway is proposed:

- Upstream sumps connected to pumped sumps (28 & 29) via gravity drain pipe work;
- Each pipe to have isolation valves to control flow from each sump;
- Level monitors at sumps 28 and 29 will transmit their state to the pump control system;
- The pumps transfer stormwater to a void sump outside of the OCA 2 boundary, this water is to be tested prior to discharge or removal;

- The void sump is to have its level monitored to ensure readiness for storm management;

- Sumps are to have sediment removed at least every 2 years to return them to design capacity.

### 7.2.1. Groundwater Ingress with Rising Reservoir Levels

Groundwater mounding that may result from reservoir water rise may result in the following impacts to sumps:

- Mounding is below or at the base of the infiltration sumps and reduces or eliminates infiltration from the sumps, increasing the likelihood that sumps are not in a storm ready state and overflow during major storm events

- Mounding is above the base of the infiltration sumps and causes groundwater ingress that reduces the sump effective capacity below the designed performance criteria, increasing the likelihood of overflow during major storm events

- Mounding is above the base of the lined cells of the three stage sumps, causing lifting and damage to the HDPE liners, resulting in hydrocarbon contamination/seepage through the sump walls following discharges from vehicle incidents.

GHD (2022b) undertook a study of the potential for groundwater mounding impacts to the sumps. The study indicated the following:

- Groundwater inflows are likely into the sump 28 third (unlined) cell as the reservoir reaches 87% capacity (210.6 mAHD) or 90% capacity (211 mAHD) for the proposed sump upgrade. This may occur around 2026 based on Water Corporation modelling of reservoir water level rise. At reservoir FSL groundwater flows may reach a maximum of approximately 100 m3/day. Impeded infiltration is likely to occur from about 2023-24 onwards and potentially earlier due to reservoir derived groundwater mounding in combination with rainfall derived / regolith groundwater.

- Groundwater levels may cause uplift on the sump 28 lined cells as the reservoir reaches 96% capacity (211.8 mAHD). This may occur around 2027-28 based on Water Corporation modelling of reservoir water level rise.

- Sumps 29 and 30 may be subject to impeded infiltration from about 2026-27 and potentially earlier due to reservoir derived groundwater mounding in combination with rainfall derived / regolith groundwater. The sumps have sufficient elevation to prevent groundwater inflows and, for sump 29, uplift on lined cells.

The other remaining 14 sumps on the primary haul road crossing that drain to Big Brook are at an elevation well above the reservoir FSL and are unlikely to be subject to impeded infiltration and will not be subject to groundwater inflows.

Alcoa will implement the following management for groundwater ingress or uplift into sump 28:

- In the event of the reservoir TWL exceeding 211 mAHD (90% reservoir capacity) and groundwater inflows into the sump 28 unlined cell, the groundwater will be allowed to accumulate in the sump. Groundwater inflows into the sump will slow then cease as water levels rise to those of the reservoir TWL.
- In the event of a major storm event forecast, the accumulated groundwater in sump 28 will be pumped out within 24 hours (see Section 5.3 and Section 7.3) to maintain the maximum sump capacity prior to the storm inflows.
- This approach will avoid ongoing pumping out of groundwater and loss of reservoir water from sump 28 in the event of the reservoir TWL exceeding 211 mAHD.
- In the event of the reservoir TWL approaching 211.8 mAHD (96% capacity), liner upgrades will be investigated and implemented (e.g. concrete liner, anchoring) to prevent liner uplift in the sump 28 lined cells.

## 7.3. Pumping Operation

The operating philosophy of the pumping system is as follows:

- Pumps to start and stop at predefined water level;
- Pump start level for sump 28 to allow accumulation of groundwater ingress from rising reservoir water levels;
- If a pump failure occurs the system will engage the standby pump and alert operators to a fault, this fault should be rectified as soon as reasonably practicable;
- Sumps and LPG levels are to be regularly inspected to ensure readiness for storm events;
- The pressure pipelines are to be regularly inspected for integrity.

## 7.4. Turbidity Management

### 7.4.1. Turbidity Monitoring

The sumps have been designed to encourage settlement of sediment to minimise the turbidity levels in discharged water. This is combined with other controls such as sealing and maintenance of the causeway surface to minimise the initial turbidity level in the first stage of the sumps.

A compliance Greenspan turbidity monitor is installed immediately downstream of the Causeway, approximately 90 m from the end of rock pitched channel (Figure 4). This monitor provides continuous turbidity levels reflecting the water quality of the stream flow prior to, during and following discharge of sump water. The turbidity incident reporting levels as stated within the Working Arrangements between Alcoa, Department of Water and Water Corporation apply to this compliance turbidity monitor.

Further, the sumps will have an annual inspection program where they are assessed for sediment loading and cleaned out with a long-reach excavator to the original design capacity during the summer months. Cleanout will occur when half a meter of sediment is present in the base of stage 1 and stage 2 of the sumps. A visual marker is installed within these stages of the sumps to indicate the sediment level at which clean out should be initiated and the level to which sediment should be removed to ensure the liner is not compromised.

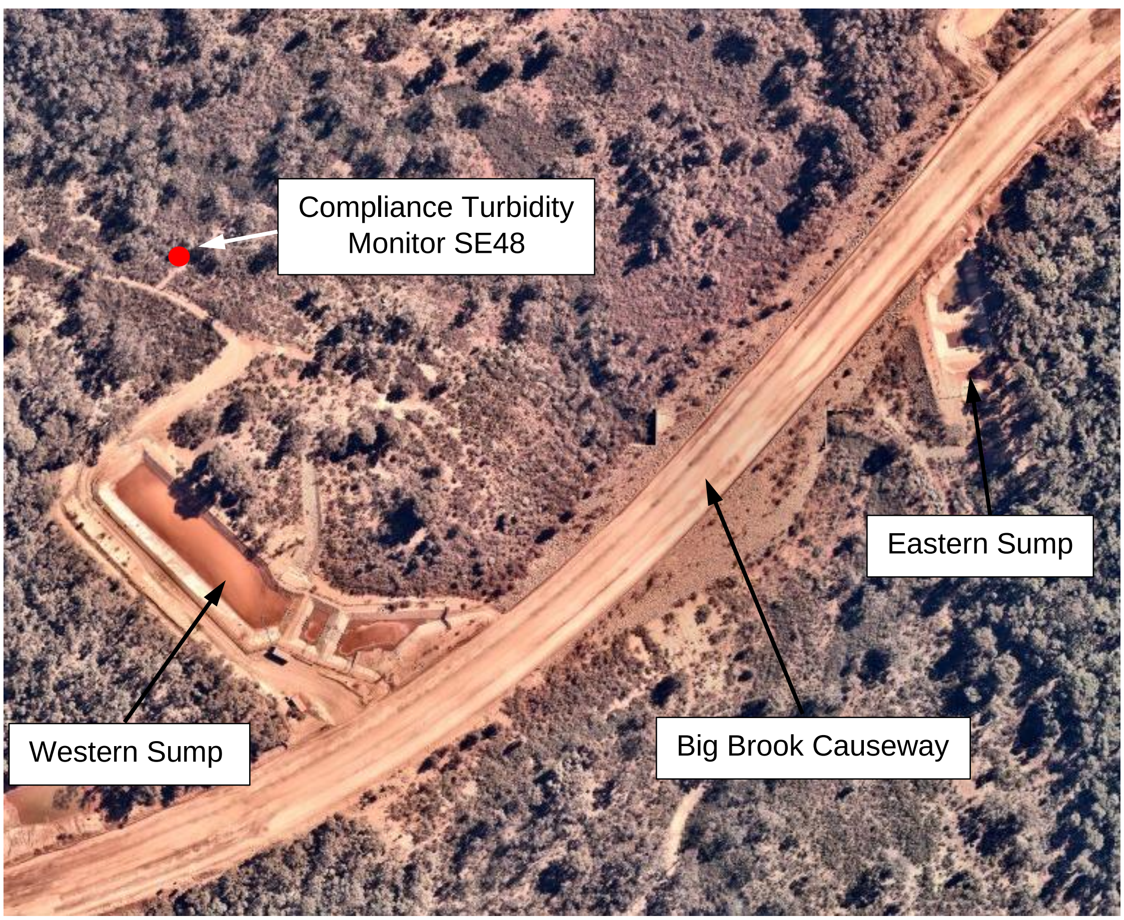



*Figure 12 – Location of Turbidity Monitor Downstream of Serpentine Causeway*

### 7.4.2. Red Alert Process

As per the letter to MMPLG 13 February 2011, the Alcoa Red Alert process applies to Big Brook Causeway. A Red Alert is issued when rain >20mm is forecast. A "Big Brook Causeway Red Alert Checklist" (refer to Appendix D) is completed for every Red Alert issued, with the checklist returned to the Mine Environmental Scientist to action any identified work or immediate controls. Completed checklists are kept for auditing purposes.

## 7.5. Emergency Response

### 7.5.1. Emergency Response Procedures

Identified situations at Big Brook Causeway that would require emergency response include a hydrocarbon spill, non-hydrocarbon chemical spill and personnel fall in sump water. Additionally, equipment is available to respond to fauna entering sumps.

***Hydrocarbon Spill***

Alcoa already has well established emergency response procedures for Willowdale's Samson Dam causeway. Similar procedures and systems have been developed for Serpentine Causeway (refer to Appendix B for a draft of the Perform Spill Recovery at Serpentine Causeway procedure). The following is a summary of this procedure.

In the event of a hydrocarbon spill on Big Brook Causeway, drains running the length of the road will capture and contain the spill. All flow from the drains is directed into one of two three-stage sumps located on the perimeter of the causeway. In the event of a spill, it is very important that the spill is removed from the sumps to prevent contamination of the dam water. Spill response equipment is located on site at both the western and eastern sumps, easily accessible from the causeway. These spill response bins provide equipment to be used to contain spills by the immediate responders. In addition to the spill response bins, stored within a shipping container at the western sump is equipment to enable skimming of hydrocarbons from the sump water surface into 1000L containers. Vacuum Loading Contractors can then be called out to recover any remnants of the spill from the collection sump.

The Mobile Maintenance Emergency Response crews have been trained on how to use the skimmer equipment, and an emergency response drill will be carried out annually as per Samson Dam practice. This has been added to the Emergency Response Plan (MIN) procedure and a training plan implemented similar to Willowdale.

***Chemical (Non-hydrocarbon) Spill***

In the case of a chemical spill at Big Brook Causeway, the Perform Spill Recovery at Big Brook Causeway procedure will still apply. In particular, the immediate responders will be required to check that discharge valves are closed and notify the Environmental Department. The nature of the chemical will determine the response strategy.

***Uncontrolled Discharge***

In the event of uncontrolled discharge at Big Brook Causeway into the stream channel, the Environmental Department will notify Water Corporation and determine the appropriate course of action at the time.

***Fall into Sump by Personnel***

Falls protection is in place around the sumps at Big Brook Causeway, including on the gangway used for sampling. However, in the event of personnel falling into the sump water, there are ladders in stages 1 and 2 (lined stages) for access out of the sump, as well as a life buoy on both the eastern and western sides of the causeway.

***Fauna in Sump***

Fauna protection fencing has been installed around both the eastern and western sumps as per the request of DBCA. In the event that fauna (e.g. kangaroo) were to fall into the western or eastern sumps, fauna egress matting has been installed in stages 1 and 2 (lined stages). The Alcoa procedure for Rescue Injured or Orphaned Fauna would be followed.

### 7.5.2. Responsibilities

***Sampling and Release***

The Mine Environmental Technicians (MET) (weekdays) or the Huntly Water Crew personnel (weekends and public holidays) are responsible for checking the sump water levels when there is a greater than 20mm rainfall event in 24 hours and reporting high water levels to the Mine Environmental Scientist (MES) (Red Alert process as per section 5.3).

***Spill Response***

The first responder (person who identifies the spill) is responsible for setting up and using the contents of the Spill Response bins to contain the spill. Where possible, all effort will be made to contain the spill on the causeway, preventing the spill from entering the sumps. The first responder is responsible for reporting the spill to Security to enable dispatch of the Mobile Maintenance Emergency Response Crew.

Security is responsible for dispatching the Mobile Maintenance Emergency Response Crew and notifying the Environmental Department of the spill.

The Mobile Maintenance Emergency Response Crews are responsible for setting up and using the skimmer pump to recover the spill from the sumps, as well as assisting with spill containment using the contents of the Spill Response bins.

The Mobile Maintenance Department or Security will contact the Vacuum Loading Contractors to complete clean out of a contaminated sump if required.

The Environmental Department will sign off that the sump clean-up is sufficient and operations can resume as normal. The Environmental Department will also provide the appropriate notifications to applicable government regulators and Water Corporation.

# 8. Appendices

| Appendix | Description | File |
|---|---|---|
| A | WA Mining Operations Environmental Management Manual 2013-2014 | Alcoa EMM 2013-2014 |
| B | Perform Spill Recovery at Serpentine Causeway (HUN) | Perform Spill Recovery at Serpentine |
| C | Risk Assessment of the Proposed Haul Road Causeway of Serpentine Dam | Alcoa Risk Assessment 2008.pdf |
| D | Serpentine Causeway Red Alert Checklist | Visual Inspection Checklist |
| E | Environmental Risk Analysis (GHD 2022) | GHD FEL2 Final Environmental Risk Analysis 2022 |

# Technical Memorandum

**March 2, 2023**

| | | | |
|---|---|---|---|
| **To** | Brett Lowcock | **Contact No.** | +61 8 6222 8222 |
| **Copy to** | Dion Sardelic, Bob Kinnell | **Email** | Anna.edgar@ghd.com |
| **From** | Anna Edgar | **Project No.** | 12594875 |
| **Project Name** | Big Brook Crossing FEL3/Detailed Design | | |
| **Subject** | Groundwater impacts to sump design - Revised | | |

# 1. Introduction

GHD are currently delivering FEL3/Detailed Design as per proposal - 12594875-MD-PPL-001 Alcoa Big Brook FEL3, which involves designing a series of sumps near the Big Brook road crossing. Alcoa have requested a technical memorandum regarding the potential impacts of groundwater on the sump design.

The aim of this technical memorandum is to review existing information on groundwater levels, including recent drilling along the Big Brook crossing, and older data to provide guidance on possible seasonal fluctuations in groundwater levels around the Big Brook crossing.

## 1.1 Purpose of this Memorandum

This Technical Memorandum is provided as interim communication under our agreement with Alcoa of Australia. It is provided to foster discussion in relation to groundwater sump levels at the Big Brook crossing and should not be relied on in any way or for any purpose.

## 1.2 Scope and limitations

*This technical memorandum has been prepared by GHD for Alcoa of Australia. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.*

*No site visits or data collection was undertaken to provide information to this memorandum and as such there is approximately an order of magnitude of uncertainty in relation to any conclusions reaching in this report.*

### Accessibility of documents

*If this Technical Memorandum is required to be accessible in any other format this can be provided by GHD upon request and at an additional cost if necessary.*

## 1.3 Background

The Huntly Mine is the world's second-largest bauxite mine and supplies Pinjarra and Kwinana alumina refineries and bauxite export. The Huntly Mine operations are currently within the Myara region, which will continue until 2027 at which point mining will transition into the proposed Myara North region. The Huntly Mine currently produces approximately 28.5 million tonnes per year (Mtpa) of bauxite and is forecast to produce up to approximately 29.6 Mtpa over the next decade.

The Big Brook crossing is used as a primary haul road crossing for the Myara region and will continue to be used for Myara North over 2027-2030. The crossing was constructed over the summer of 2012/2013 following approval by the Mining and Management Program Liaison Group (MMPLG) pursuant to Alcoa's State Agreement. The crossing was approved subject to the implementation of the Serpentine Dam Causeway Construction and Operational Plan (Alcoa 2017), which was informed by a risk assessment conducted by Professor Barry Hart (Water Science 2008).

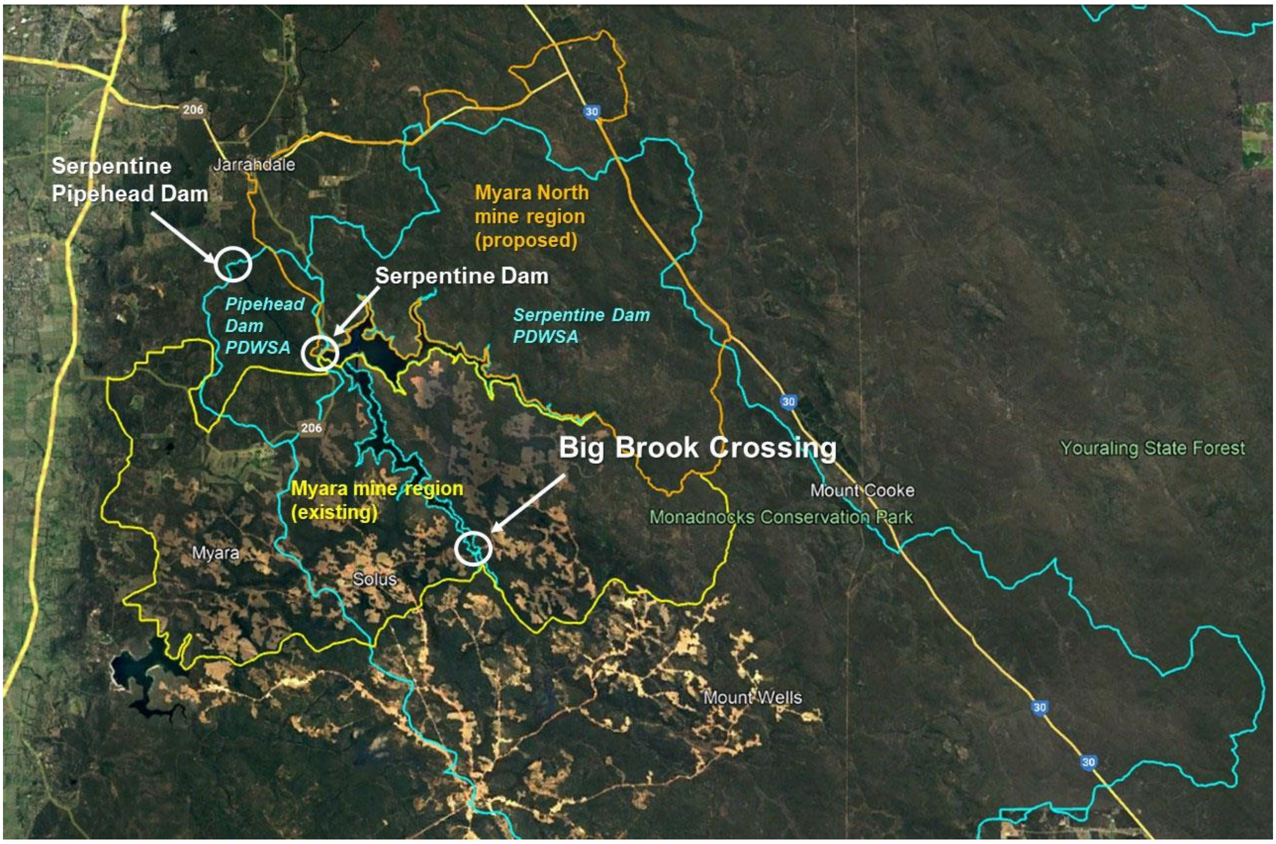



*Figure 1. Big Brook causeway regional context (basemap: GoogleEarth Pro)*

From 2019-2021 the Big Brook causeway conveyed an average of approximately 10.4 Mtpa of ore via approximately 53,000 haul truck movements (106,000 one-way crossings) at an average of approximately 196 tonnes of ore per truck. The ore is delivered to the Myara mine facilities where it is crushed and loaded onto conveyors that deliver the ore to stockpiles at Pinjarra Alumina Refinery.

Haul trucks (CAT 789C and 789D) represent the majority of Big Brook crossing movements, with other lower frequency vehicle movements comprising:

– Fuel tankers (8000 L capacity) that refuel heavy equipment in mine pits

– Sewage tankers that pump out tanks at demountable crib rooms

– Miscellaneous heavy vehicles (e.g. water carts, graders, low loaders transporting plant)

– Light vehicles.

Huntly Mine operations proposed for the Myara North region will utilise long haul trucking (CAT 789D) rather than conveying, therefore over 2027-2030 all ore from the Huntly Mine will pass over the Big Brook causeway, at up to 29.6 Mtpa or up to 151,000 haul truck movements (302,000 one-way crossings). This represents an approximate 180% increase in haul truck traffic over current operations.

# 2. Big Brook sump design

GHD have designed a series of sumps to catch road rainfall runoff along the Big Brook crossing as part of FEL3/Detailed Design deliverable. The sump design includes a series of 16 sumps, with six on the western side and 10 on the eastern side of the Big Brook Crossing. These sumps will be connected and drain into sumps 28 and 29 where water can then be pumped away from the area.

The proposed sump design involves the extension of several existing sumps, as well as the excavation of several new sumps, as shown in Figure 2. These sumps are generally dry over the late summer period, filling with rainfall and road water runoff predominantly in winter and late spring.

The Big Brook crossing sits in a valley, with the valley floor siting at an elevation of ~208 m AHD, and the sumps located at ground level elevations from ~214 m AHD to ~273 m AHD. The elevation of the base of the sumps will range from ~210 m AHD to ~268 m AHD. See Table 1 for Sump details.

*Table 1 Big Brook crossing sump details*

| Sump | Interpolated Ground level* m AHD | Designed sump depth (m AHD) | Designed sump depth (m bgl)** | Comments |
|---|---|---|---|---|
| 23 | 259.2 | 257 | 2.2 | Sump exists no changes being made. |
| 24B | 262 | 255 | 7 | Sump exists, being extended deeper |
| 25 | 241.5 | 243.9 | -2.4 | Sump exists, walls being raised |
| 26 | 252.5 | 244.9 | 7.6 | Sump exists, being extended deeper |
| 27 | 225.7 | 220 | 5.7 | Sump exists, being extended deeper |
| 28 | 213.7 | 210.3 | 3.4 | Sump exists, being extended deeper |
| 29 | 214.4 | 213 | 1.4 | Sump exists, being extended deeper |
| 30 | 216.2 | 217 | -0.8 | Sump exists, walls being raised |
| 34 | ~228 | 226.5 | ~1.5 | Sump exists, no changes being made |
| 35 | 255.6 | 251.7 | 3.9 | Sump exists no depth changes being made. |
| 38 | 273 | 268.2 | 4.8 | Sump exists no changes being made. |
| VOID SUMP | 263 | 255.8 | 7.2 | Sump exists no changes being made. |

0* Where pre-existing sump occurs ground level has been interpreted based on surrounding conditions.

** Where the sump is located against a hill face the average base of the sump may be raised.

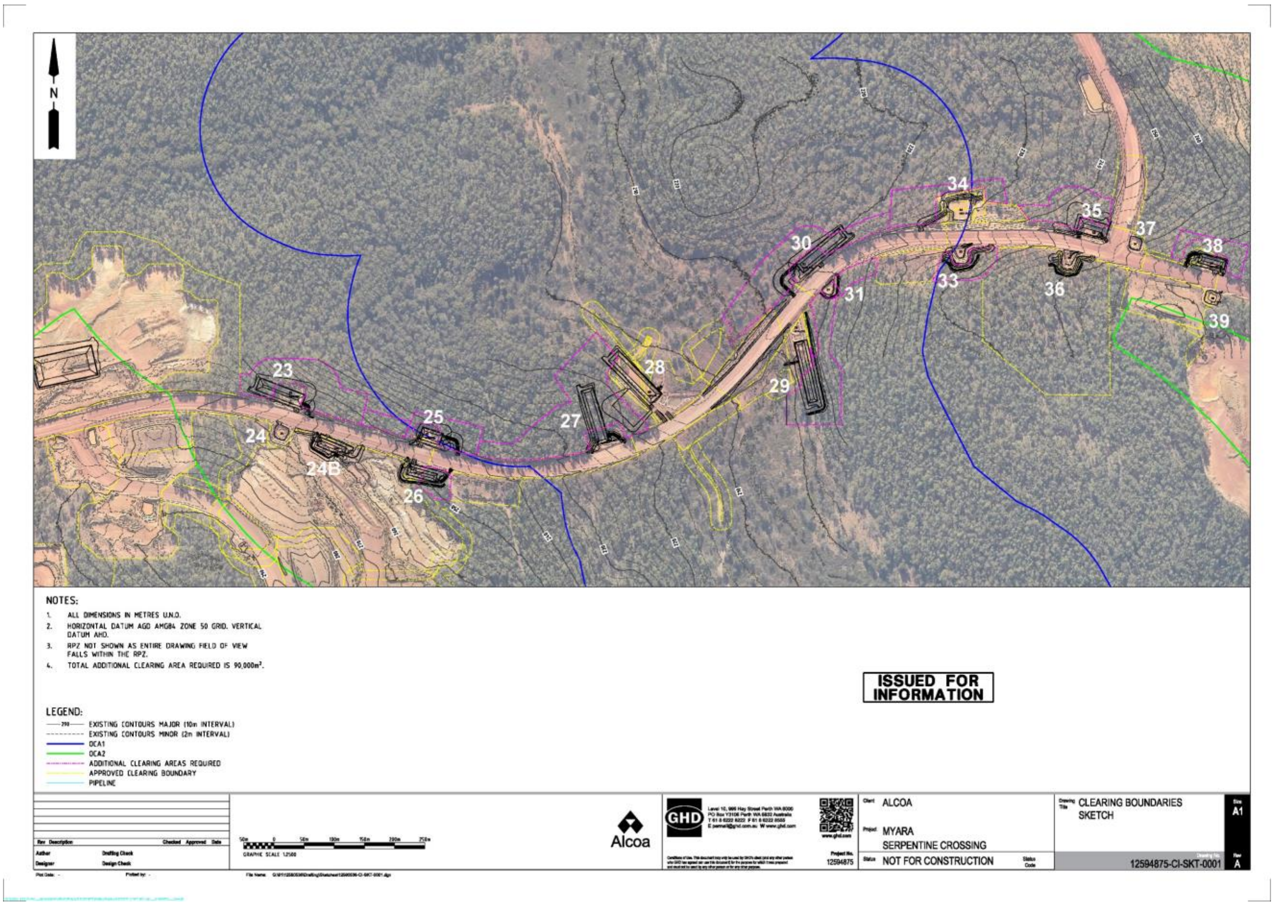



*Figure 2. Proposed Big Brook sump design.*

# 3. Groundwater levels at Big Brook crossing

## 3.1 Big Brook monitoring bores

In February 2023 a series of six groundwater bores were installed along the Big Brook crossing, extending across an area of two kilometres east to west and covering a change in elevation from 272 m AHD to 213 m AHD. Locations are depicted in Figure 3.

Standing water levels were measured at the completion of the drilling. The measured water levels varied from 5.0 meters below ground level (m bgl) at the valley floor (H4220-5A) to 31.5 m bgl at the immediate Eastern flank of the valley (H4220-4A). A cross section of the valley showing a comparison between the base of sump depths and water level is shown in Figure 4. The minimum depth of base of sump to water level was approximately 5m (Sump 28), however it is important to note this data was recorded in the drier season of February. For sumps situated at the valley floor, seasonal water level fluctuation may substantially reduce or overcome the buffer between water levels and sump base during the wet season, For further discussion on seasonal fluctuation see Section 4.

*Table 2 Big Brook crossing monitoring bores*

| Bore ID | Easting* | Northing* | Drilled Depth (m) | Ground elevation m AHD** | Water level (m bgl) | Water level (m AHD)** |
|---|---|---|---|---|---|---|
| J4218-2A | 422223 | 6406757 | 30.00 | 271.66 | 22.5 | 249.1 |
| J4217-2A | 421580 | 6406643 | 16.00 | 216.22 | 10.9 | 205.3 |

| Bore ID | Easting* | Northing* | Drilled Depth (m) | Ground elevation m AHD** | Water level (m bgl) | Water level (m AHD)** |
|---|---|---|---|---|---|---|
| H4220-6A | 421261 | 6406647 | 30.00 | 213.1 | 7.8 | 205.3 |
| H4220-5A | 421162 | 6406833 | 11.50 | - | 5.0 | |
| H4220-4A | 420988 | 6406441 | 40.00 | 246.53 | 30.8 | 215.7 |
| H4219-6A | 420147 | 6406630 | 20.00 | 262.72 | 15.4 | 247.3 |

* Handheld GPS ± 5 meters.

** Elevation in m AHD estimated from Lidar digital terrain model (October 2022).

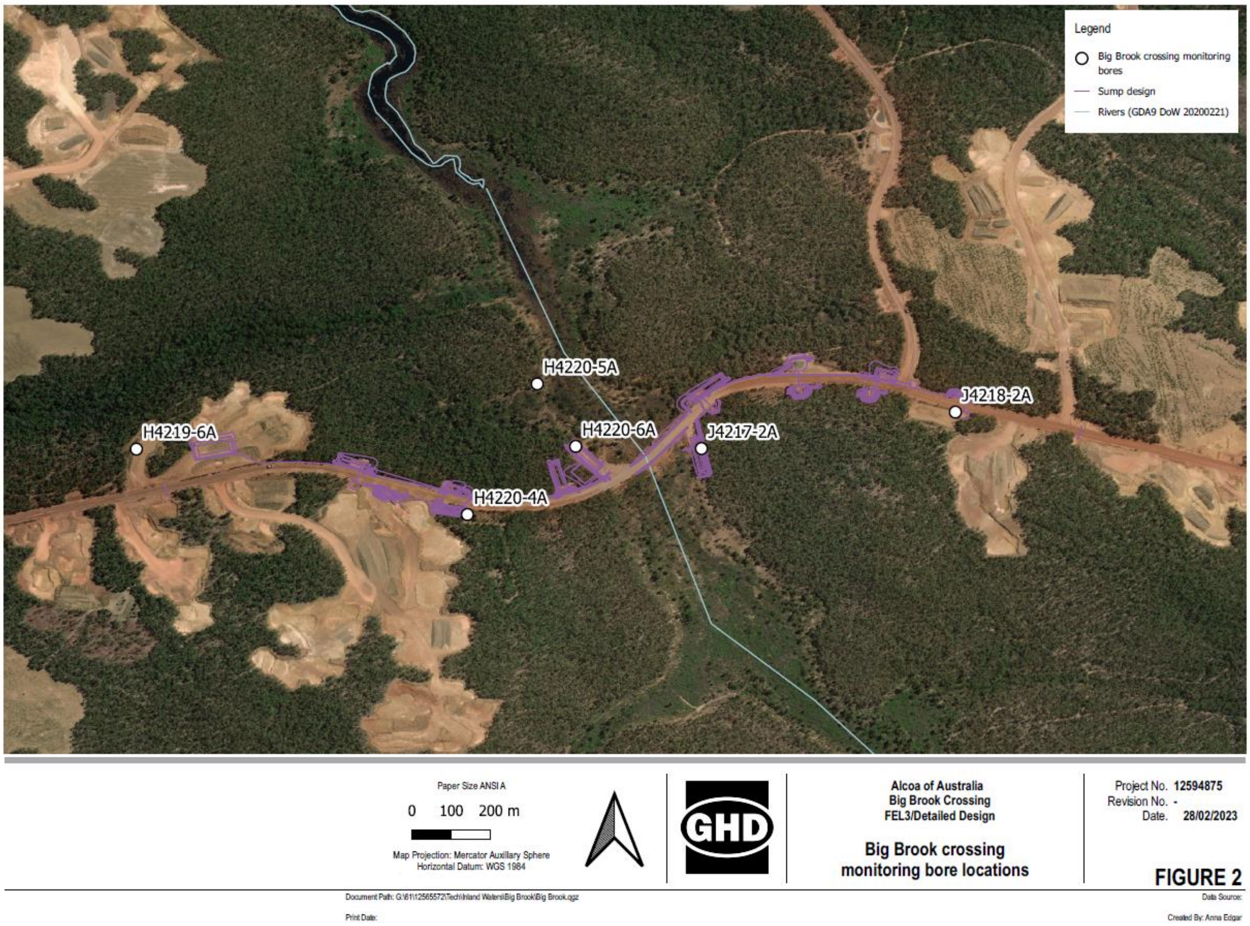



*Figure 3. Location of Big Brook crossing monitoring bores.*

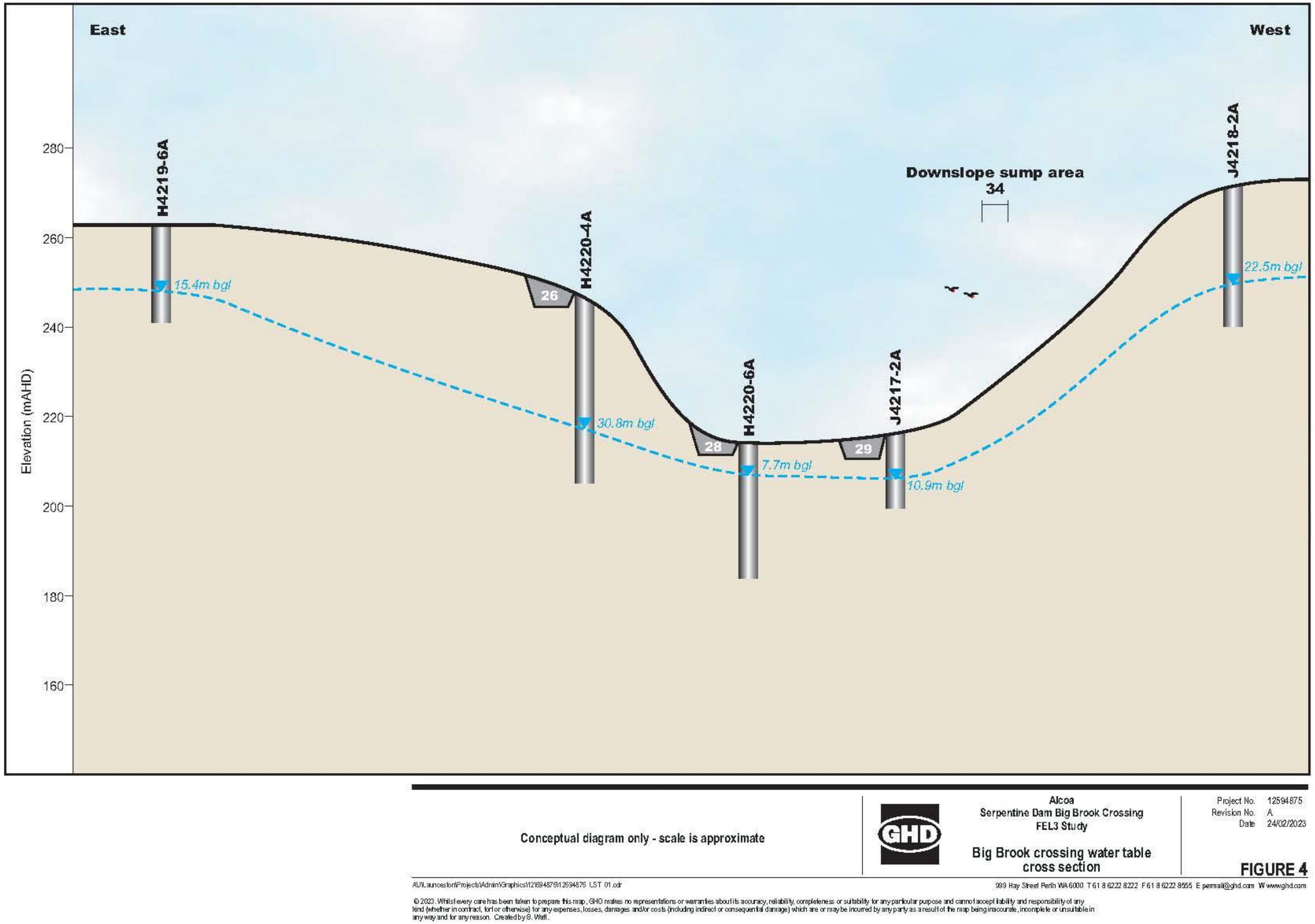



Figure 4. Cross section of Big Brook crossing, actual water levels and inferred water table in February 2023.

# Technical Memorandum

## 3.2 Satellite imagery

Satellite imagery of the existing sumps suggests Sump 34 contains permanent standing water at around 226.5 m AHD, or approximately 1.5 m bgl. This observation was supported by anecdotal evidence from site personnel. From the location and depth of water in monitoring bores J4217-2A and J4218-2A this water level is considerably higher than expected. A closer interrogation of the site conditions suggests additional water could be due to the location of the sump at the base of a hill slope. Where a slope face is cut into at the base it will intersect any permeable upper lateritic soils. Due to a combination of higher permeability and gravity flow down slope, these lateritic soils can transport additional water to the base of the slope. If there is a cut face in the base of slope dewatering of soils occurs up-gradient and water seepage at the cut face.

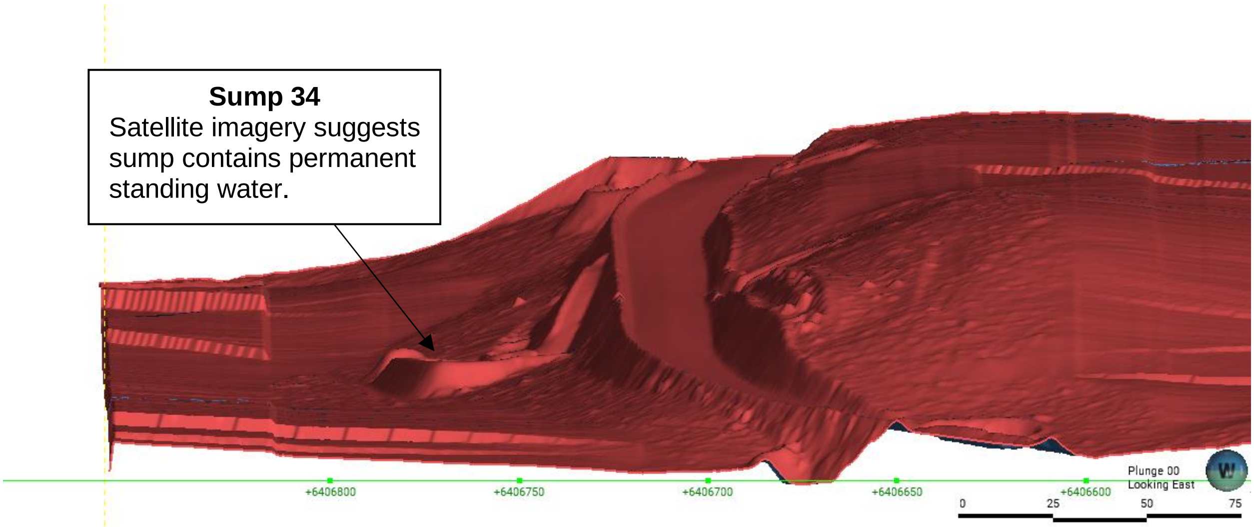



*Figure 5. Lidar DEM (17/10/2022) looking directly east from Sump 30/31 towards Sump 34 (2x vertical exaggeration).*

Furthermore, the land immediately to the north of Sump 34 has been observed as boggy and wet in February. This further implies a very shallow water table in this vicinity.

# 4. Groundwater seasonal fluctuation

Groundwater in unconfined and semiconfined aquifers is recharged from rainfall. During wet periods the increased recharge to the groundwater causes water levels to rise. Unconfined aquifers have their highest water levels during the wettest part of the year, which in the study region is generally Spring. In order to recharge the groundwater aquifer rainfall must infiltrate through the overlying unsaturated sediments before reaching the water table, and depending on the permeability of the overlying sediments this may delay the infiltration to the water table. Some aquifers will exhibit delayed water level maximum and minimums compared to rainfall and surface water levels.

While the recent Big Brook crossing monitoring bores provide details on the current water levels, they do not provide information on what the highest levels the water may achieve after the wet winter / spring period. To estimate seasonal fluctuations data from water level loggers at Myara North has been analysed.

This is the closet location of continual water level monitoring to Big Brook and whilst not exact provides an indication of the order of magnitude of water level fluctuation.

## 4.1 Myara North monitoring bores

Alcoa has previously engaged GHD to conduct a desktop review and baseline monitoring program for the Myara North region as part of the environmental approvals for mining in the region. In 2020 GHD drilled 25 bores across the Myara North region for the collection of water samples, groundwater levels and aquifer hydraulic properties. In September 2021 water level loggers recoding hourly water levels were installed in eight bores to produce a continuous record. The loggers were most recently downloaded in February 2023. See Attachment 1 for location of bores with loggers.

The eight bores containing water level loggers are spread across the Myara North region, at locations which range from 7.3 km to 17.5 km from the Big Brook crossing. The bores have level elevations which range from 225.2 m AHD to 265.8 m AHD, as listed in Table 3. The available data has been interrogated and indicates the following aquifer conditions:

Water levels show strong correlation with seasonal fluctuations with all bores having high water levels at the start of recording in September 2021 increasing until around November/December, after which they begin to fall. Water decline continues from December until around June, whereby the water levels started rising again. Several bores dried up over the summer months including bore B1 which was dry from mid-February until late July, bore B16_S was dry from late November to June and B12_S which was dry from mid-January until June. See Figure 6 for graph of water levels from September 2021 to February 2023.

Two sets of clustered bores were drilled (B12_S / B12_D and B16_S / B16_D). The comparison of these two clustered locations shows very different hydrogeological conditions. Bores B12_S and B12_D have very similar water levels prior to the B12_D logger malfunctioning, suggesting these two aquifers are well connected. In comparison B16_S and B16_D have very different water levels suggesting they are not well connected. B16_S is a shallow bore installed to a depth of 4 meters and is likely typical of an unconfined aquifer, whereas B16_D is installed to a depth of 17.7 meters and is likely characteristic of a semi-confined aquifer.

B16_D displays a similar response to B10 with both bores displaying more subdued rise and fall of water levels with levels peaking in late November/December and dipping in July. This is a delayed response compared to other bores, which is typical of a semiconfined aquifer where water infiltrates slowly into the aquifer. These conditions can occur locally due to the build-up of thicker clay units related to changes in geological, topographical, and weathering conditions. As such it is not unexpected for semiconfined conditions to only appear in some bores. For the purpose of this assessment the higher water levels of the unconfined aquifer are what will impact the sumps.

Seasonal fluctuations in water levels varied from 3.31 meters in B10 to 5.81 meters in B12_D, however three bores dried up over the summer period preventing the estimation of the full variation in water level. Additionally, the logger in the bore with the highest seasonal change (B12_D) malfunctioned in May 2022 resulting in no data past this date. The bore closest to Big Brook is B01 which had a water level variation of greater than 5.62 m. The true extent of the variation is unknown as it was dry between February and July.

***Table 3 Myara North bore details***

| Bore ID | Ground level elevation (m AHD) | Depth (m) | Min depth to water (mbgl*) | Min depth to water (m AHD) | Month | Max depth to water (mbgl*) | Max depth to water (m AHD) | Month | Variation in water level (m) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| B01 | 225.25 | 7.7 | 2.17 | 223.08 | Aug | Dry (7.7) | Dry (217.47) | Feb - Jul | 5.62 | Dry |
| B08 | 242.06 | 13.0 | 2.18 | 239.88 | Nov | 5.95 | 236.11 | Jun | 3.77 | |
| B10 | 295.43 | 21.2 | 10.40 | 285.03 | Nov | 13.71 | 281.72 | Jul | 3.31 | Semiconfined |
| B12_D** | 251.26 | 24.1 | 0.59 | 250.67 | Sep | *6.40* | *244.87* | *May* | *5.81* | |

| Bore ID | Ground level elevation (m AHD) | Depth (m) | Min depth to water (mbgl*) | Min depth to water (m AHD) | Month | Max depth to water (mbgl*) | Max depth to water (m AHD) | Month | Variation in water level (m) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| B12_S | 251.16 | 3.6 | 0.15 | 251.01 | Aug | Dry (3.6) | Dry (247.55) | Jan - Jun | 3.46 | Dry |
| B13 | 226.94 | 18.4 | 0.72 | 226.22 | Aug | 6.15 | 220.79 | May | 5.43 | |
| B16_D | 265.93 | 17.7 | 4.19 | 261.74 | Dec | 7.88 | 258.05 | Jun | 3.69 | Semiconfined |
| B16_S | 265.80 | 4.0 | 0.84 | 264.96 | Aug | Dry (4.0) | Dry (261.75) | Nov - Jun | 3.21 | Dry |

* mbgl = meters below ground level

** Logger malfunctioned May 2022, max depth to water likely higher than recorded.

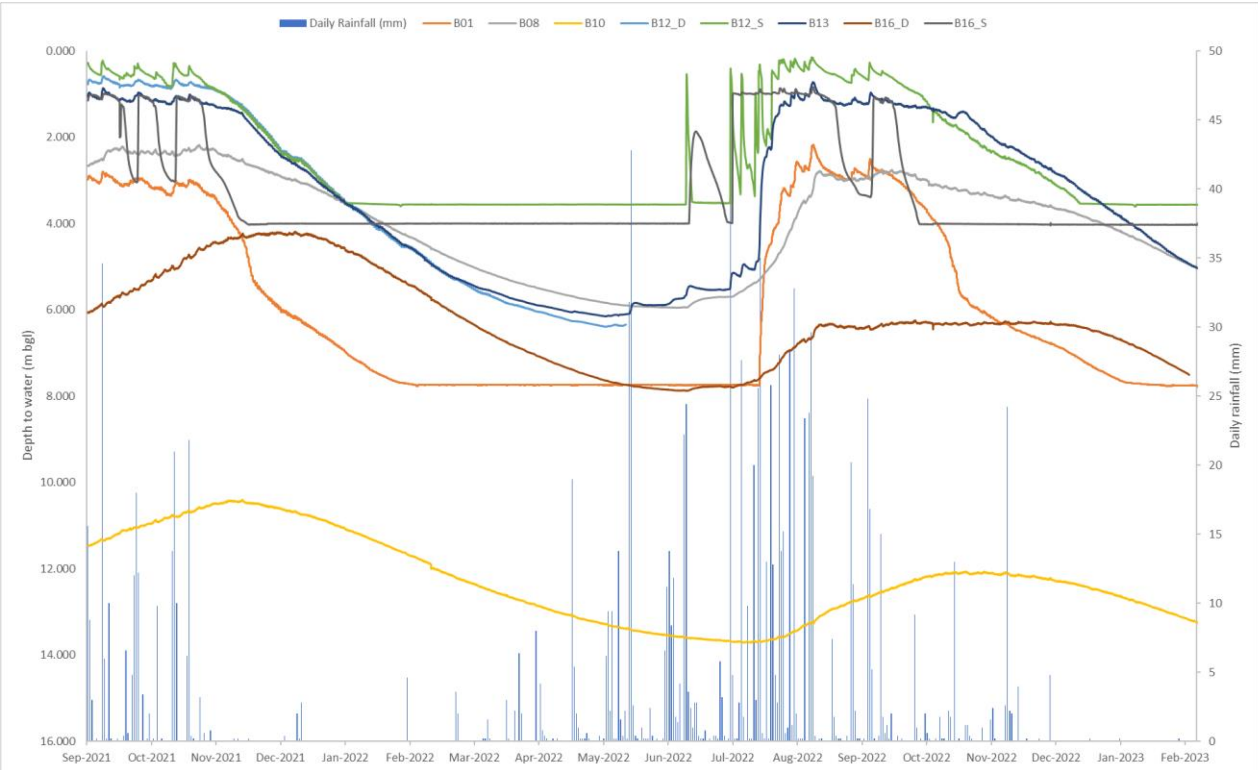



*Figure 6. Groundwater levels (logger data) for Myara North*

# 5. Discussion

Using the water levels collected in the Big Brook crossing monitoring bores, the water level below each sump has been estimated. The buffer between the base of the sump and the groundwater table has then been calculated to determine if seasonal fluctuations could cause groundwater inflow during the wetter months and immediately after. In Table 4 the proposed sump depths have been compared against the estimated water level and estimated fluctuation.

This analysis shows that under the planned future design, when the base is deepened from 213.7n AHD to 210.3m AHD, there is the potential for Sump 28 to have some groundwater inflow when groundwater levels are at their highest in September to November.  Sump 28 has the lowest elevation, located on the valley floor.

*Table 4 Estimated water level below sumps.*

| Sump ID | Nearest monitoring bore | | Estimated water level (m AHD) | Future designed base of sump height (m AHD) | Water level depth below base of sump. | Potential seasonal variation in water level (m)* |
|---|---|---|---|---|---|---|
| | Bore ID | Distance to sump (m) | | | | |
| 24B | H4219-6A | 239 | 231.5 (average H4219-6A, H4220-4A) | 255.0 | 23.5 | 3.8 – 5.8 |
| | H4220-4A | 628 | | | | |
| 26 | H4220-4A | 48 | 215.7 | 244.9 | 29.2 | 3.8 – 5.8 |
| 27 | H4220-6A | 83 | 205.3 | 220.0 | 14.7 | 3.8 – 5.8 |
| 28 | H4220-6A | 10 | 205.3 | 210.3 | 5.0 | 3.8 – 5.8 |
| 29 | J4217-2A | 17 | 205.3 | 213.0 | 7.7 | 3.8 – 5.8 |

* Based on water levels at Myara North.

# 6. Conclusion

An assessment of the groundwater depth at the Big Brook crossing monitoring bores and the water level fluctuations at Myara North indicates that one sump (28) may have groundwater infiltration during the wettest months. All other sumps are unlikely to be affected by groundwater fluctuations. Sump 34 is located above the predicted groundwater level however, historically has been impacted by groundwater. A conceptual study of the geographical area suggests this is due to water seepage caused by its location as a cut at the base of a hill slope.

To determine the magnitude of season water level fluctuations in the immediate Big Brook crossing and sump area it is recommended water level loggers be installed in each bore and monitored over a full 12-month seasonal cycle.

Regards

**Anna Edgar**
Hydrogeologist

+61 8 6222 8746
Anna.Edgar@GHD.com

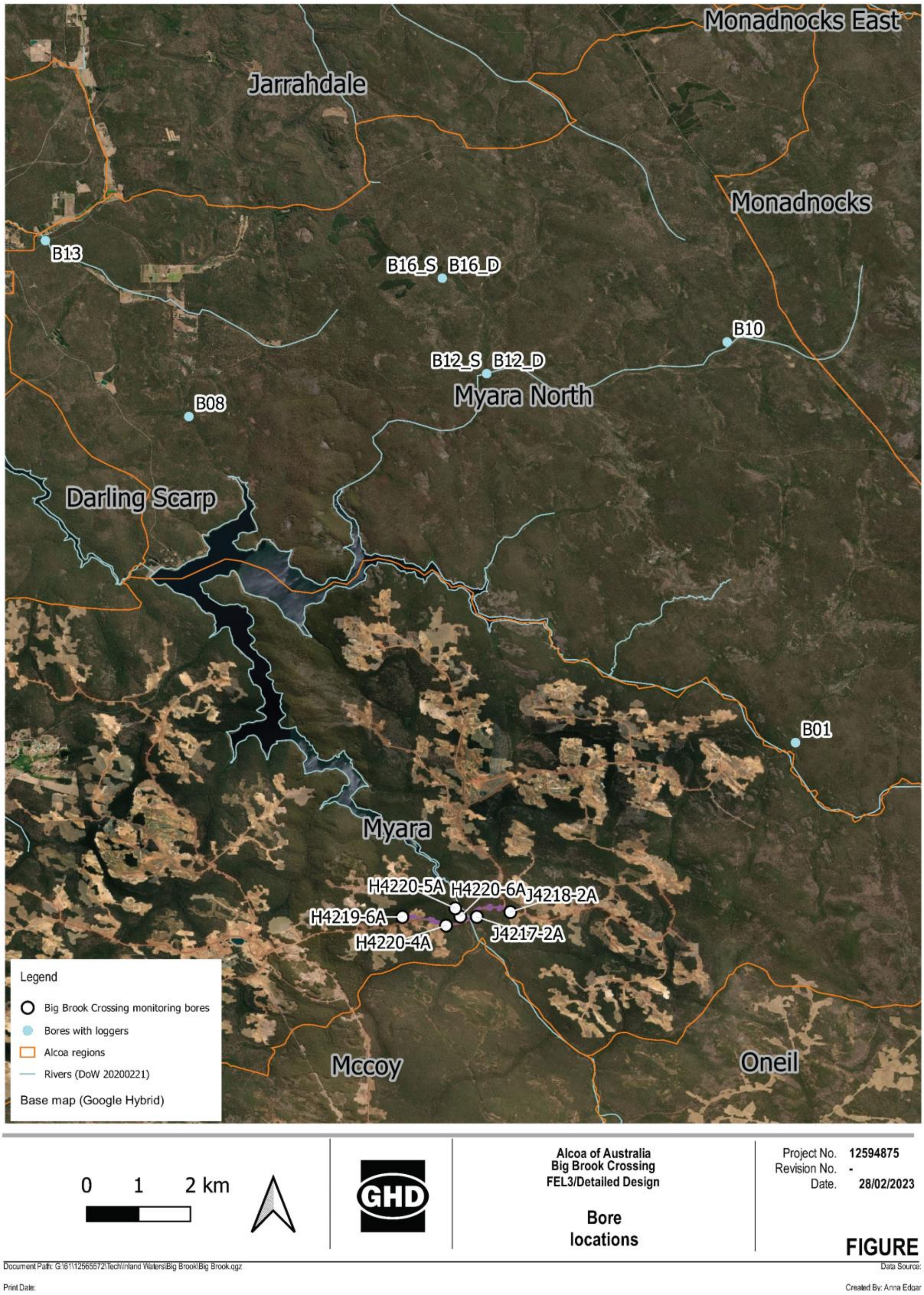
**Bob Kinnell**
Technical Director

+6 8 6222 8229
Bob.Kinnell@GHD.com

# Attachment 1

## Figure 1. Bore locations

# Technical Memorandum




This Technical Memorandum is provided as an interim output under our agreement with Alcoa of Australia. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

# Serpentine Dam Big Brook Causeway FEL3 Study

## Revised Environmental Risk Analysis

Alcoa of Australia Ltd

26 September 2023

→ **The Power of Commitment**

| | |
|---|---|
| **Project name** | Serpentine Dam Big Brook Causeway FEL2 Study |
| **Document title** | Serpentine Dam Big Brook Causeway FEL3 Study \| Revised Environmental Risk Analysis |
| **Project number** | 12580536 |
| **File name** | 12580536-RPT-Big Brook Crossing FEL2 Study_Final Environmental Risk Analysis.docx |

| **Status Code** | **Revision** | **Author** | **Reviewer** | | **Approved for issue** | | |
|---|---|---|---|---|---|---|---|
| | | | **Name** | **Signature** | **Name** | **Signature** | **Date** |
| S3 | A | H. Morgan | A. Ekanayake | | H. Morgan | | 13/07/2022 |
| S3 | B | H. Morgan | A. Ekanayake | | H. Morgan | | 4/10/2022 |
| S4 | C | H. Morgan | A. Ekanayake | | H. Morgan | | 21/10/2022 |
| S2 | 0 | H. Morgan | A. Ekanayake | | H. Morgan | | 21/11/2022 |
| S2 | 1 | H. Morgan | A. Ekanayake | | H. Morgan | | 1/02/2023 |
| S2 | 2 | H. Morgan | A. Ekanayake | | H. Morgan | | 3/03/2023 |
| S2 | 3 | H. Morgan | A. Ekanayake | | H. Morgan | | 27/09/2023 |

**GHD Pty Ltd**
999 Hay Street,
Perth, WA 6000, Australia
**T** +61 8 6222 8222 | **ghd.com**



**The Power of Commitment**

# Contents

# Table index



# Figure index



# Appendices

# Abbreviations

| | |
|---|---|
| ADWG | Australian Drinking Water Guidelines |
| AEP | Annual Exceedance Probability |
| AHD | Australian Height Datum |
| ARI | Average Recurrence Interval |
| DoH | Department of Health |
| DWER | Department of Water and Environmental Regulation |
| BTEX | Benzene, Toluene, Ethylbenzene and Xylenes |
| ERA | Environmental Risk Analysis |
| FEL | Front End Loading |
| FSL | Full Supply Level |
| GL | Gigalitres |
| HDPE | High Density Polyethylene |
| IWSS | Integrated Water Supply Scheme |
| LiDAR | Light Detection and Ranging |
| LPG | Liquefied Petroleum Gas |
| Mkm | Million kilometres |
| MMPLG | Mining and Management Program Liaison Group |
| Mtpa | Million tonnes per annum |
| PAH | polycyclic aromatic hydrocarbons |
| PDWSA | Public Drinking Water Source Area |
| PFAS | Per- and Poly-Fluoroalkyl Substance |
| RPZ | Reservoir Protection Zone |
| TPH | Total Petroleum Hydrocarbons |
| TWL | Top Water Level |
| WQPN | Water quality protection note |

# 1. Introduction

Alcoa of Australia Limited (Alcoa) have engaged GHD Pty Ltd (GHD) to undertake the Serpentine Dam Big Brook Causeway[1] FEL2 Study (the Study). The purpose of the Study was to:

1. Establish the environmental risk associated with the Big Brook Causeway in consideration of Alcoa's mine plan and Water Corporation operating philosophy for Serpentine Dam. This is documented in the Environmental Risk Analysis (this document).
2. Undertake preliminary design work to confirm the feasibility of options identified by Alcoa in FEL1. It was intended that all risks identified in the Environmental Risk Analysis are reduced to the smallest practicable level during preliminary design.

The Study involved four stages of work undertaken by GHD in collaboration with Alcoa, as presented in Figure 1.

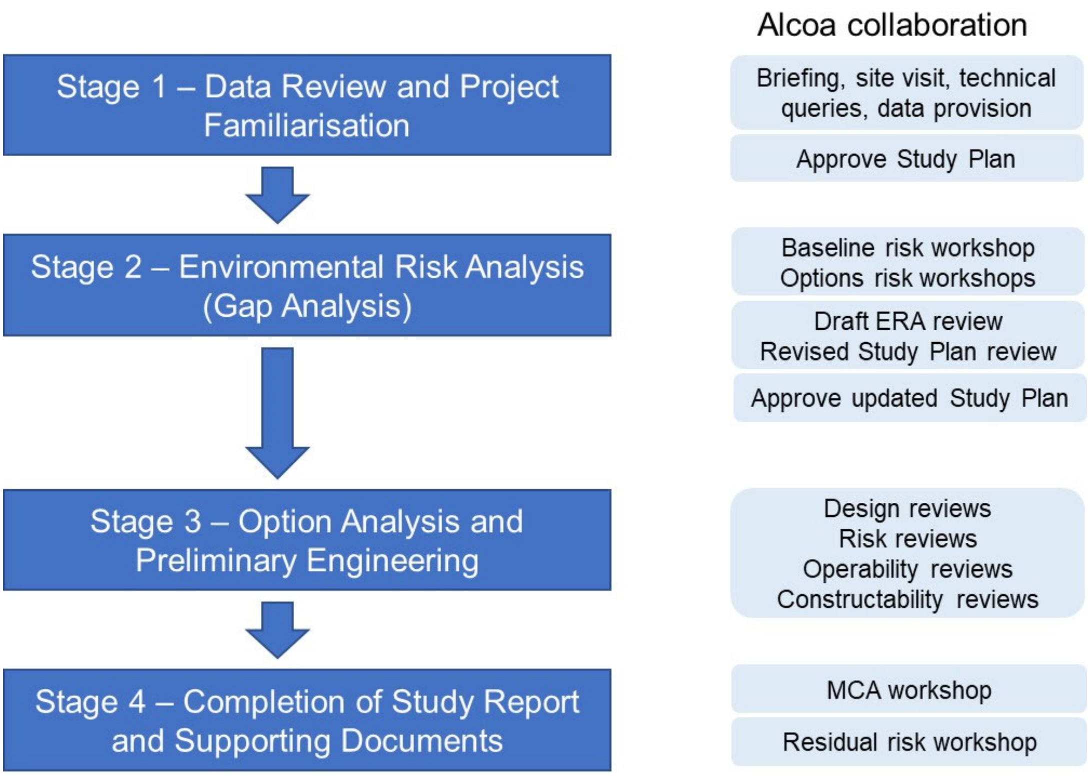



***Figure 1*** ***Serpentine Dam Big Brook Causeway FEL2 Study overview***

This final Environmental Risk Analysis (ERA) report presents the findings of Stage 4 of the Study. The final ERA reflects the residual risk of the selected preferred solution based on the Stage 3 preliminary engineering and option analysis.

## 1.1 Scope

This ERA assessed the risk to drinking water quality posed by two scenarios:

1. Baseline (existing), comprising the existing Big Brook Causeway operations and preventative barriers, including the 100 m buffer between the causeway and Serpentine Dam reservoir.
2. Future (proposed), comprising the proposed Big Brook Causeway operations and the augmented preventative barriers developed through Stage 3 of the FEL2 Study.

[1] The Big Brook Causeway has been previously referred to as the Serpentine Dam Causeway.

The ERA has been undertaken consistent with the Australian Drinking Water Guidelines (ADWG) including analysis of multiple contaminants and pathways and the presence and effectiveness (failure mode/likelihood, confidence) of barriers.

A source-receptor-pathway model was developed for each credible hazard and contaminant that may enter the Serpentine Dam reservoir as the receptor. Hazards were identified through stakeholder engagement in workshops and analysed through previous incident data available for the Huntly Mine. The failure mode, likelihood and confidence in barrier performance has been determined through engineering analysis of barriers undertaken in Stage 3 of the FEL2 Study. Details of the methodology are presented in Section 2.2.2 and Section 3.3. The ERA considered the findings of previous risk assessments (Water Science 2008, Alcoa 2021) undertaken for the Big Brook Causeway.

The ERA was updated following the completion of the FEL3 Study and detailed design for the proposed augmented preventative barriers, and comments received from the Water Corporaiton on the ERA (Rev 1) prepared during the FEL2 Study.

## 1.2 Limitations

*This report: has been prepared by GHD for Alcoa of Australia Ltd and may only be used and relied on by Alcoa of Australia Ltd for the purpose agreed between GHD and Alcoa of Australia Ltd as set out in section 1 of this report.*

*GHD otherwise disclaims responsibility to any person other than Alcoa of Australia Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

*The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*

*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.*

### Accessibility of documents

*If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.*

*GHD has prepared this report on the basis of information provided by Alcoa of Australia Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

*GHD has prepared the conceptual source-receptor-pathway model of the Big Brook Causeway ("Model") for, and for the benefit and sole use of, Alcoa of Australia Ltd to support the Serpentine Dam Big Brook FEL2 Study and to support MMPLG assessment for approval under Alcoa's State Agreement, and must not be used for any other purpose or by any other person.*

*The Model is a representation only and does not reflect reality in every aspect. The Model contains simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Model. Accordingly, the outputs of the Model cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.*

*The information, data and assumptions ("Inputs") used as inputs into the Model are from publicly available sources or provided by or on behalf of the Alcoa of Australia Ltd, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Model as further Inputs becomes available.*

*The Model is limited by the mathematical rules and assumptions that are set out in the Report or included in the Model and by the software environment in which the Model is developed.*

*The Model is a customised model and not intended to be amended in any form or extracted to other software for amending. Any change made to the Model, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Model including any outputs.*

# 2. Background

## 2.1 Context

### 2.1.1 Huntly Mine and Big Brook Causeway

The Huntly Mine is the world's second largest bauxite mine and supplies Pinjarra and Kwinana alumina refineries. The Huntly Mine operations are currently within the Myara region, which will continue until transitioning into the proposed Myara North region (Figure 2) pending currently referred State and Commonwealth environmental approvals expected in 2024. The Huntly Mine currently produces approximately 28.5[2] million tonnes per year (Mtpa) of bauxite and is forecast to produce up to approximately 29.6 Mtpa over the next decade.

The Big Brook Causeway is used as a primary haul road crossing for the Myara region and will continue to be used for Myara North from 2027 onwards. The causeway was constructed over the summer of 2012/2013 following approval by the Mining and Management Program Liaison Group (MMPLG) pursuant to Alcoa's State Agreement. The causeway was approved subject to implementation of the Serpentine Dam Causeway Construction and Operational Plan (Alcoa 2017), which was informed by a risk assessment conducted by Professor Barry Hart (Water Science 2008).

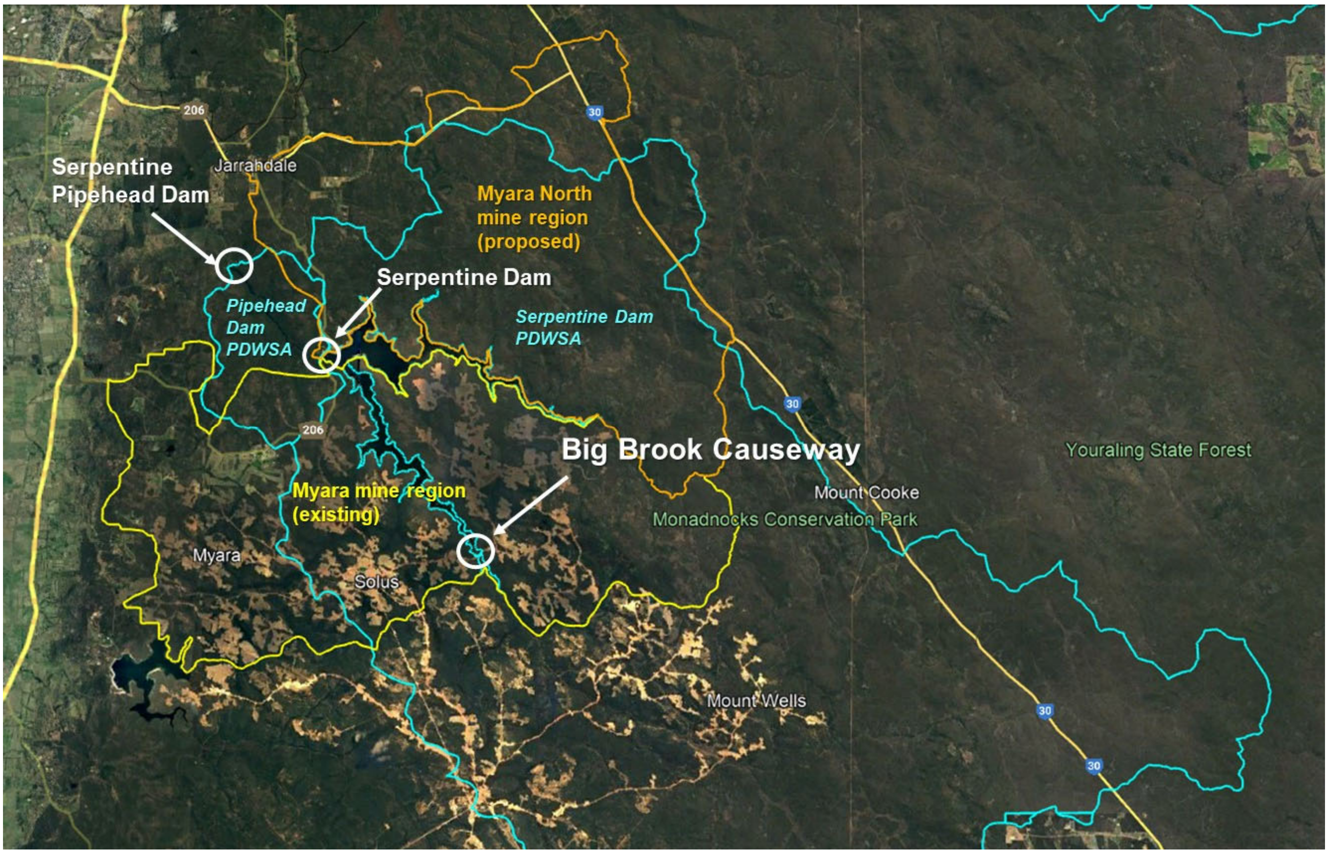



***Figure 2*** ***Big Brook Causeway regional context (basemap: GoogleEarth Pro)***

The Big Brook Causeway was initially constructed to the following key performance criteria (Alcoa 2021) (see Figure 3):

– Culvert sized to accommodate 1 in 200 year average recurrence interval (ARI) event on Big Brook
– Eastern sump capacity: 1 in 500 year ARI, 24 hour duration storm event

[2] Wet tonnes.

– Western sump capacity: 1 in 500 year ARI, 5 minute hour duration storm event
– Three stage sumps to ensure no release of hydrocarbon contaminated water
– Sump capacity to enable testing of hydrocarbons prior to release

The western three stage sump was enlarged in the summer of 2014/2015 to provide additional capacity (up to 1 in 500 year ARI, 24 hour duration) to enable testing for hydrocarbons prior to release, including the time required for laboratory analysis, reporting and approval to discharge (Alcoa 2021).

Alcoa agreed for the following strategies for the causeway operation[3] (Alcoa 2017):

– Speed limit of 35 km/hr
– Limit of 15,000 litres of hydrocarbon volume to be transported across the causeway
– Sumps regularly checked and maintained in a 'storm ready state' with water below a pre-determined level and discharge valves closed
– Specific spill response procedures, standby agreement with contract and annual spill response drill
– Program to maintain sealed surface to minimise turbidity

On the recommendation of the Water Corporation, Alcoa also committed to maintain a 100 m buffer between the Big Brook Causeway and the Serpentine Dam reservoir top water level (TWL), which is taken to be when the TWL reaches 207.5 mAHD (Figure 3). In the event that the reservoir TWL was to come within 100 m of the causeway then Alcoa was to cease causeway operations (Alcoa 2017). Alcoa (2021) have an interim strategy for managing risk in the event that the TWL exceeds 206.4 mAHD.

Alcoa agreed to a water quality regime[4] for the western and eastern three stage sumps whereby the sumps are tested for hydrocarbons (BTEX, PAH and TPH) and reported to the Water Corporation representative of the Mining Operations Group for approval prior to discharge of sump water into Big Brook. Where water quality exceeds the agreed standards for hydrocarbons the water will be disposed of, or reused of elsewhere (e.g. mine site dust control) rather than discharge into Big Brook (Alcoa 2021).

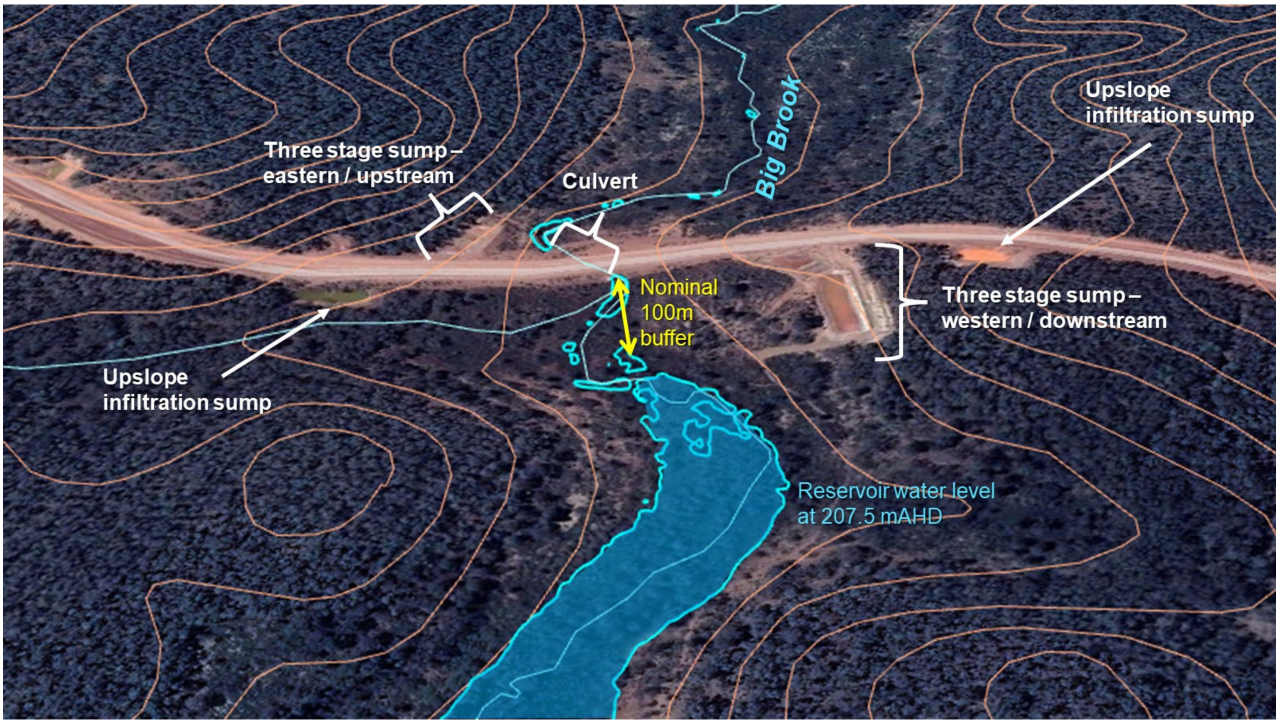



*Figure 3 Big Brook Causeway local context (basemap: GoogleEarth Pro)*

[3] Alcoa letter to Water Corporation dated 15 June 2009
[4] Alcoa letter to MMPLG dated 14 June 2012

### 2.1.2 Big Brook Causeway operations

From 2019-2021 the Big Brook Causeway conveyed an average of approximately 10.4 Mtpa of ore via approximately 53,000 haul truck movements (106,000 one-way crossings) at an average of approximately 196 tonnes of ore per loaded haul truck. The ore is delivered to the Myara mine facilities where it is crushed and loaded onto conveyors that deliver the ore to stockpiles at Pinjarra Alumina Refinery.

Haul trucks (CAT 789D typical) represent the majority of Big Brook Causeway movements, with other lower frequency vehicle movements comprising:

- Fuel tankers (8000 L capacity) that refuel heavy equipment in mine pits[5]
- Sewage tankers that pump out tanks at demountable crib rooms
- Miscellaneous heavy vehicles (e.g. water carts, graders, low loaders transporting plant)
- Light vehicles.

Huntly Mine operations proposed for the Myara North region will utilise long haul trucking (CAT 789D), therefore from 2027 all ore from Myara North will pass over the Big Brook Causeway, at up to 29.6 Mtpa or up to 151,000 haul truck movements (302,000 one-way crossings). This represents an approximate 180% increase in haul truck traffic over current operations.

### 2.1.3 Serpentine Dam

The Big Brook Causeway lies within the catchment of the Serpentine Dam (Figure 2), which is a Public Drinking Water Source Area (PDWSA) declared under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* (MWSSD Act). The Serpentine Dam collects water from a 664 km$^2$ catchment which is primarily classified as a Priority 1 PDWSA, with some private lands within the catchment classified as Priority 2. The reservoir is surrounded by a 2 km wide Reservoir Protection Zone (RPZ) around its top water level (TWL), which includes the reservoir itself and does not extend outside the catchment area.

Serpentine Dam has a full supply capacity of 137.7 gigalitres (GL) at a TWL of 212.4 mAHD which is the dam crest level, with an estimated maximum headwater level of 213.9 mAHD at the Big Brook Causeway causeway. The Big Brook Causeway 100 m buffer is defined by the Water Corporation as being at an elevation of 207.5 mAHD, which represents a reservoir capacity of approximately 92.4 GL or 67.1% of full capacity (see Figure 3, Figure 4).

Serpentine Dam discharges into the Serpentine Pipehead Dam reservoir, which is located directly downstream (Figure 2). The Serpentine Pipehead Dam has a relatively small (28 km$^2$) catchment and 2.6 GL full supply capacity and is fed primarily by inflows from the Integrated Water Supply Scheme (IWSS) including desalinated water. Discharges from the Serpentine Dam into Serpentine Pipehead Dam are relatively limited with the Serpentine Dam being used as a reserve water bank.

Water from the Serpentine Pipehead Dam is drawn and treated with chlorine. The reliance on chlorine in place of advanced treatments (e.g. direct filtration) is due to the P1 PDWSA protected catchment, which restricts human occupation (e.g. residences), itinerant human activities (e.g. recreation) and stock animals. Finished water is transferred to the IWSS for distribution to downstream customers.

### 2.1.4 Serpentine Dam water level rise

The Serpentine Dam capacity has been less than 80 GL, averaging about 45 GL, from 2000 to 2020 (Figure 5). A combination of high inflows and water banking from 2016 onwards has resulted in the reservoir capacity progressively rising. In August 2021, Water Corporation issued a cease operation order to Alcoa due to rising reservoir water levels. The temporary cessation of causeway operations had significant impacts to the Huntly Mine in terms of cost and complexity and to the Kwinana and Pinjarra Alumina Refineries in terms of ore grade.

Water Corporation have advised Alcoa that they propose to undertake maintenance activities over the summer of 2022/23 to enable increased banking of water in Serpentine Dam, such that reservoir water levels are expected to rise from winter 2023 onwards. Modelling by Water Corporation has indicated that reservoir water levels may potentially rise to over 210 mAHD in Q3-Q4 of 2023 and be sustained, which indicates the potential for further and

[5] Haul trucks, some wheeled heavy vehicles and light vehicles are refuelled at dedicated fuel bays at the mine facilities

prolonged cease operations orders for the Big Brook Causeway unless additional mitigation measures can be agreed.

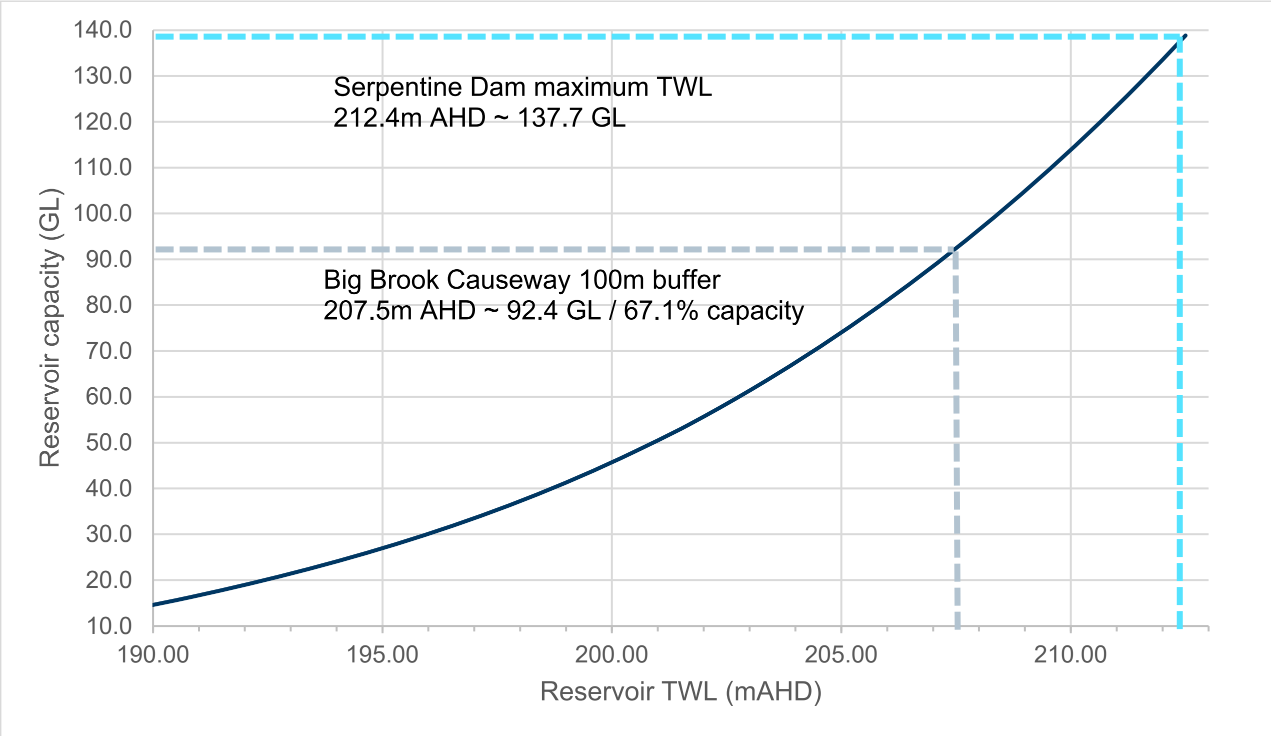



***Figure 4*** ***Serpentine Dam volume to water level curve***

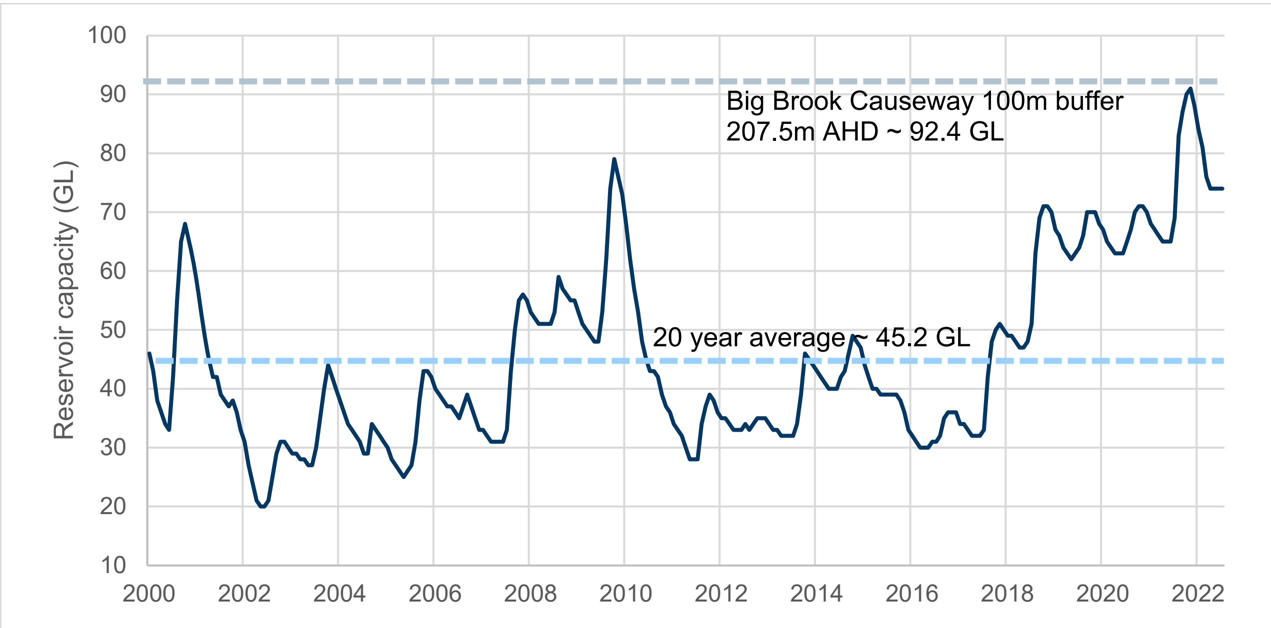



***Figure 5*** ***Serpentine Dam volume history 2000-2022***[6]

[6] https://www.watercorporation.com.au/Our-water/Rainfall-and-dams/Dam-levels/Serpentine-Main-Dam

## 2.2 Policy and guidance

The ERA has been undertaken in accordance with the following relevant policies and guidance:

- Strategic Policy – Protection public drinking water source areas in Western Australia (Department of Water 2016)
- Policy – Land use compatibility in public drinking water source areas (Department of Water and Environmental Regulation 2021a)
- Water quality protection note (WQPN) 25 – Land use compatibility tables for public drinking water source areas (Department of Water and Environmental Regulation 2021b)
- Serpentine Dam Catchment Area and Serpentine Pipehead Dam Catchment Area Drinking Water Source Protection Plan (Department of Water 2007)
- Australian Drinking Water Guidelines (National Health and Medical Research Council 2011)
- Memorandum of Understanding between the Department of Health and Water Corporation for Drinking Water (Department of Health 2017)

### 2.2.1 Western Australian policy position

The above policies establish a State Government position with respect to the protection of the Serpentine Dam and Serpentine Pipehead Dam PDWSAs, as follows:

1. Department of Health (DoH), Department of Water and Environmental Regulation (DWER) and Water Corporation will promote the primacy of water quality over other non-compatible activities in drinking water catchments to protect public health.
2. The Serpentine Dam is a strategic and important source of public drinking water for the IWSS, has an existing water quality of high standard, and should be afforded the highest level of protection.
3. Serpentine Dam as a P1 PDWSA has the fundamental water quality objective of risk avoidance.
4. DoH and Water Corporation are committed to maintain and improve catchment management and source protection as primary barriers to ensure safe drinking water.
5. Risks to drinking water quality will be assessed and managed in accordance with the Australian Drinking Water Guidelines (ADWG), which are endorsed by the Minister for Health.
6. Mining is an incompatible land use within the P1 PDWSA.
7. Existing incompatible uses within a PDWSA, such as the Huntly Mine operations, are permitted to continue subject to implementation of best management practices in accordance with relevant WQPNs or other guidelines.
8. DWER will not support expansion or intensification of an existing, incompatible land use within a PDWSA unless the overall water quality contamination risk is reduced.

### 2.2.2 Australian Drinking Water Guidelines

The ADWG establishes fundamental principles to drinking water system management, which include (NHMRC 2011):

> '*The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised*.'
>
> '*The drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply*.'
>
> '*Ensuring drinking water safety and quality requires the application of a considered risk management approach*.'

The ADWG recommends a preventative risk management approach as the most effective means of assuring drinking water quality and protecting public health. This approach includes some elements of risk management under ISO 9001[7], ISO 14001[8], AS/NZS 4360:2004[9] and HACCP[10], however the ADWG approach reflects the specific challenges for the water industry in managing drinking water quality from catchment to consumer (NHMRC 2011).

The ADWG preventative risk management framework is outlined in Figure 6. This ERA is structured in accordance with the framework, including specific components where relevant to the assessment of Big Brook Causeway under the current and proposed operational context.

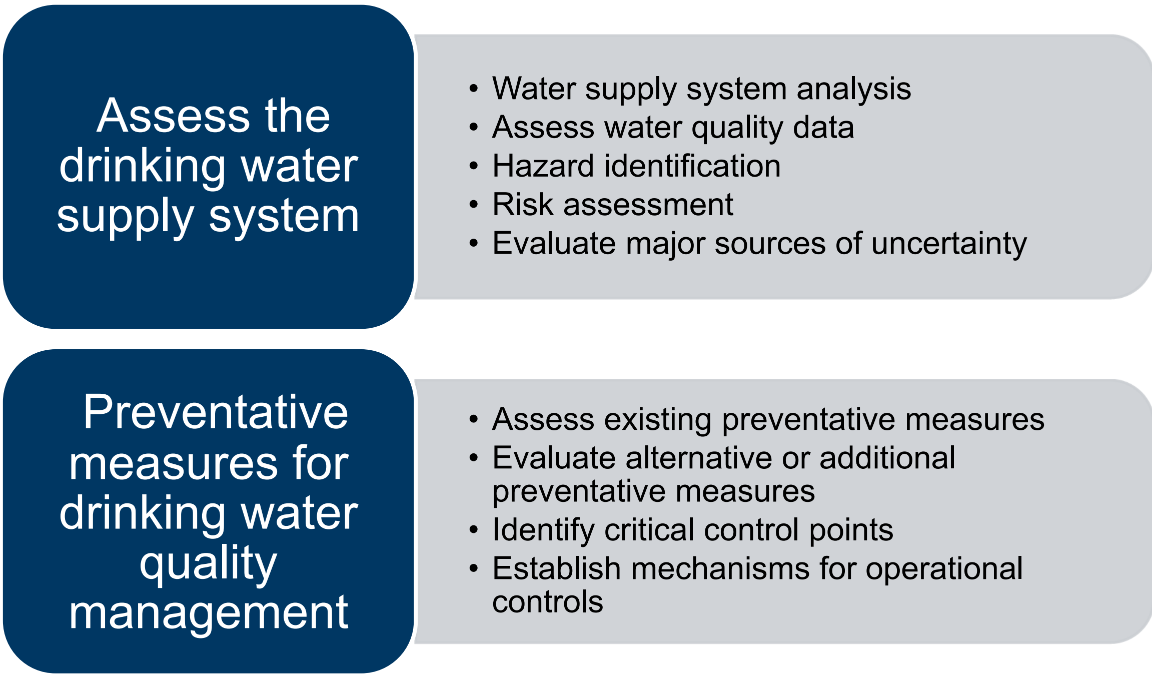



*Figure 6 Australian Drinking Water Guidelines preventative risk management framework*

The Water Corporation and DWER adopt the ADWG principles and preventative risk framework in their management of the Serpentine Dam PDWSA and their advice and position on MMPLG approvals with regard to the Huntly Mine. This includes:

– a prioritisation on catchment protection to prevent discharge of contaminants from catchment activities into the reservoir
– a presumption against reliance on reservoir attenuation (e.g. by dispersion, dilution, settling, evaporation) or water quality treatment to prevent contaminants from catchment activities reaching drinking water consumers.

[7] ISO 9001 Quality Management
[8] ISO 14001 Environmental Management
[9] AS/NZS 4360:2004 Risk Management
[10] Hazard Analysis Critical Control Point (HACCP)

# 3. Assess the drinking water system

## 3.1 System boundary

The first step of the ADWG preventative risk management framework is analysis of the water supply system from catchment to consumer, including:

– Catchments and source waters
– Storage reservoirs and intakes
– Treatment systems
– Service reservoirs and distribution systems
– Consumers

Figure 7 and Figure 8 present an overview of the water supply system with respect to the Big Brook Causeway, with identification of the source, pathways and receptor for contaminants to drinking water quality.

As presented, the Big Brook Causeway lies within the Serpentine Dam PDWSA which discharges direct to the Serpentine Pipehead Dam reservoir. The Serpentine Pipehead Dam is used to store transfers from the IWSS, with offtake water being treated and then distributed to the IWSS and drinking water customers. Details of the Serpentine Dam and Serpentine Pipehead Dam are presented in Section 2.1.

The Serpentine Dam PDWSA is subject to a range of other activities apart from the Big Brook Causeway, including the Myara and Myara North mine region activities (e.g. mining, haul road operations, mine facilities), as well as timber harvesting, mine rehabilitation and public recreation. These may generate a range of contaminants to drinking water quality. In addition to human activities, bushfires and climate change may also generate contaminants or affect the catchment quality (e.g. vegetation coverage) of the PDWSA.

As presented in Figure 7 and Figure 8, there are three main preventative measures or barriers to drinking water contaminants reaching consumers, which are Alcoa's preventatives barriers, reservoir attenuation and water treatment (chlorination). As noted in Section 2.2 the Water Corporation and DWER position is to prioritise catchment protection to prevent discharge of contaminants and avoid reliance on reservoir attenuation or water treatment to protect drinking water consumers.

Consistent with the ADWG preventative risk management approach and Water Corporation/DWER position, this ERA analyses the risks of the system comprising the Big Brook Causeway operations and Alcoa's preventative barriers, on the basis that the system is operated to prevent discharges from occurring into Serpentine Dam reservoir. This represents the system boundary of the ERA (see Figure 8), which accordingly treats the Serpentine Dam reservoir as the drinking water receptor and excludes the downstream components.

## 3.2 Assess water quality data

ADWG recommend a review of historical water quality data to assist in understanding source water characteristics and water system performance both over time and following specific events such as heavy rainfall.

Consistent with the system boundary being the Big Brook Causeway and Alcoa preventative barriers, this ERA does not assess historic water quality in the Serpentine Dam reservoir, which is expected to be predominantly affected by conditions in the wider catchment rather than the Big Brook Causeway operations.

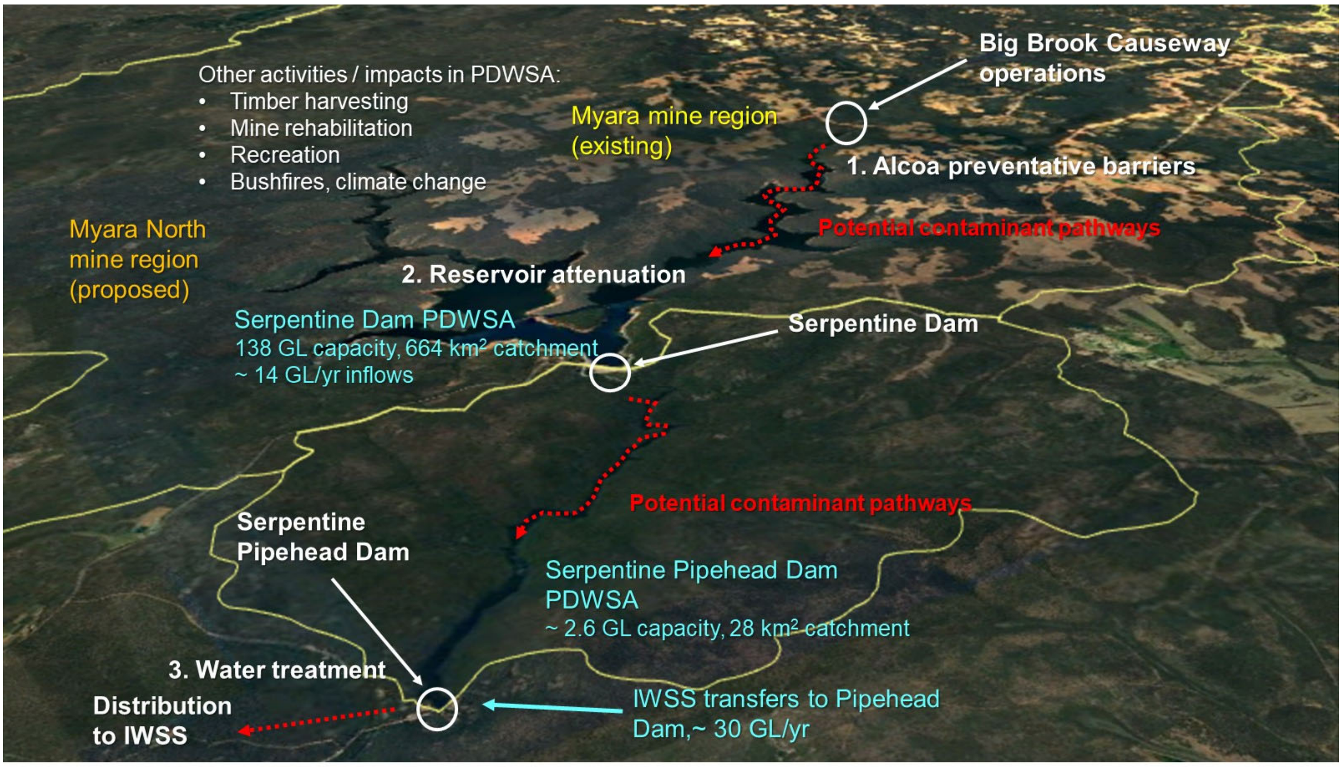



*Figure 7 Overview of water supply system with respect to the Big Brook Causeway*

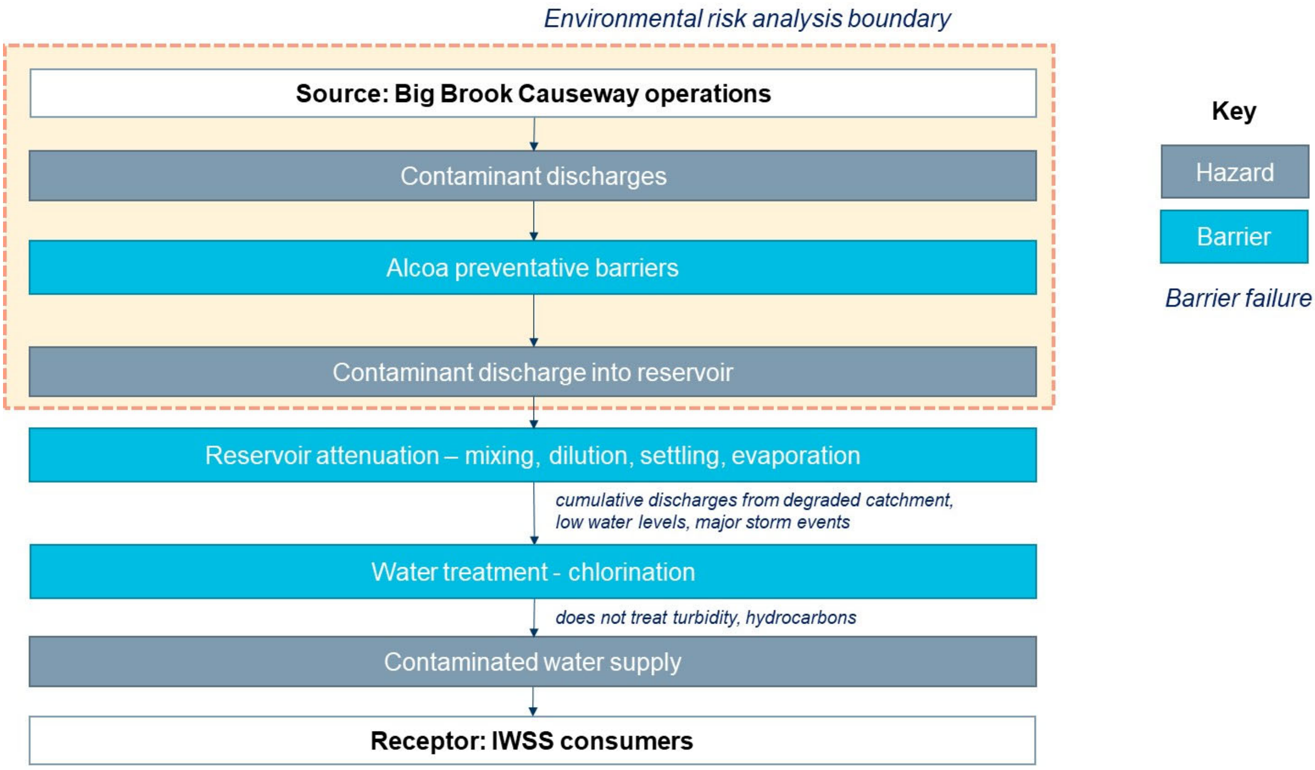



*Figure 8 Overview of water supply system – source-receptor-pathway*

## 3.3 Conceptual model and risk framework

### 3.3.1 Analysis of likelihood

This ERA adopted a source-receptor-pathway model to analyse the likelihood of contaminants from the Big Brook Causeway discharging into the Serpentine Dam reservoir. This model has the following components (Figure 9):

– Source: hazards arising from Big Brook Causeway operations
– Receptor: Serpentine Dam reservoir
– Pathway: contaminant transport pathways, which pass through a series of preventative barriers

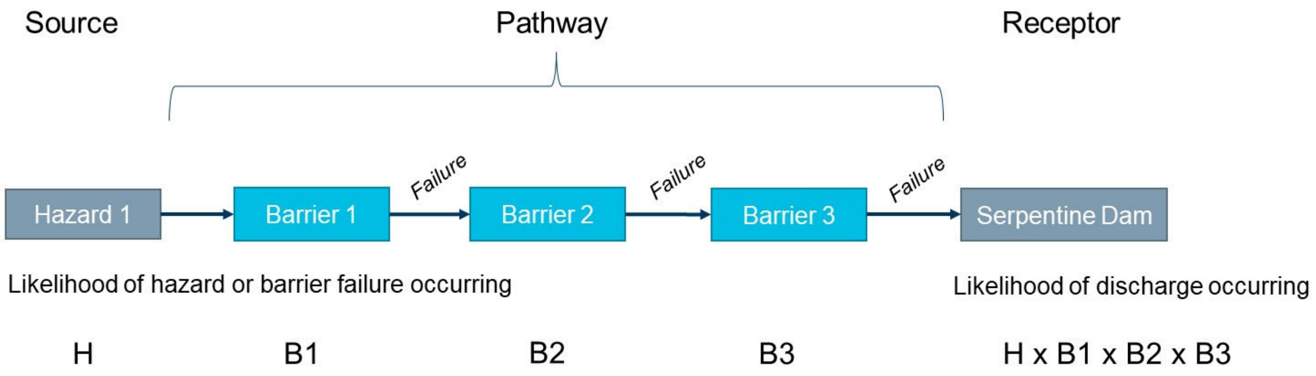



***Figure 9*** ***Source-receptor-pathway model for analysis of likelihood of discharge***

As presented, the series of preventative barries must fail in order for a given hazard to cause a discharge of contaminants to the Serpentine Dam reservoir, and hence the likelihood of a discharge occurring is the cumulative likelihood of the hazard occurring and all barriers failing during/shortly after the hazard. It is important to note that barriers may potentially fail coincident with each other in response to a single event. For example, a major storm event occurring in wet catchment conditions during/shortly after a major fuel spill (Hazard) may hamper spill response (Barrier 1) and cause sumps to overflow (Barrier 2).

This source-receptor-pathway model is consistent with the ADWG risk framework and fundamental principles of drinking water quality management in that it enables analysis of the presence and robustness of multiple barriers.

The ERA analyses the cumulative likelihood of a discharge occurring into the Serpentine Dam reservoir for baseline and proposed future scenarios as presented in Table 1.

***Table 1*** ***Environmental risk analysis scenarios***

| Scenario | 1. Baseline (current) | 2. Proposed (future) |
|---|---|---|
| **Parameter** | | |
| Big Brook Causeway operations | 53,000 haul truck movements/year (106,000 one-way crossings)<br>12 sewage tanker movements/year (24 no. one-way crossings) | 151,000 haul truck movements/year (302,000 one-way crossings)<br>~ one sewage tanker movement/year (two no. one-way crossings) |
| Serpentine Dam reservoir water levels | < 207.5 mAHD<br>> 100 m buffer in place | > 207.5 mAHD<br>< 100 m buffer in place |
| Alcoa preventative barriers | Current barriers | Upgraded barriers |

### 3.3.2 Analysis of consequence and risk level

Consistent with the system boundary being the Big Brook Causeway and Alcoa preventative barriers, this ERA does not analyse the consequence of contaminant discharges into Serpentine Dam reservoir nor assess a risk score on the basis of likelihood and consequence. Instead, environmental risk is analysed in terms of the cumulative likelihood of a discharge occurring into the Serpentine Dam reservoir.

The State Government policy position (see Section 2.2) is that the Serpentine Dam P1 PDWSA is a strategic asset with a fundamental water quality objective of risk avoidance, and that intensification of incompatible land uses is only supported if there is an overall reduction in water quality contamination risk. In the context of the future operation of Big Brook Causeway, the following risk acceptability criteria is adopted for this ERA:

> *The risk posed by future Big Brook Causeway operations to drinking water quality is considered acceptable if there is no net increase and preferably a net decrease in the likelihood of a discharge of contaminants occurring to Serpentine Dam reservoir, compared to the current Big Brook Causeway operations*.

The analysis of the increase/decrease in likelihood of contaminant discharge is undertaken with respect to each credible hazard identified for the Big Brook Causeway.

## 3.4 Hazard identification

### 3.4.1 Credible hazards

This ERA defines a 'hazard' as an event involving discharge of one of more contaminants to drinking water quality. Credible hazards were identified for the current and future Big Brook Causeway operations through the following:

– Previous risk assessment (Water Sciences 2008)
– Hazards identified by Alcoa as part of the FEL1 Study
– Risk workshop with Alcoa operations personnel held on 22 June 2022 at the Myara mine facilities.

Table 2 presents the hazards identified for the Big Brook Causeway operations, which have potential to cause discharge of the following contaminants:

– Hydrocarbons from spillage of diesel fuel, hydraulic or engine oils, or oily residue from tyre fires
– Surfactants from fire fighting foams during fire response
– Perfluoroalkyl and polyfluoroalkyl substances (PFAS) from residual contamination of pavements and mobilised by stormwater runoff
– Sediment from stormwater runoff or spillage of ore
– Heavy metals from oily residue from tyre fires
– Pathogens and nutrients from spillage of sewage tanker contents

As presented in Table 2, a total of six credible hazards have been identified, including five relating to vehicle incidents and one relating to stormwater runoff. Four hazards were identified as not credible by Alcoa operations personnel at the 22 June workshop and are not analysed further in this ERA.

It is noted that hazards 4 and 5 relating to vehicle crashes involve single vehicles only. Two vehicle crashes (i.e. collisions) have not occurred to date on haul roads in the Huntly Mine and have a substantially lower likelihood of occurring than hazards 4 and 5, due to the relatively low frequency of vehicles passing each other along the causeway. That is, hazards 4 and 5 would need to occur coincident with a passing vehicle movement in order to result in a two vehicle crash. Accordingly, two vehicle crashes are not considered credible hazards and are not analysed further in this ERA.

*Table 2 Identified hazards to drinking water quality posed by Big Brook Causeway operations*

| No. | Hazard | Description | Contaminants | Evidence of incidence | Credible hazard? |
|---|---|---|---|---|---|
| 1 | Mechanical failure causing discharge | – Heavy vehicle mechanical failure (e.g. blown hose) results in a discharge of hydraulic oil or coolant.<br>– Oil and coolant spill volumes recorded at Huntly Mine over 2021-2022 averaged 106 litres, with the 90th percentile at 217 litres oil and 250 litres coolant, and maximum at 910 litres oil and 600 litres coolant.<br>– Spill response undertaken once discharge is reported by vehicle operator. Response time ~ 20-30 minutes from McCoy mine facilities. | Hydrocarbons (hydraulic oil), coolant | Has occurred over the Big Brook Causeway | **YES** |
| 2 | Mechanical failure causing vehicle fire | – Heavy vehicle catches fire (predominantly due to mechanical failure e.g. piston rod).<br>– Vehicle fire suppression system (non-PFAS AFFF) activates to enable operator escape. Fire reported by passer-by.<br>– Moderate intensity fire suppressed with AFFF / water with spill response. Response time ~ 20-30 minutes from McCoy mine facilities.<br>– Portion of vehicle fuel and engine/hydraulic oils consumed by fire, portion may be discharged.<br>– Spill response undertaken once fire suppressed. | Hydrocarbons (fuel, hydraulic / engine oil), surfactants (AFFF) | Has occurred on haul roads at the Huntly Mine | **YES** |
| 3 | Mechanical failure causing vehicle fire & tyre fire | – Heavy vehicle catches fire (predominantly due to mechanical failure e.g. piston rod).<br>– Vehicle fire suppression system (non-PFAS AFFF) activates to enable operator escape. Fire reported by passer-by.<br>– 650m safety zone established, high intensity fire cannot be practically suppressed and is allowed to burn out. Operations suspended on affected section of haul road.<br>– Portion of vehicle fuel and engine/hydraulic oils consumed by fire, portion may be discharged.<br>– Intense fire results in pyrolysis of tyres creating oily discharge.<br>– Spill response undertaken once site is safe. | Hydrocarbons (fuel, hydraulic / engine oil, tyre residues), heavy metals (tyre residues), surfactants (AFFF) | Has occurred on haul roads at the Huntly Mine | **YES** |
| 4 | Failure of operational controls or mechanical failure causing vehicle to stray off road | – Failure of operational controls (driver training, speed limits, fatigue management, collision avoidance system) or mechanical failure causing heavy vehicle to veer off the road<br>– Heavy vehicle hits causeway panel/berm at speed, cresting the berm and crashing into the Big Brook valley floor, resulting in discharge of vehicle fuel, engine/hydraulic oils and/or ore<br>– Crashed vehicle may or may not catch fire | Hydrocarbons (fuel, hydraulic/engine oil), sediments (ore) | Collision with berm has occurred on haul roads at the Huntly Mine, of which one incident involved a vehicle cresting the berm. | **YES** |

| No. | Hazard | Description | Contaminants | Evidence of incidence | Credible hazard? |
|---|---|---|---|---|---|
| 5 | Failure of operational controls or mechanical failure causing sewage tanker to stray off road | – Failure of operational controls (driver training, speed limits, fatigue management, collision avoidance system) or mechanical failure causing sewage tanker to veer off the road<br>– Sewage tanker hits causeway panel/berm at speed, cresting the berm and crashing into the Big Brook valley floor, resulting in discharge of tanker payload of sewage<br>– Crashed sewage tanker may or may not catch fire | Pathogens, nutrients (raw sewage) | Has not occurred with sewage tankers, however haul truck collision with berms has occurred on haul roads at the Huntly Mine (see hazard no. 4) | **YES** |
| 6 | Sediment and residual contaminant runoff from causeway | – Storm event generates substantial runoff laden with sediment and residual contaminants from pavement (e.g. from oil leaks, minor spills and former dust suppression using water containing PFAS) | Sediment, hydrocarbons, PFAS | Runoff occurs regularly throughout the year during storm events | **YES** |
| 7 | Head on collision between vehicles | – Heavy vehicle collision resulting in discharge of hydraulic oil, coolant, fuel and/or ore<br>– Heavy vehicle collision resulting in vehicle fire, fire suppression | Hydrocarbons (fuel, hydraulic / engine oil, tyre residues), heavy metals (tyre residues), surfactants (AFFF) | Has not occurred at Huntly Mine<br>Vehicle collisions at the Huntly Mine have occurred in parking areas rather than on haul roads | NO |
| 8 | Bushfire causing loss of sump liner integrity | – Wildfire through Huntly Mine results in melted HDPE liner, causing loss of liner integrity<br>– Spill event + storm event results in hydrocarbon spill discharge into the sump<br>– Hydrocarbon seepage through damaged liner / sump walls | Hydrocarbons, PFAS | Has not occurred at Huntly Mine<br>Post-wildfire inspection and repair of sumps expected to reinstate liner prior to a major spill event + storm event | NO |
| 9 | Sump maintenance causing loss of liner integrity | – Excavator removing sediment from first two cells of three stage sump tears the HDPE liner causing a loss of liner integrity<br>– Spill event + storm event results in hydrocarbon spill discharge into the sump<br>– Hydrocarbon seepage through damaged liner / sump walls | Hydrocarbons, PFAS | Has not occurred at Huntly Mine<br>Post-incident inspection and repair of sumps expected to reinstate liner prior to a major spill event + storm event | NO |
| 10 | Loss of sump wall integrity | – Piping, earthquake or inundation in surrounding area causes geotechnical failure of sump walls, resulting in discharge of sump contents | Sediment, hydrocarbons, PFAS | Has not occurred at Huntly Mine<br>Post-incident inspection and repair of sumps expected to reinstate sump prior to a major spill event + storm event | NO |

### 3.4.2 Pathogen hazards

Of all the contaminants, pathogens are of greatest risk to drinking water consumers (NHMRC and NRMMC 2011). Small discharges of pathogens into Serpentine Dam may have potential to cause human health impacts, due to some pathogens (e.g. cryptosporidium) being relatively persistent in freshwater, resistant to chlorine disinfection and causing illness at very low doses

### 3.4.3 PFAS hazards

GHD understand that Alcoa has phased out the use of PFAS containing AFFF in the Huntly Mine vehicle fleet, and has received approval from the Department of Health (letter dated 12 August 2021) to use the following products:

– VDAS-F3 Fluorine Free Foam (Qtec Fire Services Pty Ltd)
– FREEDOL SF Fluorine Free Foam (Wormald Australia)
– Foamguard-F3 Fluorine Free Foam (Fire & Safety Industries Pty Ltd)
– Chubb PEF F3N Foam (SILVARA I) (VS FOCUM S.L.)

Accordingly, vehicle fires on the Big Brook Causeway, if occurring, would use vehicle mounted and fire truck AFFF that does not contain PFAS. PFAS in AFFF is therefore not an identified contaminant for the Big Brook Causeway.

GHD understands that PFAS was previously applied to haul roads at the Huntly Mine in contaminated dust suppression water, arising from PFAS contamination of the mine oily water system. GHD understands that Alcoa has installed a dedicated treatment system to remove PFAS contamination from the mine oily water system and that dust suppression water no longer contains detectable concentrations of PFAS. There remains potential for PFAS residues to be present within the haul road pavements and be leached or removed with sediment with stormwater runoff, however it is expected that the residues will be washed out over time or leach into the subsurface, and that PFAS concentrations in stormwater runoff will decline over time and eventually fall below detectable limits.

## 3.5 Likelihood of hazards

The likelihood of hazards occurring over the Big Brook Causeway in a given year has been estimated based on the following:

– spill and vehicle incident records available for the Huntly Mine
– estimated total haul truck travel over the Huntly Mine
– estimated haul truck movements over the Big Brook Causeway for current and future operations
– estimated sewage tanker movements over the Big Brook Causeway for current and future operations
– estimated causeway distance over Big Brook, for the three stage sumps and upslope sumps.

Vehicle incident records were considered for the Huntly Mine over a ten-year period (2011-2020) to give a large sample of haul truck operations (estimated 17.1 million km of travel) to estimate a representative incident rate per km of travel. Spill records were considered for the Huntly Mine over a two-year period (2021-2022), with the assumption that all spills occurred on haul roads (rather than at mine pits or mine facilities), to estimate a conservative spill incident rate per km of travel. The annual vehicle or spill incidence rate for the Big Brook Causeway was then estimated based on the length of the causeway (three stage sump and upslope sump catchments) and the estimated number of crossings per year, for current and future operations.

Table 3 presents the findings of the likelihood analysis. As presented, there is an estimate very high likelihood (> 100%) of a mechanical failure causing discharge of oil or coolant or for sediment and contaminant runoff during storm events in a given year. There is a low likelihood (1.4-6.0%) of a vehicle fire or collision with berm occurring during current operations, which is expected to rise (4.0-17%) with future operations due to the estimated 180% increase in haul truck movements.

As noted in Section 3.3, whether a discharge occurs into Big Brook is subject to the hazard occurring and the preventative measures (barriers) failing during/shortly after the hazard. The likelihood of barriers failing during/shortly after the identified hazards is presented in Section 4.

*Table 3 Likelihood of occurrence of hazards posed by Big Brook Causeway operations*

| Hazard | Incidence to date at Huntly Mine | Likelihood of occurrence (% per year) over Big Brook Causeway – current operations (106,000 one-way crossings) | Likelihood of occurrence (% per year) over Big Brook Causeway – future operations (302,000 one-way crossings) |
|---|---|---|---|
| Mechanical failure causing discharge | – Incident records: 163 oil spills and 37 coolant spills (200 spills total) recorded at Huntly Mine over 2021-2022. Conservative estimate that all oil and coolant spills occurred on haul roads.<br>– Estimated total haul truck travel of 17.1 million km (Mkm)[11] over 2011-2020 or average 1.7 Mkm/year.<br>– Average incidence rate of 58.5 per Mkm haul truck travel. | Causeway draining to 3 stage sumps:<br>– Average 3.22 incidents per year or 322%<br>– Based on 58.5 per Mkm x 106,000 crossings/yr x 0.52 km causeway draining to three stage sumps<br><br>Haul road draining to upslope sumps:<br>– Average 10.66 incidents per year or 1066%<br>– Based on 1.72 km haul road draining to upslope sumps | Causeway draining to 3 stage sumps:<br>– Average 9.18 incidents per year or 918%<br>– Based on 58.5 per Mkm x 302,000 crossings/yr x 0.52 km causeway draining to three stage sumps<br><br>Haul road draining to upslope sumps:<br>– Average 30.38 incidents per year or 3038%<br>– Based on 1.72 km haul road draining to upslope sumps |
| Mechanical failure causing vehicle fire (moderate fire) | – Incident records: 23 total vehicle fires recorded at Huntly Mine over 2011-2020 or average of 2.3 per year.<br>– Incident records do not identify the intensity of fires<br>– Verbal advice at 22 June workshop: 7 major fires in last 16 years or average 0.4 per year.<br>– Average 1.9 moderate vehicle fires per year = 2.3 – 0.4.<br>– Average 1.7 Mkm/year haul truck travel.<br>– Average incidence rate of 1.09 per Mkm haul truck travel. | Causeway draining to 3 stage sumps:<br>– Average 0.060 incidents per year or 6.0%<br>– Based on 1.09 per Mkm x 106,000 crossings/yr x 0.52 km causeway draining to three stage sumps<br><br>Haul road draining to upslope sumps:<br>– Average 0.20 incidents per year or 20%<br>– Based on 1.72 km haul road draining to upslope sumps | Causeway draining to 3 stage sumps:<br>– Average 0.17 incidents per year or 17%<br>– Based on 1.09 per Mkm x 302,000 crossings/yr x 0.52 km causeway draining to three stage sumps<br><br>Haul road draining to upslope sumps:<br>– Average 0.57 incidents per year or 57%<br>– Based on 1.72 km haul road draining to upslope sumps |
| Mechanical failure causing vehicle fire & tyre fire (intense fire) | – Incident records do not identify major fires.<br>– Verbal advice at 22 June workshop: 7 major fires in last 16 years or average of 0.4 per year.<br>– Average 1.7 Mkm/year haul truck travel.<br>– Average incidence rate of 0.26 per Mkm haul truck travel. | Causeway draining to 3 stage sumps:<br>– Average 0.014 incidents per year or 1.4%<br>– Based on 0.26 per Mkm x 106,000 crossings/year x 0.52 km causeway draining to three stage sumps<br><br>Haul road draining to upslope sumps:<br>– Average 0.05 incidents per year or 4.7%<br>– Based on 1.72 km haul road draining to upslope sumps | Causeway draining to 3 stage sumps:<br>– Average 0.040 incidents per year or 4.0%<br>– Based on 0.26 per Mkm x 302,000 crossings/year x 0.52 km causeway draining to three stage sumps<br><br>Haul road draining to upslope sumps:<br>– Average 0.13 incidents per year or 13%<br>– Based on 1.72 km haul road draining to upslope sumps |
| Failure of operational controls or mechanical failure causing vehicle to stray off road | – Incident records: 6 vehicle collisions with berms recorded at Huntly Mine over 2011-2020 or average of 0.6 per year.<br>– Average 1.7 Mkm/year haul truck travel.<br>– Average incidence rate of 0.35 per Mkm haul truck travel. | Causeway draining to 3 stage sumps:<br>– Average 0.019 incidents per year or 1.9%<br>– Based on 0.35 per Mkm x 106,000 crossings/year x 0.52 km causeway draining to three stage sumps | Causeway draining to 3 stage sumps:<br>– Average 0.055 incidents per year or 5.5%<br>– Based on 0.35 per Mkm x 302,000 crossings/year x 0.52 km causeway draining to three stage sumps |
| Failure of operational controls or mechanical failure causing sewage tanker to stray off road | – No sewage tanker incidents recorded at Huntly Mine over 2011-2020<br>– Assume same incidence rate as haul trucks = 0.35 per Mkm travel | Causeway draining to 3 stage sumps:<br>– Average 4.4 x $10^{-6}$ incidents per year or 0.00044%<br>– Based on 0.35 per Mkm x 24 crossings/year x 0.52 km causeway draining to three stage sumps | Causeway draining to 3 stage sumps:<br>– Average 3.6 x $10^{-7}$ incidents per year or 0.00004%<br>– Based on 0.35 per Mkm x 2 crossings/year x 0.52 km causeway draining to three stage sumps |
| Sediment and residual contaminant runoff from causeway | – Stormwater runoff occurs regularly during the winter-spring period<br>– Bureau of meteorology station at Mount Solus recorded an average of 32 days per year with rainfall exceeding 10 mm over 2005-2020 | 100% likelihood of rainfall generating stormwater runoff each year | 100% likelihood of rainfall generating stormwater runoff each year |

[11] Alcoa data for 2018-2021: 7.30 million km total travel. Estimated 111 Mtpa ore over this period. 2011-2020 estimated ore of 260.4 Mtpa.

# 4. Assessment of preventative measures

## 4.1 Existing preventative measures

### 4.1.1 Surface flow pathways

The preventative measures or barriers to drinking water contaminants have been identified through review of the potential flow pathways that may occur from the Big Brook Causeway into Big Brook. Advisian (2021) identified a total of 17 sumps on the primary haul road, draining a total catchment area of 17.0 ha, that drain into the Big Brook floodplain (Figure 10). Seven sumps (ID 23 to 28) lie west of Big Brook and 10 sumps (ID 29 to 39) lie east of Big Brook. Sumps 28 and 29 lie adjacent to the causeway and are three stage sumps with the first two stages being HDPE lined and the third stage being unlined. The other 15 sumps upslope of the causeway are single cell, unlined sumps. The current sumps are not connected by drains, have very low infiltration rates and overflow independently, being effectively hydraulically disconnected from each other. The upslope sumps discharge into the adjacent Jarrah forest, which drains via overfland flow into the Big Brook floodplain. The three stage sumps 28 and 29 discharge directly into the adjacent Big Brook floodplain.

The surface flow pathways into Big Brook are presented conceptually in Figure 11.

Hazards may occur in the catchments of the three stage sumps or may occur in the catchments of the upslope sumps. The upslope sumps are unlined and designed to function as infiltration basins. Big Brook is gauged at O'Neil Road (station 614037) about 5 km upstream of the Big Brook Causeway, which recorded flows over 2000-2020 as occurring for an average of 31% of the year but flows more than 1 $m^3/s$ occurring on average for 1% of the year. Due to the low flows through the brook, surface inundation is expected to be restricted to the vicinity of the stream channel and not inundate the wider valley floor of the brook.

Figure 12 presents a source-receptor-pathway conceptual model of the following:

– Contaminant source: Big Brook Causeway credible hazards
– Contaminant pathways: flow paths between the source and receptor
– Receptor: Serpentine Dam reservoir at up to 207.5 mAHD.

As presented, there are a series of preventative measures or barriers located along the contaminant pathways. These barriers are numbered in sequence (e.g. B1, B2, B3) reflecting their order along each contaminant pathway.

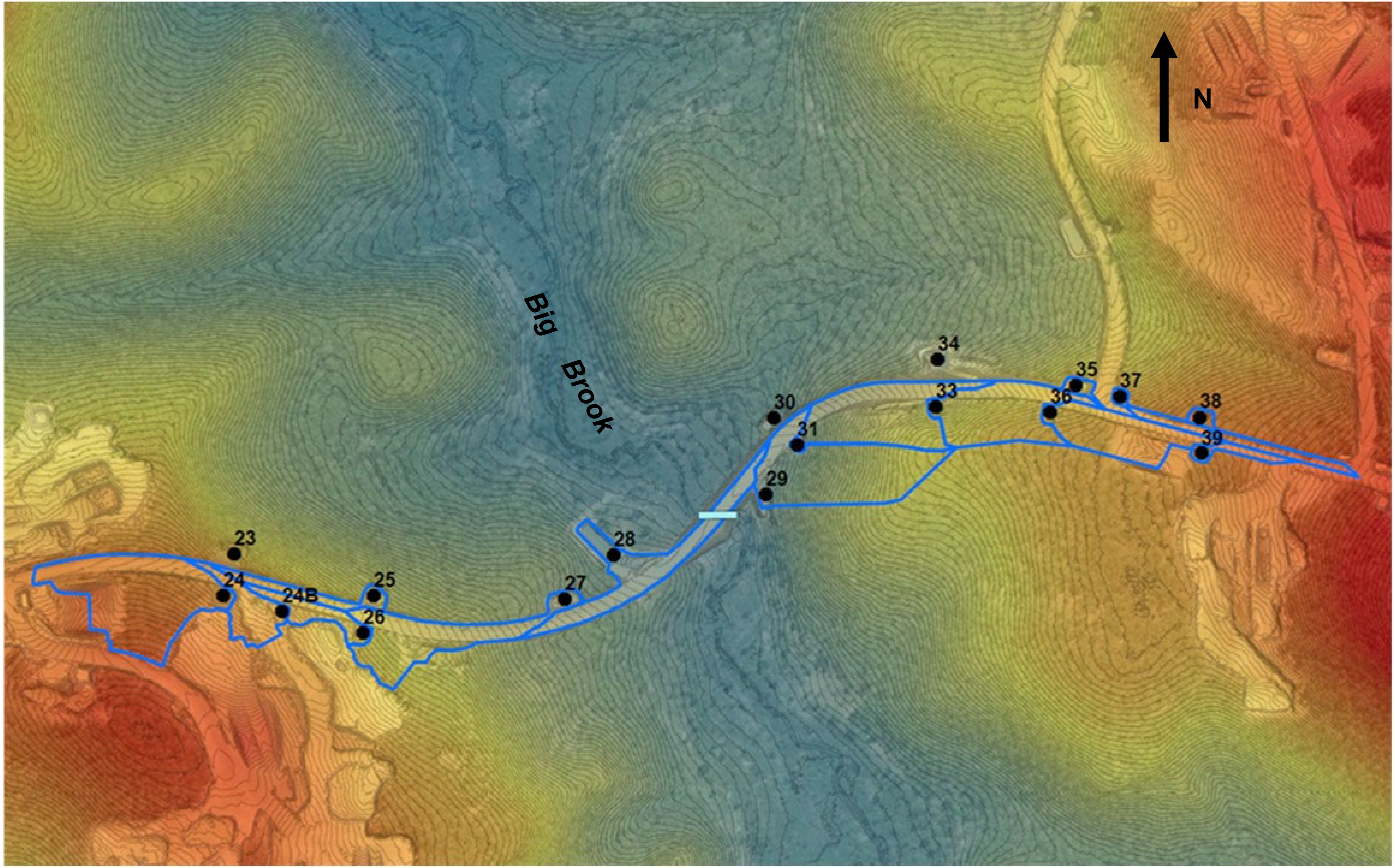



*Figure 10* ***Haul road sumps and catchments discharging into Big Brook Causeway (Advisian 2021)***

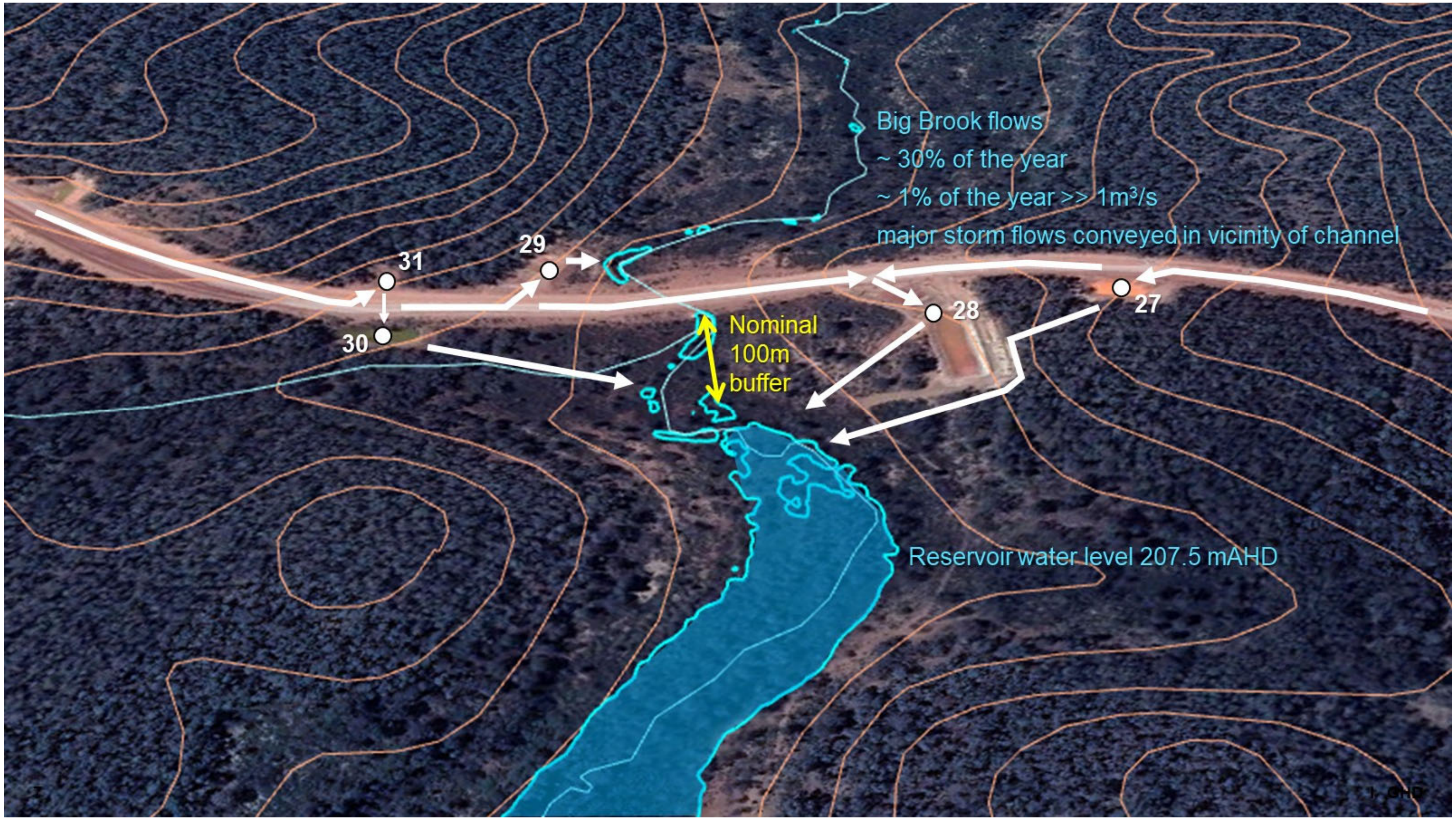



***Figure 11*** ***Big Brook Causeway – surface flow pathways (basemap: GoogleEarth Pro)***

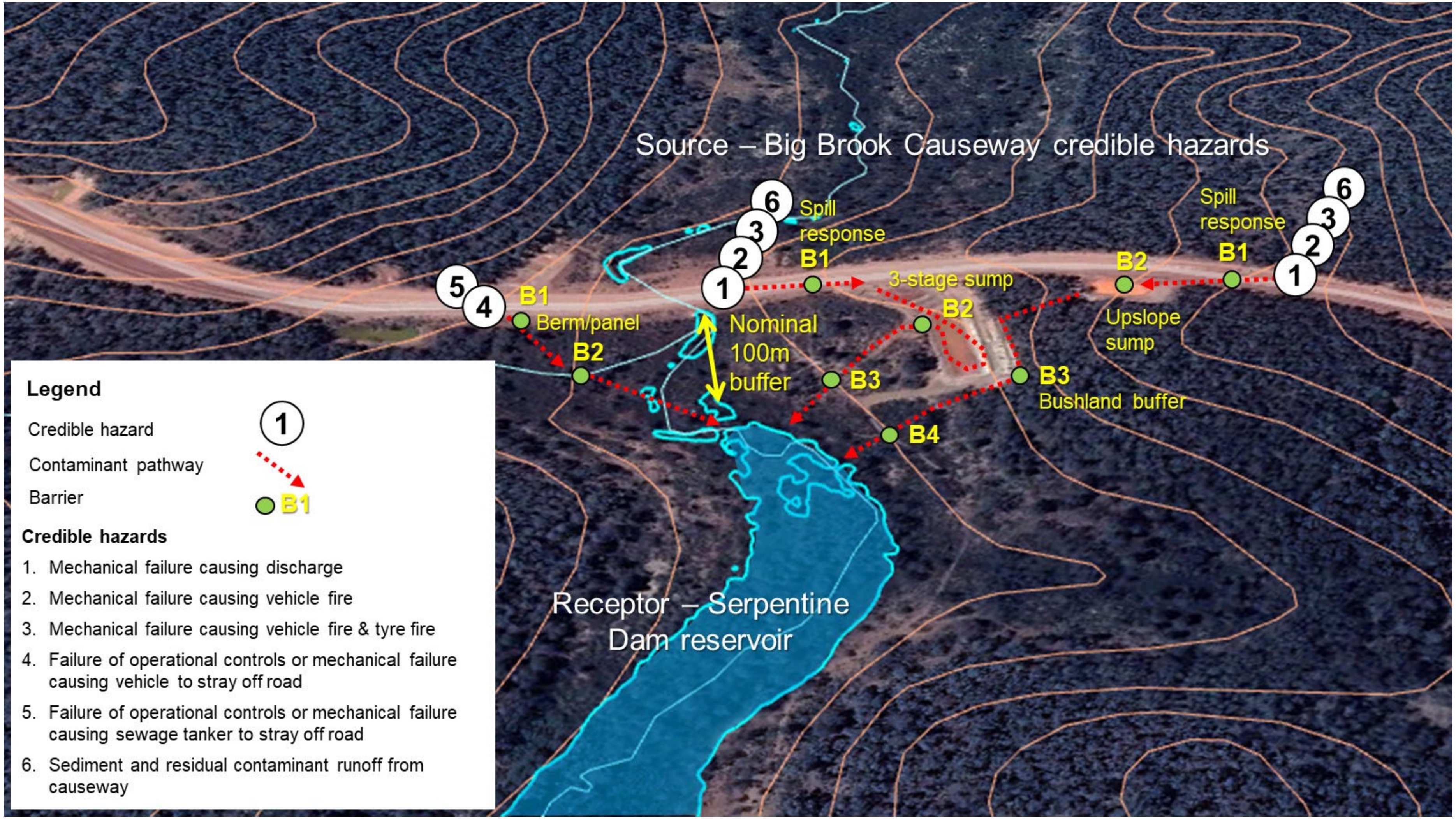



***Figure 12*** ***Big Brook Causeway – conceptual model of existing preventative measures (basemap: GoogleEarth Pro)***

The existing preventative barriers on contaminant pathways between the credible hazards and the Serpentine Dam reservoir at up to 207.5 mAHD have been identified as follows:

- Emergency spill response on the causeway, which intercepts contaminants prior to discharge into sumps
- Sealed pavements along the causeway, which reduce sediment loads into the three stage sumps
- Three stage sumps, which intercept contaminants prior to discharge into the Big Brook valley floor
- Upslope sumps, which intercept contaminants prior to discharge into bushland
- Bushland overland flow, which may attenuate contaminants through filtering in vegetation or via infiltration prior to discharge into the Big Brook valley floor
- Causeway concrete panel/berm, which may deter a vehicle from crashing off the causeway and into the Big Brook valley floor
- 100 m buffer agreed with Water Corporation, which may allow for emergency response activities or attenuate contaminants through filtering in vegetation or infiltration into the Big Brook valley floor, prior to discharge into the Serpentine Dam reservoir

These preventative barriers lie in differing arrangements depending on the credible hazard. Table A-1 in Appendix A presents the sequence of preventative barriers for each credible hazard.

### 4.1.2 Subsurface flow pathways

There is also potential for contaminants to flow into Big Brook via subsurface flow pathways. For credible hazards involving a mechanical failure and discharge or fire, there is potential for contaminants to seep into the haul road pavement or gutters as they pool on the surface or drain towards the sumps. This could result in contamination of the underlying causeway subsurface beneath the pavement. If left in-situ, the contamination would be expected to migrate with unsaturated flow through the causeway subsurface and eventually seep into the Big Brook valley floor.

To cause substantial subsurface contamination capable of discharging through the causeway and into Big Brook valley floor would require a large spill volume. Alcoa's emergency response procedure following a major spill event includes inspection of the spill site and the excavation of any identified contaminated material, which would be evident from stained ground and odour. Contaminated pavement and underlying earth material would be 'chased out' by excavator and the material disposed off-site at a licensed waste facility. Once the material was removed, the exposed soil surface would be tested to validate that contamination had been fully removed and the causeway subsurface and pavement reinstated with new, uncontaminated materials. Alcoa do not consider it credible that this emergency response procedure would not be followed such that substantial contamination would be left in-situ. Accordingly, subsurface flow pathways and preventative measures are not considered further in this ERA.

### 4.1.3 Potential failure of preventative measures

Preventative barriers may fail due to a range of factors, as presented in Table 4, with some barriers failing coincident with others in response to certain events.  As presented, the key event causing multiple barrier failure is a major storm event after a series of storm events or wet year, which would result in failure of spill response, sumps and overland flow attenuation as barriers. The likelihood of failure of sumps will be determined through engineering analysis in Stage 3 and will consider storm frequency, infiltration rates and pumping factors.

As presented in Table 4, the 100 m buffer between the Big Brook Causeway and the Serpentine Dam reservoir is expected to be an effective preventative barrier in the event of a vehicle crash over the causeway panel/berm and into Big Brook valley floor. This is due to the limited stream flow/inundation over the Big Brook valley floor, which would enable emergency response action to occur in the weeks following the vehicle crash. The 100 m buffer is not expected to be an effective preventative barrier for sump overflows, as these would occur during major storm events and wet ground conditions and would likely form concentrated flow paths through the Big Brook valley floor into the channel, with contaminants carried by stream flows (likely during major storm events) into the reservoir. In the absence of data for sump overflows during major storm events, a conservative barrier performance is assumed for the 100 m buffer.

Table 5 presents the estimated likelihood of failure (i.e. overflow) in the existing sumps, based on negligible infiltration losses during a storm event. The sump catchments and volumes have been determined through LiDAR analysis (Advisian 2021a). The equivalent Annual Exceedance Probability (AEP) storm that would result in overtopping of the sumps is estimated based on design rainfall depths generated by Bureau of Meteorology for the Big Brook Causeway location. A seven day storm event is selected as the longest duration for which design rainfall depths are available.

As presented in Table 4, a total of seven sumps draining a total of 10.2 ha are likely to overflow at least once per year. Four sumps draining a total of 2.3 ha have a 50% likelihood of overflowing in a year. The remaining six sumps draining a total of 4.3 ha have a 10% or less likelihood of overflowing in a year.

While there is incident data available to estimate the likelihood of vehicle incidents occurring on the Big Brook Causeway (see Table 3), there is insufficient data on which to derive speed-angle-frequency relationships. Accordingly, it is not possible to estimate the likelihood of failure of the causeway panel/berm based on the panel/berm's impact resistance. This is in contrast to the estimation of likelihood of sump overflows, which is achieved through the intensity-frequency-duration rainfall depths that Bureau of Meteorology have derived from analysis of extensive rainfall datasets.

Table A-1: Baseline Scenario in Appendix A presents the sequence of preventative barriers for each credible hazard.

*Table 4* ***Potential failure of existing preventative barriers on Big Brook Causeway***

| Barrier | Potential failure mode | Potential for failure to occur coincident with other barriers failing | Incidence to date at Huntly Mine<br>Likelihood of occurrence (% per hazard) |
|---|---|---|---|
| Emergency spill response on the causeway | – Response delay and/or heavy rainfall occurring during the hazard results in contaminant / stormwater / firewater runoff mix discharging into sumps | Likely to fail coincident with failure of three stage or upslope sumps due to a storm event | No incident data demonstrating effectiveness or failure of spill response.<br>Assume 100% as occurs coincident during sump failure. |
| Sealed pavement along causeway | – Importation of sediment with vehicle movements (tyres), damage to pavement exposes unsealed material, causing sediment discharge into sumps. | Unlikely | No sediment discharge data.<br>Requires further analysis. |
| Three stage sumps | – Sump capacity exceeded during major storm event or during series of storm events with insufficient time for infiltration or pumping to drain the third cell to a storm ready state | Unlikely | Varying likelihood of failure depending on sump capacity and catchment.<br>See Table 5 |
| Upslope sumps | – Sump capacity exceeded during major storm event or during series of storm events with insufficient time for infiltration to drain the third cell to a storm ready state | Unlikely | Varying likelihood of failure depending on sump and catchment.<br>See Table 5 |
| Bushland overland flow | – Upslope sump overflow may form a concentrated flow path rather than distributed overland flow, short circuiting attenuation via overland flow/infiltration | Likely to fail coincident with failure of upslope sumps, as major storm event or series of storm events are likely to cause wet catchment conditions that promote concentrated flow and prevent infiltration | No incident data.<br>In the absence of data, a conservative assumption of 10% due to saturated forest floor and concentrated flow during major storm events. Actual likelihood of failure may be higher. |
| Causeway concrete panel / berm | – Concrete L-panel/berm may not deter the vehicle due to loss of control. Vehicle kinetic energy may exceed panel/berm impact resistance, vehicle mounts over panel/berm and lands in Big Brook valley floor, crash causes discharge of contaminants | Unlikely | Insufficient incident data from which to derive speed-angle-frequency curves that could enable quantitative analysis of panel/berm failure. |
| 100 m buffer agreed with Water Corporation | – Sump overflow likely to form concentrated flow path through Big Brook valley floor into Big Brook stream channel, short circuiting attenuation via overland flow/infiltration<br>– Emergency response to sump overflows into Big Brook valley floor (e.g. installation of temporary sediment barriers or absorbent booms) is impractical and unlikely to be effective<br>– Emergency response to a vehicle crash off the causeway is likely to be complex and prolonged, requiring inspection and approval by Water Corporation/DWER, establishment of temporary access into Big Brook valley floor and use of heavy equipment (e.g. crane, excavator) to retrieve vehicle and remove contaminants. Potential for crash to occur in | Likely to fail coincident with failure of upslope sumps, as major storm event or series of storm events are likely to cause wet ground conditions in the Big Brook valley floor that promote concentrated flow and prevent infiltration<br>Unlikely to fail coincident with vehicle crash off the causeway, as the Big Brook valley floor will predominantly be dry during the year and enable | No incident data.<br>For sump overflows, in the absence of data a conservative assumption of 10% due to saturated valley floor and concentrated flow during major storm events. Actual likelihood of failure expected to be higher.<br>For vehicle crash off causeway, assume 10% as substantial flows in Big Brook are only estimated to occur for about 1% of the year while emergency response may take weeks. Big Brook flows are expected to be confined to the vicinity of the stream |

| Barrier | Potential failure mode | Potential for failure to occur coincident with other barriers failing | Incidence to date at Huntly Mine<br>Likelihood of occurrence (% per hazard) |
|---|---|---|---|
| | vicinity of Big Brook stream channel when stream flow is occurring. | emergency response over prolonged period | channel with the majority of Big Brook valley floor being dry, enabling emergency response. |

*Table 5 Capacity analysis of existing sumps at Big Brook Causeway*

| Causeway Side | Sump ID | Catchment Area (ha) | Total Runoff Coeff. | Available Sump Volume ($m^3$) | Event Depth (mm) to Overtop Sump | Equivalent AEP[13] of 7 day duration storm event to overtop Sump |
|---|---|---|---|---|---|---|
| Eastern | 39 | 0.23 | 0.76 | 773 | 441 | Rarer than 0.05% |
| | 38 | 0.41 | 0.81 | 651 | 198 | 2% |
| | 35, 36 and 37* | 1.82 | 0.49 | 1089 | 123 | 50% |
| | 33 and 34* | 1.76 | 0.43 | 2841 | 379 | Rarer than 0.05% |
| | 30 and 31* | 2.08 | 0.46 | 776 | 81 | 3EY[14] |
| | 29 | 2.61 | 0.28 | 386 | 53 | 12EY |
| | ***Subtotal*** | ***8.91*** | n/a | ***6516*** | n/a | n/a |
| Western | 23 and 24* | 3.01 | 0.40 | 716 | 59 | 6EY |
| | 24B | 0.73 | 0.36 | 273 | 104 | 1EY |
| | 25 | 0.44 | 0.78 | 451 | 131 | 50% |
| | 26 | 0.52 | 0.54 | 444 | 159 | 10% |
| | 27 | 1.75 | 0.56 | 631 | 64 | 4EY |
| | 28 | 1.61 | 1.00 | 2855 | 177 | 5% |
| | ***Subtotal*** | ***8.06*** | n/a | ***5370*** | n/a | n/a |
| **Total** | | **16.97** | n/a | **11,886** | n/a | n/a |

*Sumps are considered together where drop boxes have been utilised to place a sump in a location that is more favourable to the local topography. These sumps are connected by culverts.

[13] AEP = Annual Exceedance Probability. 1% AEP is equivalent to 100 yr ARI. 10% AEP is equivalent to 10 yr ARI. 63% AEP is equivalent to 1 yr ARI.
[14] EY = annual number of exceedances per year, for storms more frequent than 63% AEP / 1 yr ARI.

### 4.1.4 Changes with future operations

The effect of future changes in operations to the likelihood of contaminant discharges occurring into the Serpentine Dam reservoir are due to two factors:

- Increase in vehicle traffic with an approximately 180% increase ore haulage over the causeway, increasing the likelihood of vehicle incidents (see Section 3.5)
- Increase in Serpentine Dam reservoir water levels, which removes the 100 m buffer as a barrier (Figure 13) and may increase failure of three stage sumps due to groundwater mounding/ingress

The removal of the 100 m buffer as a barrier may increase the likelihood of discharge for the hazards that pass through sumps (hazards 1, 2, 3 and 6), as the 100 m buffer may continue to function during major storm events that cause sump overflows. The ERA has assumed a conservative 10% likelihood of the 100 m buffer failing during major storm events, though the actual likelihood is expected to be higher as the Big Brook valley floor is likely to be saturated during major storm events and the sump overflows likely to form concentrated flow paths into the Big Brook stream channel that short circuit attenuation of contaminants. Removing the 100 m buffer would result in a 100% likelihood of barrier failure.

The removal of the 100 m buffer would increase the likelihood of discharge from hazards 4 and 5 (vehicle strays off road) as the Big Brook valley floor is currently dry for most of the year but would become inundated with the Serpentine Dam reservoir water levels rising and any discharge of contaminants from the crashed vehicle would directly enter the reservoir (see Figure 13). The increase in likelihood of discharge with removal of the 100 m buffer would depend on the location of the crash within Big Brook valley floor and the reservoir water level at the time, which may vary from just over 207.5 mAHD to up to the reservoir full supply level (FSL) (212.4 mAHD). For the purposes of the ERA it is assumed that reservoir water may rise up to the FSL and impound either side of the causeway, which would result in a 100% likelihood of barrier failure for the 100 m buffer.

The groundwater mounding that may result from reservoir water rise may result in the following impacts to sumps:

- Mounding is below or at the base of the infiltration sumps and reduces or eliminates infiltration from the sumps, increasing the likelihood that sumps are not in a storm ready state and overflow during major storm events
- Mounding is above the base of the infiltration sumps and causes groundwater ingress that reduces the sump effective capacity below the designed performance criteria, increasing the likelihood of overflow during major storm events
- Mounding is above the base of the lined cells of the three stage sumps, causing lifting and damage to the HDPE liners, resulting in hydrocarbon contamination/seepage through the sump walls following discharges from vehicle incidents.

GHD (2022) undertook a study of the potential for groundwater mounding impacts to the sumps. The study indicated the following:

- Groundwater inflows are likely into the sump 28 third (unlined) cell as the reservoir reaches 87% capacity (210.6 mAHD) or 90% capacity (211 mAHD) for the proposed sump upgrade[15] (see Section 4.2.1). This may occur around 2026 based on Water Corporation modelling of reservoir water level rise. At reservoir FSL groundwater flows may reach a maximum of approximately 100 $m^3$/day. Impeded infiltration is likely to occur from about 2023-24 onwards and potentially earlier due to reservoir derived groundwater mounding in combination with rainfall derived / regolith groundwater.
- Groundwater levels may cause uplift on the sump 28 HDPE lined cells as the reservoir reaches 96% capacity (211.8 mAHD). This may occur around 2027-28 based on Water Corporation modelling of reservoir water level rise.
- Sumps 29 and 30 may be subject to impeded infiltration from about 2026-27 and potentially earlier due to reservoir derived groundwater mounding in combination with rainfall derived / regolith groundwater. The sumps have sufficient elevation to prevent groundwater inflows and, for sump 29, uplift on lined cells.

[15] This is due to a proposed increase in the sump floor elevation for the sump 28 unlined cell, from 210.6 mAHD to 211.0 mAHD, as part of the proposed sump upgrades.

- The other remaining 14 sumps on the primary haul road crossing that drain to Big Brook are at an elevation well above the reservoir FSL and are unlikely to be subject to impeded infiltration and will not be subject to groundwater inflows.

In addition to groundwater mounding, the rise in reservoir water levels may cause a loss of geotechnical strength at the base of the sump walls and potentially a loss of integrity, sump embankment failure and release of contaminants. This is an uncertainty that requires further study (see Section 4.2.3).

The effect of the future changes in operations are presented in Table A-2 Future (Un-Mitigated) Scenario in Appendix A.

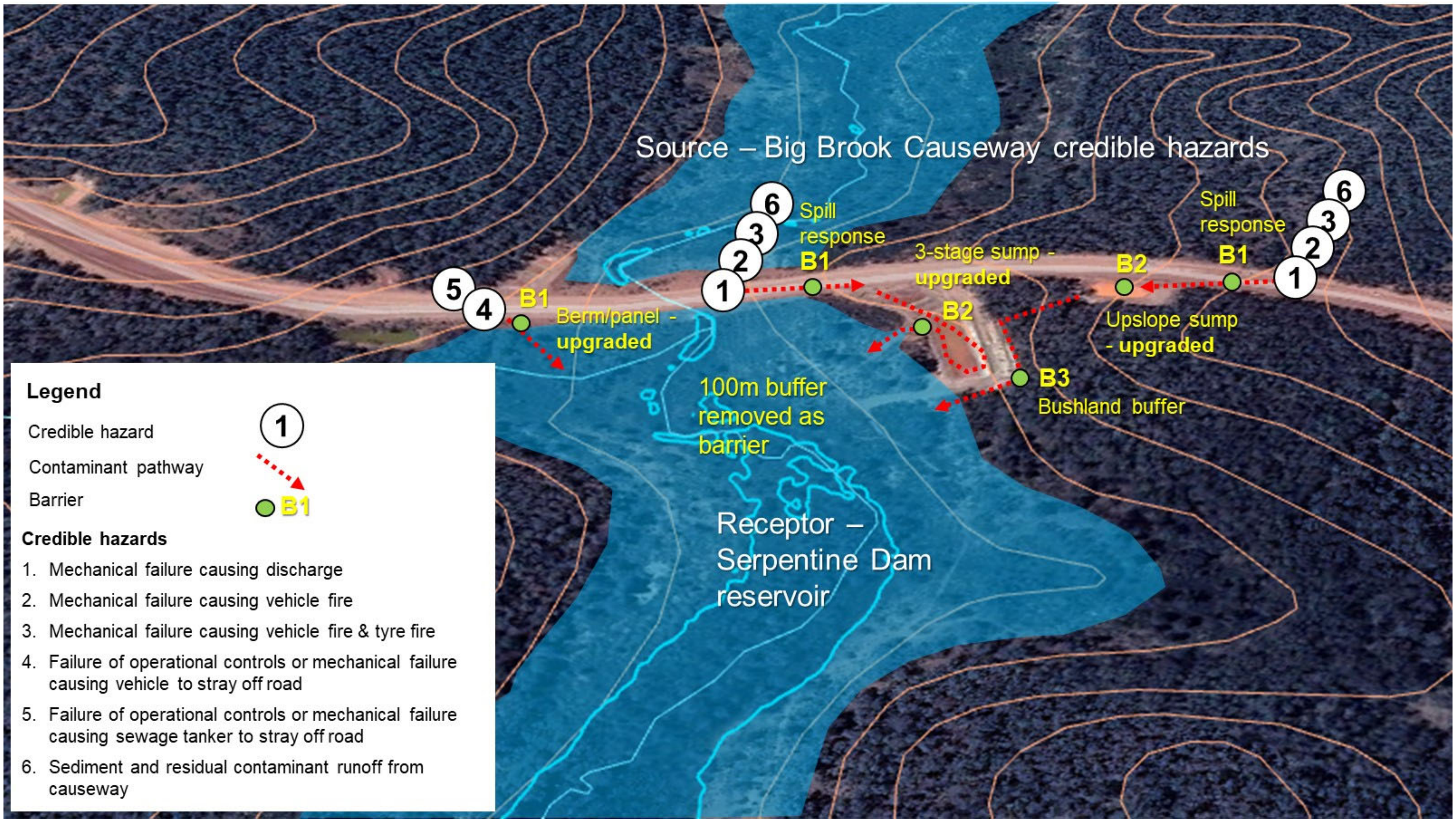



*Figure 13 Big Brook Causeway – conceptual model of preventative measures with future operations (basemap: GoogleEarth Pro)*

## 4.2 Additional preventative measures

### 4.2.1 Identified preventative measures

Additional preventative measures have been developed to mitigate the partial or full loss of the 100 m buffer for the Big Brook Causeway, through a process of options identification (FEL[16] 1) and options selection (FEL 2). The additional preventative measures comprise the following:

1. Upgraded sump capacities and connection of sumps.
2. New permanent pumps and associated infrastructure.
3. Upgraded causeway panel/berm to improve impact resistance.
4. Sewage treatment and effluent irrigation at Kisler facilities to reduce sewage transport.

The identified additional preventative measures are presented in Table 6. As presented, there is a high confidence in the performance of the four preventative measures. The exception is in the highly unlikely event of a vehicle losing control (e.g. operator is unconscious, steering/brakes do not respond) over the causeway and crashing into the panel/berm. In this event, there is potential for the vehicle speed and/or incidence to exceed the substantially increased impact resistance of the upgraded panel/berm.

Preventative measures 1 (sumps) and 2 (pumps) function as combined solution. Engineering analysis of the combined sump upgrades and pumping infrastructure indicates that the system can accommodate runoff from at least a 0.05% AEP 7 day storm event over the 17 sumps and 17.0 ha catchment on the primary haul road that drains into Big Brook. The use of standby pumps and LPG generations and telemetered alerts provides a high degree of redundancy and confidence in the performance of the pumps. Accordingly, the scenario that the pumps fail coincident with a major storm event that exceeds the upgraded sump capacities is extremely remote and not a credible risk.

The likelihood of measures 3 and 4 failing cannot be estimated. As noted in Section 4.1.3, there is insufficient data on which to derive speed-angle-frequency relationships for vehicle incidents on the Big Brook Causeway. Accordingly, it is not possible to estimate the likelihood of failure of the upgraded causeway panel/berm based on the panel/berm's impact resistance. There is insufficient data on which to estimate the likelihood of a mechanical/controls failure in the sewage treatment and irrigation systems at Kisler, however the likelihood of a failure coincident with a vehicle incident on the Big Brook Causeway is considered extremely remote and not a credible risk.

### 4.2.2 Preventative measures as barriers against identified hazards

Table A-2 Future (Mitigated) Scenario in Appendix A presents the position of the additional preventative barriers for each credible hazard. As presented, all six identified credible hazards have at least one additional preventative barrier on their respective contaminant pathways. Accordingly, there are no gaps in credible hazards or contaminant pathways that are not addressed by the additional preventative barriers.

Table 7 presents an analysis of the net reduction in likelihood of discharge of contaminants into the reservoir due to the additional preventative measures (upgraded sumps and pumping infrastructure) for the future operations (increased vehicle crossings and partial or full loss of the 100 m buffer). In summary:

– Three sumps (2.0 ha catchment) will have a 28.5 times increase in likelihood of discharge
– Three sumps (2.5 ha catchment) will have up to 10 time decrease in likelihood of discharge
– Five sumps (3.0 ha catchment) will have 11-100 times decrease in likelihood of discharge
– Six sumps (9.4 ha catchment) will have more than 100 times decrease in likelihood of discharge

[16] FEL = Front End Loading

The analysis of reduction in likelihood is conservative as it assumes that the existing 100 m buffer will attenuate contaminants if sumps overflow, with a 10% likelihood of failure, whereas it is considered likely to fail during storm events due to saturated ground conditions and concentrated flow paths in the Big Brook valley floor.

While there is an estimated increase in likelihood of discharge from three sumps (ID 39, 33, 34), this is due to these sumps having an existing estimated capacity greater than a 0.05% AEP 7 day storm event. Accordingly, the likelihood of contaminants arising from the 2.0 ha catchments of these three sumps overflowing into the three stage sumps and then overflowing into Big Brook is very low, particularly coincident with a vehicle incident on the causeway.

*Table 6* ***Additional preventative barriers that may be implemented for future Big Brook Causeway operations***

| No. | Additional preventative barrier | Description | Potential failure mode | Confidence in performance |
|---|---|---|---|---|
| 1 | Upgraded sump capacities and connection of sumps. | – Sump capacities upgraded to 0.2% AEP 7 day storm event for the three stage sumps 28 and 29, and 1% AEP 7 day storm event for the upslope sumps.<br>– Sump capacities include sediment holding volume based on a two year clean out frequency.<br>– Sump network hydraulically connected. Upslope sumps designed to overflow during > 1% AEP storm events back onto primary haul road crossing and into the three stage sumps 28 and 29. | – Larger than design criteria storm event and/or sediment accumulation<br>– Reservoir water causing groundwater mounding below sumps 28, 29 and 30 – groundwater ingress and/or impeded infiltration capacity, affect liner integrity<br>– Geotech stability failure due to reservoir inundation, piping, earthquake<br>– In the event of the reservoir TWL exceeding 211 mAHD (90% reservoir capacity) and groundwater inflows into the sump 28 unlined cell, the groundwater will be allowed to accumulate in the sump.<br>– In the event of a major storm event forecast, the accumulated groundwater will be pumped out within 24 hours (see barrier 2 below) to maintain the full sump volume prior to the storm inflows.<br>– This approach will avoid ongoing pumping out of groundwater and loss of reservoir water from sump 28 in the event of the reservoir TWL exceeding 211 mAHD.<br>– In the event of the reservoir TWL approaching 211.8 mAHD (96% capacity), liner upgrades will be investigated and implemented (e.g. concrete liner, anchoring) to prevent liner uplift in the sump 28 lined cells. | HIGH |
| 2 | Pumps and associated infrastructure. | – Permanent pumps and associated infrastructure at sumps 28 and 29 to manage water levels in these sumps.<br>– Pipes will connect upslope sumps into 28 and 29 to enable the upslope sumps to be emptied through the use of valves. This will restore the maximum capacity of the upslope sumps following a major storm event, preventing overflow into sumps 28 and 29.<br>– Pumping infrastructure has been designed to allow all connected sumps to be emptied within 24 hours after a 1% AEP 7 day storm event.<br>– Combined with the sump upgrades, the pumping infrastructure can accommodate runoff from more than a 0.05% AEP 7 day storm event over all connected sumps. | – Mechanical failure of pumps and/or generators – use standby systems<br>– Electrical/controls<br>– LPG pump/genset runs out of fuel<br>– Mechanical/electrical/fuel failures mitigated by use of telemetry and alarms<br>– Pipeline rupture due to mechanical damage or thermal stress – appropriate placement will mitigate<br>– The likelihood of the pumping system failing coincident with a major storm event rarer than 1% AEP is considered extremely remote and not a credible risk. | HIGH |

| No. | Additional preventative barrier | Description | Potential failure mode | Confidence in performance |
|---|---|---|---|---|
| | | – Duty/standby arrangement for both pumps and LPG fuelled generator sets to provide continued operation in the event of equipment failure.<br>– Telemetry back to operations to provide warning of any potential malfunctions in the system.<br>– Pumped water will be discharged to a mine pit void outside of the OCA 2 boundary. | | |
| 3 | Upgraded causeway barrier. | – Upgrade of existing concrete panel through installation of additional earth and rock material behind the panel, to increase the impact resistance to prevent a vehicle crashing off the causeway and into the Big Brook valley floor.<br>– Proposed upgrade will provide sufficient energy absorption capacity to match that of Recognised standard 19 *Design and construction of mine roads* (Queensland Government 2019), an industry standard adopted for the protection of human life. Proposed upgrade will enable an approximate doubling of the energy absorption capacity of the existing barrier.<br>– Deterrent barriers are an established practice on Main Roads grade separated intersections to prevent heavy vehicles from crashing off bridges and causing loss of life on underlying roads. | – Vehicle speed / angle of incidence exceeds the increased impact resistance of the barrier, in the highly unlikely event that the vehicle is out of control (e.g. operator is unconscious, steering / brakes do not respond). | HIGH – operator has control of the vehicle<br>LOW – vehicle is out of control |
| 4 | Sewage treatment and effluent irrigation at Kisler facilities. | – Sewage treatment plan (Biomax) at Kisler facilities, including primary and secondary treatment and disinfection via chlorination.<br>– Treated sewage effluent irrigated in vicinity of Kisler facilities.<br>– Sewage treatment and effluent disposal at Kisler facilities will avoid the requirement for raw sewage transport using a tanker as is the case for the current operations.<br>– The sewage treatment plant will require less frequent pump for de-sludging, with the transport of sludge over the Big Brook Causeway as a reduced frequency compared to the current requirement for raw sewage transport. | – Mechanical failure of sewage treatment plant or irrigation – mitigate by standby systems and regular maintenance by a qualified supplier<br>– Electrical/controls<br>– If the sewage treatment plant or irrigation system cannot function then raw sewage would need to be pumped out and tankered across Big Brook.<br>– The likelihood of the sewage treatment and irrigation system failing and raw sewage transport being required, coincident with a vehicle incident on the Big Brook Causeway, is considered extremely remote and not a credible risk. | HIGH |

*Table 7* ***Reduction in likelihood of discharge of contaminants into Big Brook with upgrade of sumps and pumping infrastructure***

| Causeway Side | Sump ID | Catchment Area (ha) | Equivalent AEP of 7 day duration storm event to overtop existing Sump | Equivalent AEP of 7 day duration storm event to overtop upgraded sump with pumping infrastructure | Increase in likelihood of discharge of contaminants into reservoir for future operations - increased vehicle crossings and loss of 100 m buffer | Net reduction in likelihood of discharge of contaminants into reservoir due to additional preventative measures and future operations |
|---|---|---|---|---|---|---|
| Eastern | 39 | 0.23 | Rarer than 0.05% | Rarer than 0.05% | 28.5 times<br>= (302,000/106,000 vehicle crossings) x (100% / 10% buffer likelihood of failure) | 28.5 x increase |
| | 38 | 0.41 | 2% | | | 1.4 x REDUCTION |
| | 35, 36 and 37* | 1.82 | 50% | | | 35.1 x REDUCTION |
| | 33 and 34* | 1.76 | Rarer than 0.05% | | | 28.5 x increase |
| | 30 and 31* | 2.08 | 3EY[17] | | | 211 x REDUCTION |
| | 29 | 2.61 | 12EY | | | 842 x REDUCTION |
| | ***Subtotal*** | ***8.91*** | n/a | | | n/a |
| Western | 23 and 24* | 3.01 | 6EY | Rarer than 0.05% | 28.5 times<br>= (302,000/106,000 vehicle crossings) x (100% / 10% buffer likelihood of failure | 421 x REDUCTION |
| | 24B | 0.73 | 1EY | | | 70 x REDUCTION |
| | 25 | 0.44 | 50% | | | 35 x REDUCTION |
| | 26 | 0.52 | 10% | | | 7.0 x REDUCTION |
| | 27 | 1.75 | 4EY | | | 281 x REDUCTION |
| | 28 | 1.61 | 5% | | | 3.5 x REDUCTION |
| | ***Subtotal*** | ***8.06*** | n/a | | | n/a |
| **Total** | | **16.97** | n/a | n/a | n/a | n/a |

*Sumps are considered together where drop boxes have been utilised to place a sump in a location that is more favourable to the local topography. These sumps are connected by culverts.

[17] EY = annual number of exceedances per year, for storms more frequent than 63% AEP / 1 yr ARI.

### 4.2.3 Assessment of risk to drinking water quality with change to Big Brook Causeway operations

Table A-2 presents the performance of the additional preventative measures for the future operations, including:

- increased likelihood of vehicle incidents due to increased vehicle crossings
- reduced likelihood of sewage tanker incidents due to Kisler sewage plant operations reducing the frequency of tanker movements from one per month (raw sewage) to one per year (de-sludging)
- loss of 100 m buffer between Big Brook Causeway and reservoir
- improved performance of additional preventative measures

Tables A-1 and A-2 present the example of the western 3 stage sump (ID 28, 5% AEP 7 day storm capacity) and an eastern upslope sump (ID 30/31, 3EY 7 day storm capacity) as representative of the sumps on the Big Brook Causeway. This is for the purposes of identifying the cumulative likelihood of contaminant discharges entering Big Brook.

#### 4.2.3.1 Risk posed by existing operations

As presented in Table A-1, the baseline (current) operations and preventative measures are expected to limit contaminant discharges from a major spill incident into the three stage sump which then overflows (Risks 1.1 to 1.3) to about once in 2600 to 745,000 years. A major spill incident into the upslope sumps that overflows (Risks 3.1 to 3.3) is limited to about once in 130 to 37,000 years. The range in frequencies is due to the range in frequencies of hazards, with larger spill events (e.g. high intensity / tyre fire) less likely to occur.

Annual runoff of residual contaminants into the sumps that then overflow (Risks 4.1 to 4.2) is limited to about once in 30 to 200 years, which is more frequent that an overflow coincident with a major spill but expected to be lower in contaminant loading and thus a lower consequence.

As presented in Table A-1, no analysis of discharge from a crash over the causeway berm is possible, due to the lack of data to analyse the likelihood of the barrier failing (see Section 4.1.3). However, vehicle crashes into the berm are relatively unlikely to occur, at about once in 50 years for a haul truck or once in 230,000 years for a sewage tanker.

#### 4.2.3.2 Risk posed by future operations

As presented in Table A-2, the proposed (future) operations and upgraded preventatives measures are expected to reduce the likelihood of contaminant discharges compared to baseline (current) operations. Contaminant discharges from a major spill incident into the three stage sump which then overflows (Risks 1.1 to 1.3) will be reduced to about once in 9100 to 2.6 million years. A major spill incident into the upslope sumps that overflows (Risks 3.1 to 3.3) is limited to about once in 2800 to 780,000 years.

Annual runoff of residual contaminants into the sumps that then overflow (Risks 4.1 to 4.2) is expected to reduce to about once in 2000 years, which is the upgraded capacity of the sump and pumping network.

Similar to Table A-1, no analysis of discharge from a crash over the causeway berm is possible. Haul truck crashes into the berm are estimated to increase to about once in 18 years, whereas crashes involving sewage tankers servicing the Kisler sewage treatment plant are expected to reduce to about once in 2.7 million years. This represents an extremely remote likelihood of a sewage tanker crash occurring, which is the hazard with the greatest consequence to drinking water quality identified in the ERA.

# 5. Conclusion

## 5.1 Risk from baseline (current) operations

The baseline (current) operations and preventative measures at the Big Brook Causeway are expected to limit contaminant discharges from a major spill incident into Big Brook to about once in 160 to 745,000 years. The range in frequencies is due to the range in sump capacities and the range in frequencies of hazards, with larger spill events (e.g. high intensity / tyre fire) less likely to occur than smaller spill events (e.g. mechanical failure causing oil or coolant spills averaging about 100-140 litres).

Annual runoff of residual contaminants into the sumps that then overflow is limited to about once in 30 to 200 years, which is more frequent that an overflow coincident with a major spill but expected to be lower in contaminant loading and thus a lower consequence.

No analysis of discharge from a crash over the causeway berm is possible, due to the lack of data to analyse the likelihood of the barrier failing. However, vehicle crashes into the berm are relatively unlikely to occur, at about once in 50 years for a haul truck or once in 230,000 years for a sewage tanker.

## 5.2 Risk from proposed (future) operations

The proposed (future) operations and upgraded preventatives measures at the Big Brook Causeway are expected to reduce the likelihood of contaminant discharges compared to baseline (current) operations. Contaminant discharges from a major spill incident into Big Brook will be reduced to about once in 3400 to 2.6 million years. This represents an approximate 3.5 to 21 fold reduction in likelihood of discharge into Big Brook, compared to the baseline (current) operations and based on a conservative assumption on the performance of the 100 m buffer.

Annual runoff of residual contaminants into the sumps that then overflow is expected to reduce to about once in 2000 years, which is the upgraded capacity of the sump and pumping network. This represents an approximate 10 to 60 fold reduction in likelihood of discharge into Big Brook, compared to the baseline (current) operations and based on a conservative assumption on the performance of the 100 m buffer.

No analysis of discharge from a crash over the causeway berm is possible. Haul truck crashes into the berm are estimated to increase to about once in 18 years, whereas crashes involving sewage tankers servicing the Kisler sewage treatment plant are expected to reduce to about once in 2.7 million years. This represents an extremely remote likelihood of a sewage tanker crash occurring, which is the hazard with the greatest consequence to drinking water quality identified in the ERA.

# 6. References

Advisian 2021, *Serpentine Causeway Sump Capacity Assessment*, Memorandum prepared for Alcoa of Australia.

Alcoa of Australia Ltd (Alcoa) 2017, *Serpentine Crossing Construction and Operational Plan*, Version 4 – Third MMPLG Submission, Doc No: AUACDS-2053-3277, Update 13/12/2017.

Department of Health (DoH) 2017, *Memorandum of Understanding between the Department of Health and Water Corporation for Drinking Water*, MoU2017v1, entered into on 28 November 2017, Government of Western Australia.

Department of Water (DoW) 2007, *Serpentine Dam Catchment Area and Serpentine Pipehead Dam Catchment Area Drinking Water Source Protection Plan*, Water Resource Protection Series, Report No. 78, July 2007, Government of Western Australia.

Department of Water (DoW) 2016, *Strategic Policy – Protection public drinking water source areas in Western Australia*, June 2016, Government of Western Australia.

Department of Water and Environmental Regulation (DWER) 2017, *Managing releases for the Serpentine River*, *Serpentine River allocation statement*, Integrated Water Supply Scheme release review, November 2017, Government of Western Australia.

Department of Water and Environmental Regulation (DWER) 2021a, *Policy – Land use compatibility in public drinking water source areas*, August 2021, Government of Western Australia.

Department of Water and Environmental Regulation (DWER) 2021b, *Land use compatibility tables for public drinking water source areas*, Water quality protection note 25, August 2021, Government of Western Australia.

GHD Pty Ltd 2022, *Serpentine Dam – Big Brook Causeway Sumps Groundwater Study*, Memorandum prepared for Alcoa of Australia.

National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC) 2011, Australian Drinking Water Guidelines 6 2011, Version 3.7 updated January 2022, Australian Government.

Water Science Pty Ltd 2008, *Risk Assessment of the Proposed Haul Road Crossing of Serpentine Dam*, prepared for Alcoa World Alumina Australia, May 2008.

# Appendix A

## Risk assessment tables

**SERPENTINE DAM BIG BROOK CAUSEWAY FEL2 STUDY**
**FEL 3 REVISED ENVIRONMENTAL RISK ANALYSIS**
**TABLE A-1 BASELINE SCENARIO - SUMMARY - CURRENT BIG BROOK CAUSEWAY WITH 100M BUFFER FROM RESERVOIR**

| | | SOURCE | | | PATHWAY Barrier 1 | | Barrier 2 | | Barrier 3 | | Barrier 4 | | RECEPTOR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | S | | B1 | | B2 | | B3 | | B4 | S x B1 x B2 x B3 x B4 | |
| **Risk no.** | **Hazard group** | **Hazard** | **Contaminants** | **Likelihood of hazard (per year)** | **Barrier** | **Likelihood of failure (per hazard)** | **Barrier** | **Likelihood of failure (per hazard)** | **Barrier** | **Likelihood of failure (per hazard)** | **Barrier** | **Likelihood of failure (per hazard)** | **Likelihood of discharge to reservoir (per year)** | **Average recurrence frequency (years)** |
| 1.1 | Vehicle incident on causeway - 3 sump catchment | Mechanical failure causing discharge | Hydrocarbons (hydraulic oil), coolant | 322% | Spill response | 100% | Three stage sump (~5% AEP capacity) | 0.10% | **100m buffer to reservoir** | 10% | None | 100% | 0.03% | 3,239 |
| 1.2 | Vehicle incident on causeway - 3 sump catchment | Mechanical failure causing vehicle fire | Hydrocarbons (fuel, hydraulic/engine oil), surfactants (AFFF), sediments (ore) | 6.0% | Spill response | 100% | Three stage sump (~5% AEP capacity) | 0.10% | **100m buffer to reservoir** | 10% | None | 100% | 0.00% | 173,810 |
| 1.3 | Vehicle incident on causeway - 3 sump catchment | Mechanical failure causing vehicle fire & tyre fire | Hydrocarbons (fuel, hydraulic/engine oil, tyre residues), heavy metals (tyre residues), surfactants (AFFF), sediments (ore) | 1.4% | Spill response | 100% | Three stage sump (~5% AEP capacity) | 0.10% | **100m buffer to reservoir** | 10% | None | 100% | 0.0001% | 744,898 |
| 2.1 | Vehicle incident on causeway | Failure of operational controls or mechanical failure causing vehicle to stray off road | Hydrocarbons (fuel, hydraulic/engine oil), sediments (ore) | 1.9% | Causeway berm | N/A | **100m buffer to reservoir** | 10% | None | 100% | None | 100% | N/A | N/A |
| 2.2 | Vehicle incident on causeway - sewage tanker | Failure of operational controls or mechanical failure causing sewage tanker to stray off road | Pathogens (sewage tanker contents), hydrocarbons (fuel, hydraulic/engine oil) | 0.00044% | Causeway berm | N/A | **100m buffer to reservoir** | 10% | None | 100% | None | 100% | N/A | N/A |
| 3.1 | Vehicle incident upslope of causeway | Mechanical failure causing discharge | As per 1.1 | 1066% | Spill response | 100% | Upslope infiltration sump (~ 3EY capacity) | 6% | Overland flow in bushland | 10% | **100m buffer to reservoir** | 10% | 0.6% | 163 |
| 3.2 | Vehicle incident upslope of causeway | Mechanical failure causing vehicle fire | As per 1.2 | 20.0% | Spill response | 100% | Upslope infiltration sump (~ 3EY capacity) | 6% | Overland flow in bushland | 10% | **100m buffer to reservoir** | 10% | 0.012% | 8,690 |
| 3.3 | Vehicle incident upslope of causeway | Mechanical failure causing vehicle fire & tyre fire | As per 1.3 | 4.7% | Spill response | 100% | Upslope infiltration sump (~ 3EY capacity) | 6% | Overland flow in bushland | 10% | **100m buffer to reservoir** | 10% | 0.003% | 36,981 |
| 4.1 | Major storm event on causeway | Sediment and residual contaminant runoff from causeway (outside of vehicle incidents) | Sediment / hydrocarbons (residual) / PFAS (residual) | 100% | Sealed pavement reduces sediment load into sumps | 100% | Three stage sump (~5% AEP capacity) | 5% | **100m buffer to reservoir** | 10% | None | 100% | 0.5% | 200 |
| 4.2 | Major storm event upslope of causeway | Sediment and residual contaminant runoff from causeway (outside of vehicle incidents) | Sediment / hydrocarbons (residual) / PFAS (residual) | 100% | Upslope infiltration sump (~ 3EY capacity) | 300% | Overland flow in bushland | 10% | **100m buffer to reservoir** | 10% | None | 100% | 3.0% | 33 |

GREEN CELLS REPRESENT THE CONSERVATIVE BARRIER EFFECT OF A 100M BUFFER TO SERPENTINE DAM RESERVOIR INUNDATION AREA

**SERPENTINE DAM BIG BROOK CAUSEWAY FEL2 STUDY**
**FEL 3 REVISED ENVIRONMENTAL RISK ANALYSIS**
**TABLE A-2 PROPOSED SCENARIO - SUMMARY - FUTURE BIG BROOK CAUSEWAY WITH PROPOSED RISK REDUCTION SOLUTION**

| | | SOURCE | | | PATHWAY Barrier 1 | | Barrier 2 | | Barrier 3 | | Barrier 4 | | RECEPTOR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | S | | B1 | | B2 | | B3 | | B4 | S x B1 x B2 x B3 x B4 | | |
| Risk no. | Hazard group | Hazard | Contaminants | Likelihood of hazard (per year) | Barrier | Likelihood of failure (per hazard) | Barrier | Likelihood of failure (per hazard) | Barrier | Likelihood of failure (per hazard) | Barrier | Likelihood of failure (per hazard) | Likelihood of discharge to reservoir (per year) | Average recurrence frequency (years) | Reduction in average recurrence frequency |
| 1.1 | Vehicle incident on causeway - 3 sump catchment | Mechanical failure causing discharge | Hydrocarbons (hydraulic oil), coolant | 918% | Spill response | 100% | Upgraded three stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.00096% | None | 100% | None | 100% | 0.01% | 11,360 | 3.5 |
| 1.2 | Vehicle incident on causeway - 3 sump catchment | Mechanical failure causing vehicle fire | Hydrocarbons (fuel, hydraulic/engine oil), surfactants (AFFF), sediments (ore) | 17.1% | Spill response | 100% | Upgraded three stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.00096% | None | 100% | None | 100% | 0.00% | 610,060 | 3.5 |
| 1.3 | Vehicle incident on causeway - 3 sump catchment | Mechanical failure causing vehicle fire & tyre fire | Hydrocarbons (fuel, hydraulic/engine oil, tyre residues), heavy metals (tyre residues), surfactants (AFFF), sediments (ore) | 4.0% | Spill response | 100% | Upgraded three stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.00096% | None | 100% | None | 100% | 0.0000% | 2,614,543 | 3.5 |
| 2.1 | Vehicle incident on causeway | Failure of operational controls or mechanical failure causing vehicle to stray off road | Hydrocarbons (fuel, hydraulic/engine oil), sediments (ore) | 5.4% | Upgraded causeway berm | N/A | None | 100% | None | 100% | None | 100% | N/A | N/A | N/A |
| 2.2 | Vehicle incident on causeway - sewage tanker | Failure of operational controls or mechanical failure causing sewage tanker to stray off road | Pathogens (sewage tanker contents), hydrocarbons (fuel, hydraulic/engine oil) | 0.000036% | Upgraded causeway berm | N/A | None | 100% | None | 100% | None | 100% | N/A | N/A | N/A |
| 3.1 | Vehicle incident upslope of causeway | Mechanical failure causing discharge | As per 1.1 | 3038% | Spill response | 100% | Upgraded upslope sump overflowing to upgraded 3 stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.00096% | None | 100% | None | 100% | 0.0% | 3,433 | 21 |
| 3.2 | Vehicle incident upslope of causeway | Mechanical failure causing vehicle fire | As per 1.2 | 57% | Spill response | 100% | Upgraded upslope sump overflowing to upgraded 3 stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.00096% | None | 100% | None | 100% | 0.001% | 183,018 | 21 |
| 3.3 | Vehicle incident upslope of causeway | Mechanical failure causing vehicle fire & tyre fire | As per 1.3 | 13% | Spill response | 100% | Upgraded upslope sump overflowing to upgraded 3 stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.00096% | None | 100% | None | 100% | 0.000% | 778,800 | 21 |
| 4.1 | Major storm event on causeway | Sediment and residual contaminant runoff from causeway (outside of vehicle incidents) | Sediment / hydrocarbons (residual) / PFAS (residual) | 100% | Sealed pavement reduces sediment load into sumps | 100% | Upgraded three stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.05000% | None | 100% | None | 100% | 0.05% | 2,000 | 10 |
| 4.2 | Major storm event upslope of causeway | Sediment and residual contaminant runoff from causeway (outside of vehicle incidents) | Sediment / hydrocarbons (residual) / PFAS (residual) | 100% | Upgraded three stage sump + pumping infrastructure (~0.05% AEP capacity) | 0.05000% | None | 100% | None | 100% | None | 100% | 0.05% | 2,000 | 60 |

BLUE CELLS REPRESENT THE CHANGE IN LIKELIHOOD DUE TO CHANGE IN CAUSEWAY OPERATIONS

# Table of Contents

## Policies and Principles

WA Mining Operations has adopted the Corporate Environment, Health and Safety Policy as its own. The Environment, Health and Safety Policy (MIN) represents the values that WA Mining Operations use to guide operations to achieve the identified EHS objectives.

## EHS Policy Implementation

### *Standard*

Line management, beginning with the CEO, will communicate Alcoa's EHS Policy and Principles to all employees and to others involved in or affected by Alcoa operations.

- In accordance with Alcoa's Operating Plan requirements, each business unit is required to develop an annual written plan describing environmental, health and safety goals and objectives that will assist the business unit in achieving the letter and spirit of Alcoa's EHS Value, Policy and Principles. (The plan, however, should not be limited to an annual basis. If a situation arises or is identified during the year that requires immediate attention, a corrective action plan and timetable should be developed and implemented immediately.) The annual plan should address issues related to EHS audit findings and compliance, including issues of potential non-compliance with Alcoa's internal standards and relevant laws and regulations.
- It should include ambitious annual environmental, health and safety goals and objectives with the ultimate goal of zero incidents. The plan should be linked to an EHS management system. It will be reviewed as part of the regular operating plan review.

### *Accountabilities*

The Business Unit President, or individual who has been designated by the Business Unit President, is responsible for developing the EHS annual written plan in accordance with Operating Plan requirements.

Contract managers will require any parties with whom Alcoa has a contract for services to conduct themselves in accordance with Alcoa's EHS Policy and Principles when performing work for Alcoa.

# Planning

## Business Planning Process

Business plans are established at three levels within the Alcoa operations in Western Australia. These plans are based on the six key requirement areas of environment, people, safety, cost, quality, and production. Planning is carried out in accordance with the “Corporate Planning for Improvement Process”.

The Business Planning Process identifies the objectives and targets and associated enablers for each of the three levels of the organisation.

The development of the environmental component of business plans at all three levels is described in Environmental Planning (WAO).

### *Environmental Improvement Plan*

An EIP is an agreement between a company, the community and the environmental regulator. The EIP forms part of the WA Mining Group’s operational plan. It is designed to set clear targets for improvement and identifies the actions and initiatives that will be implemented to achieve the targets. The current Environmental Improvement Plan can be found at http://www.alcoa.com/australia/en/pdf/EIP_Mining_2014_2018.pdf.

## Environmental Aspects

### *Identification and Ranking of Environmental Aspects*

The environmental aspects and impacts of an operational area are determined in accordance with Identify and Evaluate Environmental Aspects and Impacts (WAO). Aspects are assessed in respect to their environmental impact, frequency / likelihood of occurrence, legislative requirements, stakeholder concerns (including community and employees) and financial liability.

### *Significant Aspects*

A list of significant aspects is identified to facilitate identification of priorities. Significant aspects are defined in Identify and Evaluate Environmental Aspects and Impacts (WAO) and are used to determine the activities that require operational controls in place (as a minimum). They are also considered in the development of objectives (non-financial indicators (NFI’s)) and targets, and through the establishment of enablers in the individual department business plans.

Aspects and Impacts for each Department are contained in the EHS risk assessment registers which can be found on the Controlled Document System (CDS).

### *Review of Aspects*

EHS risk assessment registers are reviewed biennially as a minimum, in accordance with Identify and Evaluate Environmental Aspects and Impacts (WAO).

The registers are also updated as required due to introduced control measures, new activities and projects.

### *New Projects*

Environmental issues associated with a project are considered at the design review stage. The ALCPPR170 Project Safety/Health/Environmental Review Process Overview identifies the process for communicating the results of design activity to customers and ensuring conformance with customer expectations, safety standards, environmental standards and related statutory requirements. If any environmental impacts result from these activities, the engineer will notify the Environment Manager for inclusion on the site EHS risk assessment register. Where required, procedures and standard work instructions are developed to address specific environmental aspects associated with the construction phase of the project. The WA Mining Environment Department will submit all Government approvals/submissions for new projects.

The legislative review of the project requirements is supported by ALCFRM405 Statutory Approval Checklist, which provides Engineers with guidelines as to what legislation may apply to their project and measures required to meet the requirements.

## Legal & Other Requirements

The Corporate EHS Policy and Principles require the site to comply with all applicable legislation, corporate and site standards. Legal requirements and commitments are tracked in IHS Permits and Tasks modules.

### *Regulatory Requirements*

The WAO Legal Department has developed an Environmental Legislative Review Manual (legal register) \\Wao_services\Teams\ENVIRONM\Legal\. This details the regulatory obligations of Alcoa's WA operations. It is updated periodically in response to new legislation or from the identification of new impacts at operating sites. Updates are provided to the Environment Department. Refer to Identification and Access to Legal and Other Requirements (WAO) for details.

Access to the register is restricted to the WAO Legal Department, location management teams and environmental teams.

### Monitoring Compliance with Legislation and Standards

An ongoing process of evaluation is in place in to ensure compliance with legislation and other regulatory requirements. See Evaluation of Compliance with Environmental Legislation and Regulations (WAO).

The main legislation relating to Alcoa's WA Mining Operations is summarised below.

### Alumina Refinery Agreement Acts

There are four Acts that relate to the WA Mining Operations. These Acts form the foundation of legislative approval for Alcoa Mining and Refining in WA.

- *Alumina Refinery Agreement Act 1961*
- *Alumina Refinery (Pinjarra) Agreement Act 1969*
- *Alumina Refinery Agreements (Alcoa) Amendment Act 1987*
- *Alumina Refinery (Wagerup) Agreement and Acts Amendment Act 1978*

These Acts approve, ratify and amend an agreement between the State and Alcoa for bauxite mining, production of alumina and for incidental and other purposes.

All Acts are accessible on the State Law Publisher Website at www.slp.wa.gov.au

### Environmental Protection Act & Regulations

This Act and associated Regulations provides for the prevention, control and abatement of environmental pollution, and for the conservation, preservation, protection, enhancement and management of the environment. Environmental Protection Regulations include noise, controlled waste and clearing. The Department of Water and Environment Regulation (DWER) administer the Environmental Protection Act.

### Part IV Approvals

Ministerial Statement 728 (Wagerup III) includes requirements for mining rehabilitation, approvals, reporting, neighbour consultation and mining operation requirements not covered under the State Agreement Acts or Part V approvals.

Procedure 4 of Ministerial Statement 728 includes the Mining Management Plan review requirements of the MMPLG.

### Part V Approvals

Under the Environmental Protection Act 1986 and its supplementary legislation, licences are issued to prescribed premises for discharges to air, water and/or land. WA Mining Operations has two DER licences:

Huntly DWER Licence

Willowdale DWER Licence

Alcoa is required to pay the annual licence fee each year prior to the anniversary of the licence expiry date. Principal aspects of the licence include prescribed conditions which relate to:

- General operational conditions of the Mining Operational areas;
- Waste water treatment and discharge;
- Reporting requirements; and
- Emergencies, accidents or malfunction management and reporting.

The licence contains specific requirements with respect to the reporting of non-compliance situations. The Environmental Manager (or his/her delegate) may be required to report non-compliance events to the DWER.

Any plant or process modification that increases or changes the nature of mine site emissions, installs or alters equipment, or alters materials or products used or produced, must be approved by the DWER under this Act.

#### Vegetation Clearing

Alcoa is permitted to access State forest for the purposes of its operations in the *Alumina Refinery Agreement Act 1961* (under first Schedule Access to Forests).

In 2004 Alcoa was granted an exemption from the Environmental Protection Native Vegetation Clearing Regulations for all land within Mineral Lease 1SA. The Clearing Exemption titled Environmental Protection (Alcoa - Huntly and Willowdale Mine Sites) Exemption Order 2004 requires Alcoa to obtain approval for the clearing plan and mining plan from the Minister for State Development after taking into account advice from the Minister for the Environment and the MMPLG. To meet the requirements of the Exemption Order, Alcoa submits a Clearing Advice twice per year in March and September. The Clearing Advice must be developed as per Create a Clearing Advice and fully approved by the Minister via the MMPLG prior to clearing commencement.

For small areas of vegetation (<1ha) that were not included in the Clearing Advice, a Local Notice may be developed and submitted to the Department of Biodiversity, Conservation and Attractions (DBCA) for approval as per Request Approval for Local Clearing (MIN). A local notice should only be developed for areas requiring urgent clearing due to increased risk. Reference to this process is included in the five-year mine plan which is signed off by the Department of Jobs, Tourism, Science and Innovation (JTSI).

## Dangerous Goods Act & Regulations

This Act regulates the manufacture, importation and use of explosives and the classification, labelling, storage, transportation and sale of explosives and dangerous goods. The Department of Mines, Industry Regulation and Safety (DMIRS) administers the Dangerous Goods Act and Regulations.

WA mining operations has been issued a Dangerous Goods storage and explosives licence for each mine.

Willowdale Dangerous Goods Site Licence DGS009279

Huntly Dangerous Goods Site Licence DGS008201

Willowdale Explosives Storage Licence ETS002354

Huntly Explosives Storage Licence ETS 002357

Dangerous Goods are management in accordance with Dangerous Goods Management (WAO).

## Rights in Water and Irrigation Act

This Act relates to rights in natural waters. It makes provision for conservation and utilisation of water for industrial irrigation, prevention of water pollution, control of the disposal of waste and industrial effluent and construction, maintenance and management of irrigation works for other purposes.

The WA Mining Operations has been issued licences for surface water abstraction. Licences are also issued for the construction/amendment of wells/bores and any alteration to natural drainage areas.

Water licences enable WA Mining Operations to abstract a specified allocation of water from surface water sources for mining operations use. Water licence allocation limits must not be exceeded, and specific monitoring, reporting and renewal requirements are identified within the licences.

Each Water Licence refers to a Water Licences Operating Strategy. WA Mining Operations has two Water Licences Operating Strategies. These are the Huntly Water Licences Operating Strategy and Samson Dam Water Licence Operating Strategy.

Current water abstraction licences held by Alcoa mining are:

SWL 63409 Banksiadale Dam

SWL 83356 Boronia Dam

SWL 68893 Marrinup Nursery

SWL 153635 Pig Swamp

SWL 61024 Samson Dam

Alcoa also has in place Water Agreements with the Water Corporation to take water from South Dandalup Dam and Samson Dam which are used as public drinking water supplies.

### NPI Reporting

The National Pollutant Inventory (NPI) project is a collaborative initiative of the Australian Commonwealth, state, and Territory Governments. NPI requires the submission of reportable substances annually to the DWER. NPI data will subsequently be made available to the public via the NPI website. The NPI Report is developed as per Describe National Pollutant Inventory Reporting (MIN).

### Environmental Greenhouse and Energy Reporting Act

The National Greenhouse & Energy Reporting (NGER) Act introduced a national framework for the reporting and dissemination of information about the greenhouse gas emissions, greenhouse gas projects, and energy use and production of corporations.

The objectives of the NGER Act, as stated in the legislation, are to:

- Inform government policy formulation and the Australian public;
- Help meet Australia's international reporting obligations;
- Assist Commonwealth, state and territory government programs and activities;
- Avoid the duplication of similar reporting requirements in the states and territories; and,
- Underpin the introduction of an emissions trading scheme.

The NGERs report is developed as per National Greenhouse and Energy Reporting systems Guidance Notes (MIN).

### Department of DBCA Flora and Fauna Licences

The Department of DBCA issues licences relating to flora and fauna removal or collection. These licences are issued to permit individuals to remove or relocate fauna. The licences issued by DBCA do not relate to vegetation clearing. Licences currently held by the WA Mining Operations include:

Reptile Removalist's Licence

Licence to Take Fauna for Scientific Purposes

### Department of DBCA – Disease Risk Area Permits

This permit is required for entry into the Disease Risk Area (DRA). This permit is represented by an authorisation from DBCA stating that access into DRA is controlled. This authorisation is carried on a sticker on each vehicle operating in DRA. The DRA is only valid for activities identified in the Describe Alcoa/DEC Working Arrangements (MIN), all other activities require additional authorisation. Currency of the DRA permit must be maintained by the vehicle driver via the site Environmental Department.

### Water Corporation and DWER – Reservoir Protection Zone Access Permits

This permit is required for access into the Reservoir Protection Zones (RPZ) associated with the drinking water supply dams including: North Dandalup Dam, South Dandalup Dam, Serpentine Dam and Samson Dam. The permit is an authorisation from the Water Corporation and Department of Water to access the RPZ as described in Working Arrangement Between Alcoa World Alumina, Dept of Water and Water Corp – Mining Operations Darling Range (MIN). This authorisation is carried on a sticker on each vehicle operating in RPZ. Currency of the RPZ access permit must be maintained by the vehicle driver via the Site Environmental Department.

### Mine Planning and Approvals

Alcoa is required to submit a detailed Five Year Mine Plan to the Mining and Management Program Liaison Group (MMPLG) each year for Ministerial approval under the Alumina Refinery (Wagerup) Agreement and Acts Amendment Act 1978 Clause 5. The Act requires a ten-year plan to be submitted, however in addition to that Ministerial Statement 728 requires additional information in Commitment 2 of Schedule 2. This additional commitment resulted in the transition to a more detailed five-year mine plan submission with generic planning to ten years. The Five-Year Mine Plan must be approved by the Minister for State Development on advice received from the Minister for Environment and MMPLG. The Five-Year Mine Plan must be developed as per the requirements in Create a Five Year Mine Plan for the Mining and Management Program (MIN) which address the requirements in the Alcoa/DEC Working Arrangements (MIN) and consultation with stakeholders must be as per Carry Out Five Year Mine Plan Consultation (MIN).

### *Application for New and Review of Licences and Approvals*

Licensing and Approvals Review (WAO) describes the process for application and review of licences and approvals.

### *Other Requirements*

The WA Mining Operations are located on the Darling Range in State Forest and drinking water catchments. To ensure that these natural assets are protected, agreements with the governing bodies of these resources have been developed.

### Alcoa/DEC Working Arrangements

The Alcoa/DEC Working Arrangements (MIN) is an agreement between the natural resources governing body (currently DBCA) and Alcoa. The Alcoa/DEC Working

Arrangements (MIN) is a framework for management of Alcoa's mining operations within the Western Australian State Forest.

Aspects covered by the ADWA include:

- Prescriptions for Developing and Mining Bauxite;
- Prescription for Rehabilitation of Bauxite mines;
- Dieback Forest Rehabilitation; and
- Associated Works.

### Rehabilitation Completion Criteria

The Rehabilitation Completion Criteria identifies the standards that post mining rehabilitation must meet to ensure that landforms are stable and safe sustaining. Once completion criteria for mining area are met Alcoa may then apply to hand over ownership of the land to the State Government. The rehabilitation is required to meet the standards of the day. The completion criteria for different periods are:

Completion criteria for early era (pre-1988) Rehabilitation

Completion Criteria for 1988-2004 Rehabilitation

Completion Criteria for 2005-2014 Rehabilitation

Completion Criteria for 2016 Onwards (MIN)

### Alcoa/Water Corporation Working Arrangements

The Working Arrangement Between Alcoa World Alumina, Dept of Water and Water Corp – Mining Operations Darling Range (MIN) is a framework for management of Alcoa's mining operations within the Western Australian public drinking water supply catchments.

### *Corporate Procedures and Internal Standards*

Corporate Procedures and Internal Standards provide a framework for standardisation within the company. A full list of Alcoa EHS standards can be found at Alcoa Corporation EHS Standards.

The procedure Identification and Access to Legal and Other Requirements (WAO) provides details of how changes to the standards and procedures are communicated.

## Voluntary Signatory Agreements

Additional to mandatory requirements, Alcoa of Australia has become a signatory to voluntary agreements. These agreements often require the organisation to provide details on or demonstrate improvements in environmental performance.

The procedure Identification and Access to Legal and Other Requirements (WAO) provides details of how these commitments are updated and communicated.

# Environmental Management Systems

## Environmental Structure & Responsibility

Environmental responsibilities are detailed in Roles and Responsibilities of Environmental Management. The core roles of the WA Mining Environment Department are:

- Manage environmental approvals, permits and licences; and
- Facilitate environmentally sound mining operations.

A full list of EMS references is in Summary of EMS Systems and References (AOA).

### *WA Mining Operations Management*

The WA Mining Management structure can be found at Organisation Charts.

## Training

Environmental training is implemented via:

- Inductions;
- Department and Crew training packages;
- Operational Training; and
- Ongoing training provided by the Environmental Department.

The aims, content, intended audiences and training frequency for inductions and awareness training are outlined in Environmental Training.

The environmental inductions and awareness packages are competency based. Training records are maintained on the Learning Management system (LMS).

Further information on the education material available can be obtained directly from the Environment Department.

### *Inductions*

All new permanent or temporary employees and contractors undergo an induction as per Safe Access Procedure & Matrix (WAO).

### *Legal and Other Requirement Training for Group Leaders, Supervisors and Managers (MIN)*

A Legal and Other Requirements package has been developed for Group Leaders, Supervisors and Managers at WA Mining Operations. The package focuses on the obligations contained in the DWER Licences and other legislative requirements. The package also includes non-legislative commitments (e.g. Working Arrangements). This training is provided face-to-face by the Environment Department on a two-yearly basis.

### *General Environmental Awareness Training (MIN)*

The General Environmental Awareness Training Package (MIN) is required to be completed by all WA Mining Operations Employees and Contractors. The package provides, and overview of the environmental management practices employed at

Mining to ensure environmental obligations are met. The package is provided in person by a member of the Environmental Department.

### *Operational Training*

Employees are trained to be competent at their jobs. Training includes Standard Work Instructions (SWI) and Procedures and highlights aspects of critical importance to environment management at the mines. The process for identifying and delivering operational training to new and existing employees can be obtained from Area Trainers.

### *Ongoing Environmental Training*

Training is provided in response to the significant aspects identified for the site or new systems/initiatives being developed. Ongoing training provided by the Environment Department is determined on an annual basis and is included as required in training schedules/plans.

## Communication

WA Mining Operations is committed to communicating promptly and openly with employees and the community on environmental issues. The Mine Manager and Environmental Manager determine appropriate levels of communication with external parties.

### *Internal Communication*

Updates to WA Mining environmental aspects, management systems and planning objectives are conducted through a series of hierarchical reviews. Once these updates are approved, they are communicated to WA mining personnel as per Internal Environmental Communication (WAO).

Employees may raise environmental concerns or queries through the Environmental Incident Reporting system, to their supervisor or with the Environmental Department.

### *Communication with Stakeholders*

The WA Mining Operations community consultation focusses on addressing concerns with individuals or groups as they arise. Mining Community Consultation (MIN) provides and overview of the process. The transient nature of mining lends itself to an individual consultation process specific to the concerns of the stakeholders. The initial need for a consultative group is identified during the early planning phase to ensure all stakeholder concerns are acknowledged prior to mining commencement.

WA Mining Operations community consultation program objectives are:

- Provide information about Alcoa's mining operations to current and future mine neighbours to assist them to understand the potential impacts of mining and how Alcoa manages them.

- Assist Alcoa to understand the concerns the community may have about Alcoa's mining operations.
- Provide the community with an opportunity to provide feedback about Alcoa's management of the mining operations.
- Provide a framework for resolution of issues that may arise between Alcoa and its neighbours.
- Fulfil MMPLG requirements for community consultation.

The Five year mine plan is created as per Create a Five Year Mine Plan for the Mining and Management Program (MIN) and includes consultation with the community on significant aspects as per Carry Out Five Year Mine Plan Consultation (MIN).

### Public Complaints

Details of the process for managing complaints are described in Process for Handling Complaints and other Community Contacts (MIN). All contact with community member must be recorded in the Community Contact system as per Describe Process for Recording and Community Contact in CCS (MIN).

## Environmental and Health Allegations

From time to time workforce or public members present allegation of incidental effects on the environment or health of individuals that they believe result from the operations. The correct management of these allegations is crucial for Alcoa to maintain good relations with its workforce and external stakeholders. Allegations are managed using the following procedure Investigation of Chemical Related Health and Environmental Concerns (WAO).

## Documentation

Documentation supporting the Environmental Management System includes records management, procedures and standard work instructions. Documentation is controlled to ensure it remains current, accessible and approved by appropriately authorised personnel.

### *Document Control*

All documents relevant to the Environmental Management System are controlled by procedures stored under the Document Management Principles (WAO).

### *Records Management*

Records, which are relevant to the Environmental Management System, are managed as per Describe Environmental Records Management (MIN).

## Report Requirements

Following are a list of key routine environmental reports generated to communicate both internally and externally with key stakeholders.

### External Reports

| Report | Frequency | Report to | RESPONSIBILITY |
|---|---|---|---|
| Alcoa Corporate Environmental Audit/Follow-up | Triennially | Pittsburgh Environmental | Mine Manager |
| Strategic Environmental Metrics | Quarterly | Pittsburgh | Senior Mine Environmental Scientist |
| Environmental Licence Reports | Annual | DWER | Senior Mine Environmental Scientist |
| Annual/Triennial Environmental Review | Annual and Triennially | DMIRS, DWER, DBCA DWER, JTSI | Environment Manager |
| Rehabilitation Completion Criteria Report | Annual | DBCA | Environment Manager |
| Sustainability Report | Annual | Public | Environment Manager |
| Potable Drinking Water Report | Quarterly/Annually | DoH | Senior Mine Environmental Scientist |
| Self-Certification Review | 6 Monthly | Pittsburgh Environmental | Environment Manager |
| Quarterly Compliance Reports | Quarterly | Quarterly update to Board | Environment Manager |
| Mine Monthly Environmental Report | Monthly | Manager of Mines, Site, Env. Dept | Site MES |
| Environmental Review Committee Reports | Quarterly | WA Environmental Review Committee (ERC) | Mine Manger |
| Rehabilitation Review | Annual | Managers, Supervisors and Rehab Crews | Site MES |
| Environmental Incident Notifications and Reports | As Required | Various Government Departments | Environment Manager |
| NPI Reports | Annual | DWER (Emissions Inventories Section) | Senior Mine Environmental Scientist |
| National Greenhouse Emission Report | Annual | DCC | Senior Mine Environmental Scientist |

## Auditing

Auditing Process (WAO) details the management systems auditing process. Audit processes vary slightly at each site, for mining the detailed audit process is described in Describe Environmental Auditing (MIN).

### Internal Auditing System

The Internal Auditing System assesses conformance of the Environmental Management System (EMS) with ISO 14001 requirements and ensures appropriate implementation and ongoing maintenance of the EMS. Manage Internal Environmental Auditing (MIN) describes the internal auditing process.

### Alcoa Self-Assessment Tool

The Alcoa Self-Assessment Tool (ASAT) has been designed to provide guidance on the minimum corporate expectations of environmental performance and management for all of Alcoa's sites. The frequency with which the protocols of the ASAT are audited is determined by a risk rating process.

The detailed ASAT protocols are located at the Alcoa "Audit & Self-Assessment Tool (ASAT)" community portal.

### Alcoa Corporate Environmental Audits

Approximately every three years a corporate integrated audit is scheduled. This audit covers Environmental, Safety, Health, Accounting, Commercial and Information Systems. In response to findings arising out of the audits, corrective action plans are developed and implemented. Progress of the actions is tracked in IHS Audit.

Protocols covered by the environmental section during these corporate audits include water/wastewater, air pollution control, chemical release, toxic substances, land management, hazardous/industrial waste, health and safety management systems. Each protocol addresses management systems and compliance with legislation and corporate standards.

### Contractors Audits

Contractors are required to conduct themselves in accordance with the Alcoa Environment, Health and Safety Policy (MIN) and the procedures described in the Alcoa Contractors Manual.

Prospective major contractors are audited across a range of areas including environment, health, safety, and quality. Results of these audits are considered when identifying 'preferred contractors' and developing long-term partnership agreements.

### Waste Contractor Audits

All contractors responsible for the management and disposal of wastes generated by the mining operations are required to be audited in accordance with Assessment of Waste Disposal Contractors (WAO). This audit task is undertaken as a cooperative activity between the three WA refineries and WA mining operations.

Waste disposal contractors are audited to ensure that the waste is treated and disposed of in an environmentally responsible manner. A representative from the Environmental Department or an appropriately experienced consultant conducts the audits at the contractor's site, using the Waste Management and Transport Contractor Inspection Form (AOA). Records of inspection and the list of approved contractors are maintained on the LAN at Contractor Waste Inspections.

Waste removal contractors (not recyclers) must be licensed under the *Health (Liquid Waste) Regulations 1993* and must comply with the *Environmental Protection (Controlled Waste) Regulations 2004*.

### *Property Transfer*

Prior to the transfer of real property, an environmental assessment must be carried out in accordance with the EHS Assessments of Property Transactions (AOA). The assessment may be conducted by representatives from the site Environmental / Safety / Industrial Hygiene Departments, or an approved consultant in accordance with the requirements of the standard, and in conjunction with BU President-approved arrangements for some WA residential property assessments.

## Environmental Incident Reporting

The Alcoa Incident Management system is a computer-based reporting system used to summarise details and corrective / preventative actions relating to:

- events or situations which have impacted on the environment;
- events demonstrating potential to impact the environment;
- events that may have an environmental influence, e.g. dust emissions, odour emissions, liquor spills;
- Failure of pollution control equipment.

The Alcoa Incident Management system is accessible to all employees and contractors with Alcoa LAN access.

Incidents are reported as per Environmental Incident Reporting Guidelines (MIN).

Incidents raised in the EI reporting system are reviewed and categorised at least weekly by the site environment department to ensure categorisation is consistent and correct.

The environmental incident categorisation and reporting process is detailed in Environmental Incidents – Communicating and Categorising (WAO).

## Emergency Response

The Introduction to the Emergency Response Plan (MIN) provides a detailed description of the responsibilities and responses required in the event of an emergency on a WA Mining Operations site. Environmental emergencies covered within the document include chemical handling, fires and natural events.

# ENVIRONMENTAL MANAGEMENT AND MONITORING PROGRAMS

## Chemical Release

### *Spill Management*

Alcoa Western Australian Operations has a Loss of Containment (Spills) Response, Notification and Reporting (WAO) procedure that must be followed whilst on Alcoa Operations. Hydrocarbons present the greatest environmental risk at WA Mining Operations.

Personnel handling chemicals or who are involved in environmental protection and product safety activities at this facility receive training in the following as required by their assigned jobs:

- the safe handling of oils, hazardous substances/wastes;
- spill release prevention and response; and
- emergency action or emergency response.

This training covers site specific information including implementation of the spill control plan.

#### Willowdale - Samson Dam Causeway

For spills that occur within the vicinity of the Samson Dam causeway or have the potential to impact Samson Dam should be treated as per Spill Recovery at Samson Dam Causeway (WDL).

#### Huntly - Serpentine Dam Causeway

Serpentine Dam is part of the Integrated Water Scheme supplying Perth Metropolitan Area and surrounds. Spills that occur within the vicinity of the Serpentine Dam crossing or have the potential to impact Serpentine Dam should be treated as per Perform Spill Recovery at Serpentine Crossing (HUN).

### *Dangerous Goods*

The Department of Mines, Industry Regulation and Safety (DMIRS) administer dangerous goods in Western Australia according to the applicable acts and regulations. Both Huntly and Willowdale Mine Sites are licensed to store and process non-explosive dangerous goods materials under Huntly Dangerous Good Licence and Willowdale Dangerous Goods Licence. Dangerous Goods Management (WAO) details the system by which licence and regulatory requirements are achieved.

Huntly and Willowdale mines are licensed to store and handle explosives under Huntly Dangerous Goods Licence (Explosives) and Willowdale Dangerous Goods Licence (Explosives). Explosives are managed as per the Explosives Management Plan (MIN).

### *Underground Storage Tanks (USTs)*

All underground storage tanks have been removed from WA Mining Operations. The Alcoa mandated standard on USTs prohibits the installation of any new below ground facilities. See EHS STD 60_24 Use of Underground Storage Tanks.

All underground lines carrying hazardous materials are double sleeved lines with inspection points.

## Waste Management

Waste management policy, procedures, operational control, auditing and inspections, standards and statutory requirements are documented in Waste Management Manual (WAO).

All WA Mining Operations Waste is sent offsite for treatment or disposal. Waste to be landfilled is sent to an appropriate landfill facility, with Wagerup and Pinjarra Refinery landfills the preferred option. The Consolidated Waste Guidelines (WAO) details the disposal requirements for each type of waste. For disposal of waste not listed in the Consolidate Waste Handling guidelines please contact the site Environment Department.

### *Waste Minimisation*

Waste minimisation is driven by the WA Waste team, which consists of members from all WA sites. Details of waste materials are recorded in a comprehensive database located at Waste database.

## Catchment Protection

Areas of WA Mining Operations are located within Drinking Water catchments. At Huntly, the mining areas intercept Serpentine Dam, North Dandalup and South Dandalup drinking water catchments and at Willowdale the Mining areas intercept the Samson Dam drinking water catchment. The facilitate access for mining and ensure protection of these resources the Working Arrangement Between Alcoa World Alumina, Dept of Water and Water Corp – Mining Operations Darling Range (MIN) (Water Working Arrangements) were developed. The Water Working Arrangements detail the catchment protection requirements for WA Mining Operations for all stages of development, mining and rehabilitation.

### *Access to Bauxite in the Intermediate Rainfall Zone*

The eastern part of Alcoa's bauxite mining lease lies within the intermediate rainfall zone (IRZ) (900-1100 mm per annum) and low rainfall zone (LRZ) (700-900 mm per annum), where clearing for agriculture has led to salinization of land and water resources. A commitment was made by Alcoa in the revised 1978 Environmental Review and Management Program (ERMP) for the Wagerup Alumina Project that “mining will not take place in the eastern, lower rainfall portion of Alcoa’s lease until research shows that operations can be conducted without significantly increasing the salinity of water resources". A detailed research program commenced in 1979 and was reviewed in 2010.

Results have shown an almost complete absence of observable response to mining with for streamflow and stream salinity. An increase in groundwater levels was observed in proximity to mine pits indicating increased recharge. There was no indication of groundwater rising in the valley floor sufficient to discharge to the stream. The results implied that under continuing dry conditions and ongoing declines in overall groundwater levels in the IRZ there is little or no potential for a significant streamflow or stream salinity response. These findings were endorsed by the BHC and the MMPLG.

Prior to development of mining in the IRZ or LRZ, the MMPLG must be consulted.

## Water Management and Monitoring

### *Stormwater Management*

Stormwater at Huntly and Willowdale mine sites is not permitted to be discharged in an uncontrolled manner into the forest. Stormwater runoff that may contain traces of hydrocarbons must be treated via a waste water treatment systems and meet DWER licence requirements prior to discharge or reuse. Details for the management of stormwater potential hydrocarbon contamination are in Describe McCoy Stormwater and Wastewater Management Overview, Describe Myara Stormwater and Wastewater Management Overview and Waste Water and Storm Water Management Overview (WDL). Stormwater runoff from pits, hauls roads and other areas that are considered to have a low risk of hydrocarbon contamination may be discharged in a controlled manner that prevents sediment discharge to the forest and/or surface water.

### Serpentine and Samson Dam Sumps

Alcoa has haul road crossings on Serpentine and Samson Dams. To prevent contaminated or turbid runoff into the drinking water supply, sumps have been constructed to capture all runoff. Water may be released from the sumps into the respective dam to ensure capacity is available for additional stormwater capture as per Release of Water from Samson Causeway Sumps (WDL) and Perform Sampling and Release of Serpentine Crossing Sump Water.

### Waste Water

WA Mining has four waste water treatment facilities, these are located at Huntly Mine (Myara & McCoy) and Willowdale Mine (Orion and Arundel). Most water from Myara, McCoy and Orion is reused on the respective mine sites, however treated wastewater from Arundel is currently discharged into the forest. Wastewater discharged must meet the limits specified in Huntly DWER Licence (HUN) for McCoy and Myara, and Willowdale DWER Licence for Arundel and Orion. The waste water facilities are managed as per Waste Water and Storm Water Management (WDL), Describe Myara Waste Water and Stormwater Management (HUN) and Describe McCoy Stormwater and Wastewater Management (HUN).

### Surface Water Drainage Management

Alcoa is required by the Alcoa/DEC Working Arrangements (MIN) and Working Arrangement Between Alcoa World Alumina, Dept of Water and Water Corp – Mining Operations Darling Range (MIN) to prevent uncontrolled surface water runoff from its operations to the surrounding forest and/or surface water.

All surface water captured within the mining operations must be retained on site to allow sediment settling prior to release from the mine. Describe Responsibilities for Mine Drainage Control (MIN) details the drainage control requirements for all stages of mining.

### Drainage Protection Planning

The highest risk period for drainage failures is after removal of topsoil and prior to breaking cap. Drainage protection must be planned prior to clearing (usually during the development of the Clearing Advice) as per Install Drainage Protections Slots (MIN).

Alcoa is required under section 4.2.2 of the Working Arrangement Between Alcoa World Alumina, Dept of Water and Water Corp – Mining Operations Darling Range (MIN) to develop a Water Resource Sensitive Zone Management Plan as part of the April Clearing Advice as per Develop Water Resource Sensitive Zone Plan (MIN).

### Turbidity Monitoring

In section 4.2.5 of the Working Arrangement Between Alcoa World Alumina, Dept of Water and Water Corp – Mining Operations Darling Range (MIN) Alcoa has committed to installing and operating turbidity monitors on streams that feed into public drinking water supply dams. Installation, maintenance and calibration of the turbidity monitors is detailed in Maintain and Review the Turbidity Monitoring Network (MIN).

### *Sewage Treatment*

Domestic waste water at the mines is treated through a biological aeration treatment unit manufactured by BioMAX. An EHS risk assessment and register of all BioMAX treatment systems is available at U:\ENVIRO\11_Operational_Control\Water\Sewage_Water. The BioMax systems are managed as per Operate BioMAX Aeration Treatment Units.

Septic systems for processing sewage are managed as per Inspect and Service Septic Systems.

Portable toilet systems are used in the field only where appropriate and are managed as per Describe Use of Portable Toilets.

### *Water Supply*

The WA Mining Operations uses the majority of water for:

- Dust suppression;
- Dieback washdown;
- Conveyor belt washdown;
- Vehicle workshops and vehicle cleaning; and,

- Potable water.

The water supplies to mining consist of licenced surface water sources supplemented with treated wastewater from vehicle wash downs, stormwater runoff and maintenance workshops.

#### Licensed Water Abstraction

Alcoa holds several water licences for Huntly and Willowdale Mine Sites. The details of these licences are identified in Rights in Water and Irrigation Act.

#### Water Agreements

Abstraction of water from South Dandalup Dam and Samson Dam is authorised in individual agreements with the Water Corporation. The agreements are managed by the WA Mining Controller (Finance Department).

### *Potable Water*

Potable water supplies are sourced from licensed surface water supplies. Potable water is managed as per the WA Mining Drinking water Quality Management Plan.

Potable water quality is monitored for identification of possible biological or chemical contamination. The procedures for collection and analysis of potable water samples are detailed in the Potable Water Monitoring Manual (WAO).

### *Water Conservation*

Water use efficiency programs implemented and investigated at mining include:

- Wastewater recycling at McCoy, Myara and Orion.
- Water conservation training for all crews.
- Modified water carts and operating procedures for efficient watering of haul roads.
- Effective mine planning to reduce the requirement for dust control.
- Pumping and re-using water from roadside sumps.

The WA Mining Operations continually review water management to improve efficiency.

### *Groundwater*

Alcoa has a long-term research project within the IRZ as described in Access to Bauxite in the Intermediate Rainfall Zone.

WA Mining operations have no additional groundwater monitoring programs associated with legislation, licences or approvals. Additional groundwater monitoring may be required if:

- Groundwater quality or quantity has been identified as potentially at risk due to mining activities, or
- Potential exists for mining to impact offsite/private groundwater supply quantity or quality.

All groundwater monitoring proposals must be reviewed and approved by the WA Mining Environmental Scientist (Hydrologist).

# Air Emissions

## *Smoke Pollution*

Wood waste burning is managed as per Guidelines for Burning Wood Waste from Clearing Operations. On each day when clearing debris is to be burnt, Alcoa notifies the DBCA duty officer that burning will be occurring. DBCA may indicate that burning is not advised due to smoke pollution concerns.

Fuel reduction burns in forest around the mines are managed by DBCA as per Mine Site Protection Burning Overview.

## *Dust Monitoring*

An ambient monitoring program is established to identify and quantify fugitive dust emissions from operating areas. Ambient Air Monitoring Manual (WAO) details of sampler location and frequency of sampling. Dust monitors are implemented when mining operations moved in proximity to private residences. Dust monitoring has been implemented for the Myara mining region due to the location of the Yamba community to the immediate west of operations. The monitor at Yamba is a BAM1020.

## *Ozone Depleting Substances*

The use of Ozone Depleting Substances (ODSs) is regulated in Western Australia by the Environmental Protection (Ozone Protection) Policy 2000 (EPP) as well as Ozone Protection and Synthetic Greenhouse Gas Management Act 1989. All new products on site are reviewed prior to approval for use as per Hazardous Materials Management (WAO), this includes avoidance of products containing OSDs.

### Refrigerants - Motor Vehicles

Mine sites Mobile Maintenance Departments are licensed under the Ozone and Synthetic Gas Management Regulations 1995 and hold current Refrigerant Trading Authorisation certificate. All fitters who handle refrigerants are accredited with a Refrigerant Handling Licence and are trained in record keeping.

# Hazardous Materials Management

Hazards material are managed as per Hazardous Materials Management (WAO). Materials that are planned for use in the environment and not managed as per the standard spill clean-up process (e.g. herbicides, fertilizers etc.) must also be approved by the Water Corporation and DWER as per Describe Water Corporation Chemical Approval Process (MIN).

Hazardous waste must be managed as per Waste Management Manual (WAO).

## *Asbestos*

The WA Operations Policy Statement commits to the removal as soon as practicable, of all sources of asbestos fibre that have the potential to exceed existing standards. No new products containing asbestos are permitted to be utilised on WA Mining Operations sites.

Asbestos is managed as per the Asbestos Management Programme (WAO). An Asbestos Register for WA Mining operations identifies all know locations of asbestos.

### *Synthetic Mineral Fibre*

Synthetic mineral fibre is a generic term to describe amorphous (non-crystalline) fibrous materials including fibreglass, rockwool, slagwool and ceramic fibre. The main sources of synthetic mineral fibre on the mines are fibreglass and thermal/acoustic insulation. These materials are removed and disposed as per Synthetic Mineral Fibre Management (WAO).

### *Polychlorinated Biphenyls (PCBs)*

Polychlorinated Biphenyls (PCBs) are a group of synthetic chlorinated organic compounds widely used in the electrical industry from the 1940s through to the 1980s. Their use was discontinued in Australia in the early 1980s for environmental and health reasons.

Huntly and Willowdale mines have no known PCBs on site.

## Land Management

### *Mine Rehabilitation*

Alcoa has developed EHS Standard 60.3 (via generic logon → Environment) Bauxite mine rehabilitation. The standard identifies Alcoa's mine rehabilitation objects, which in summary is to establish a self-sustaining jarrah forest ecosystem, planned to enhance or maintain conservation, timber, water, recreation and other forest values. The Rehabilitation process consists of several aspects that must be successfully implemented to achieve the target condition.

Rehabilitation is the reestablishment of self-sustaining locally native vegetation and habitat post mining as described in Describe Rehabilitation (MIN).

Rehabilitation must achieve standards before it may be handed back to the State. The conditions for hand back are detailed in the Rehabilitation Completion Criteria. Alcoa is required to meet the completion criteria applicable at the time of rehabilitation:

Completion Criteria Early Era (pre1988) Rehabilitation

Completion Criteria for 1988-2004

Completion Criteria for 2005 – 2015

Completion Criteria 2016 onwards

Alcoa is required to re-establish forest tracks under the Alcoa/DEC Working Arrangements where mining has removed previous access as per Build, Re-establish and Upgrade Forest Tracks (MIN).

### Recording/Reporting

The site MES and mine planner records the location and timing of all soil removal, landscaping, soil return, ripping and seeding. These records are collated each month by the mine's surveyors, transferred to maps and entered into ArcGIS. Details of each operation, and the location and date that it occurred can be recalled and used to explain differences in rehabilitation species numbers.

### Rehabilitation Monitoring

Rehabilitated areas are monitored in March each year, nine months after revegetation, to check that the number of established plants meets the Completion Criteria targets, and to identify any areas which need remedial treatment to control weeds or repair erosion damage.

Further monitoring is undertaken at 15 months, to check that species richness targets are being met, to locate and identify areas with weed outbreaks or erosion scours. This allows assessment for any remedial treatments if required and also enables refinements to be made to the model for calculating the Predicted Species Index. Monitoring is carried out as per Carry Out 9 Month Botanical Monitoring (MIN) and 15 Month Botanical Diversity Monitoring in Rehabilitated Areas (MIN).

## *Dieback Management*

*Phytophthora cinnamomi* (Pc) is a root pathogenic fungi which causes a disease known as "dieback" in susceptible plants. Pc can be transferred from infested areas to healthy areas in soil, plant material and water.

The main risks associated with dieback spread are:

- Water movement (drainage)
- Vehicular movement
- Animal and human access.

Dieback must be managed in accordance with the Alcoa/DEC Working Arrangements (MIN). Describe Alcoa's Dieback Management System (MIN) details Alcoa dieback management processes.

### Forest Access

Access to the mining region via forest tracks is managed as per Review and Update Mine Access Plan (MIN).

### Dieback Mapping and Field Identification

Dieback interpreters accredited by DBCA and funded by Alcoa map the occurrence of dieback symptoms in forest areas in which mining is planned as per the Alcoa/DEC Working Arrangements (MIN). After logging or burning, dieback symptoms may not be expressed for up to three years, so some areas cannot be interpreted. Boundaries are marked in the field between areas classified as "dieback-free", "uninterpretable", and "dieback".

Dieback boundaries must but managed and marked as per Describe Alcoa's Dieback Management System (MIN) for the entirety of operations including exploration/drilling to final rehabilitation.

## *Forest Clearing*

Alcoa is permitted to clear vegetation for mining and associated activities as per Vegetation Clearing. Initial forest clearing is managed as per Clearing Guidelines (MIN).

Forest clearing operations have the potential to damage soils, and the surrounding forest by erosion and disease spread.

### Stream Zones and Rock Outcrops

Alcoa is required under Ministerial Statement 728, Commitment 3 of Schedule 2 to minimise disturbance to biological diverse area fringing major rock outcrops and stream zones, including the application of appropriate buffers to these areas.

Stream zones need to be crossed by haul roads and conveyors. Under Commitment 3 Alcoa is required construct stream crossings in a manner which facilitates removal and rehabilitation. Design and Construct Haul Roads (MIN) details how stream crossings are designed and constructed.

### Clearing Advice and Clearing Schedules

Alcoa submits a Clearing Advice in April and September of each year as per Create a Clearing Advice (MIN). The process for Clearing Advice approval is detailed in the Alcoa/DEC Working Arrangements (MIN).

For vegetation clearing not included in the Clearing Advice and less than 1 hectare a Local Clearing Advice may be submitted directly to DBCA as per Request Approval for Local Clearing (MIN).

Alcoa is required under the Alcoa/DEC Working Arrangements (MIN) to submit a Clearing Schedule to DBCA in July of each year that is required to be updated every 6 months. The Clearing Schedule includes proposed clearing activities for the ensuing 12 months which facilitates dieback and timber salvage management. A Clearing Schedule must be developed as per Create a Clearing Schedule (MIN).

The Mining Management Plan, Clearing Advice and Clearing Schedule processes are required to meet the conditions of the Alumina Refinery Agreement Act 1961 (Access to Forests).

### Area Cleared

Alcoa is required to pay the State compensation for forest destroyed by or in connection with mining operations in the Alumina Refinery Agreement Act 1961 (Access to Forests). This payment is to be made in January for the area of forest proposed to be destroyed in that year and any changes to the planned cleared area will be compensated for in the following January. Annual Clearing Reconciliation Audit (MIN) details the process for clearing reconciliation.

### Timber Salvage

The Alumina Refinery Agreement Act 1961 (Access to Forests) requires that Alcoa facilitate the removal of merchantable timber by the State (via forest Products Commission) prior to mining. A Timber salvage schedule must be developed as per Create a Timber Salvage Schedule (MIN).

### Disposal of Clearing Debris

Timber debris remaining after timber salvage will be utilised or disposed of in one of the following ways:

- Timber debris and logs may be stored along pit edges to be reclaimed after mining and used to provide habitat for fauna in rehabilitated areas as per Fauna Habitats Description (MIN). Alcoa are required to include fauna habitats as part of rehabilitation. Details are included in the relevant Completion Criteria.
- Non-merchantable trees and other vegetation are burnt as per Guidelines for Burning Wood Waste from Clearing Operations (MIN).

## *Flora and Fauna Management*

Alcoa is required to complete flora and fauna surveys and support activities contributing to the conservation of rare, endangered and priority species in Commitment 4 of Ministerial Statement 728.

Pre mining flora and fauna surveys are managed as per Survey Pre-Mining Vegetation and Flora (MIN) and Describe Fauna Monitoring Program (MIN).

The surveys map the site vegetation types, identify declared rare or priority flora, and identify fauna populations and distribution with a focus on rare or endangered species. Mine plans will be modified where appropriate, or management programs will be developed, to minimise the risk to site vegetation types or fauna habitat which are poorly represented elsewhere in the forest, and to protect rare flora and fauna.

Threatened Fauna Species Management (MIN) describes the process for managing Threatened fauna that could be present in Alcoa's mining areas. This includes species listed as threatened under the Environment Protection and Biodiversity Conservation Act (1999): Baudin's black cockatoo, Carnaby's black cockatoo, forest red-tailed black cockatoo, quokka, chuditch, and noisy scrub bird; and for species listed for special protection under the WA Conservation Act (195): western carpet python and peregrine falcon.

### *Reserves*

Alcoa is required under Clause 4(4) of the Alumina Refinery Agreement Act 1961 that it will not conduct mining operations in the conservation area (Dale, Serpentine, Monadnock and Lane-Poole), however may cross the conservations area to access or transport bauxite which would otherwise be inaccessible upon consultation with the regulating authority (DBCA).

The Regional Forest Agreement for the South-West Forest Region of Western Australia (RFA) is a 20-year plan with three main objectives:

- Protect environmental values in a world class system of national parks and other reserves, based on nationally agreed criteria;
- Encourage job creation and growth in forest-based industries, including wood products, tourism and minerals; and
- Manage all native forests in a sustainable way.

Included in the RFA is the identification of Informal and Formal Comprehensive Adequate Representative (CAR) Reserves. The RFA (section 85) states that "Western Australia will ensure that proposed mining and related infrastructure in the CAR Reserve system will be referred for environmental impact assessment procedures under the Environment Protection Act (1986)." Alcoa may apply for such access as per Request Approval for Informal CAR Reserves (MIN).

### *Visual Amenity*

Alcoa is required to consider the aesthetic impacts as part of the mine planning process by Ministerial Statement 728. Procedure 4 states that the MMPLG shall consider aesthetic impacts when reviewing mining plans. Condition 15.2 of Part C requires Alcoa to consult with neighbours whose visual amenity may be affected by operations.

Visual amenity concerns will be address on an individual basis.

### *Dieback Forest Rehabilitation*

Alcoa is required under Commitment 9 in the Ministerial Statement 728 Schedule 2, to rehabilitated dieback affected areas adjacent to operating areas, in accordance with procedures agreed with State Agencies (Forest Enhancement Agreement). The Forest Enhancement Agreement between Alcoa and DBCA was established in 1993 and has been periodically updated. Dieback Forest Rehabilitation, Associated Works and CAFE Overview (MIN).

### *Fuel Reduction Burning*

Fuel reduction burns are managed by DBCA in unmined forest around mine facilities and in rehabilitated areas. Alcoa provides funding to compensate DBCA for focussing prescribed burning activities around its mining operations.

### *Wildfires*

Alcoa has committed to assist managing wild fires in section 5.4 Interagency Agreement for Fire Control of the Alcoa/DEC Working Arrangements (MIN). Alcoa's attendance at a forest fire is managed as per Emergency Response Crew Attending a Fire (MIN).

### *Heritage Management*

#### Aboriginal Heritage

Alcoa is required under Section 15 of the Aboriginal Heritage Act 1972 to report any known aboriginal heritage sites to the Department of Planning, Lands and Heritage (DPLH). An identified aboriginal heritage site may be disturbed approval received under Section 18 of the Aboriginal Heritage Act 1972.

Alcoa undertakes pre-mining Aboriginal heritage surveys of proposed mining areas. The aboriginal heritage assessment process is managed as per Aboriginal Heritage Assessment Overview (MIN).

#### European Heritage

Alcoa is required to preserve listed European heritage sites in the Heritage of Western Australia Act (1990). This process is managed as per European Heritage Assessment Overview (MIN).

## Noise Management

Alcoa is required to comply with the Environmental Protection (Noise) Regulations 1997 for operational and blast noise. In addition to the regulations, Alcoa is required under condition 15.2 of Part C of Ministerial Statement 728 to consult with all neighbours within the 35dB line. Noise is managed as per Noise Management Plan (MIN).

## Glossary of Acronyms

| | |
|---|---|
| **ASAT** | Alcoa Self-Assessment Tool. |
| **CAR** | Comprehensive Adequate and representative Reserve |
| **CEO** | Chief Executive Officer |
| **DBCA** | Department of Biodiversity, Conservation and Attractions |
| **DMIRS** | Department of Mines, Industry Regulation and Safety |
| **DWER** | Department of Water and Environment Regulation |
| **DRA** | Disease Risk Area |
| **EHS** | Environmental, Health and Safety |
| **EIP** | Environmental Improvement Plan |
| **EMS** | Environmental Management System |
| **FPC** | Forest Products Commission |
| **HUN** | Huntly Mine |

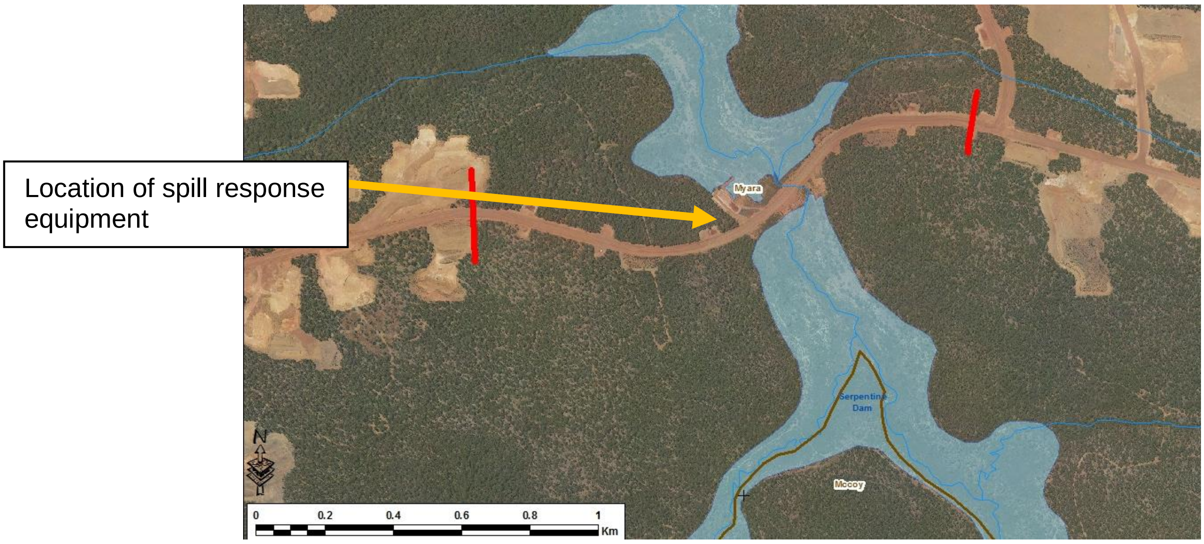
| | |
|---|---|
| **IRZ** | Intermediate rainfall Zone |
| **MES** | Mine Environmental Scientist |
| **MIN** | Mining |
| **MMPLG** | Mining and Management Program Liaison Group |
| **NPI** | National Pollution Inventory |
| **PCB**s | Polychlorinated Biphenyls |
| **RFA** | Regional Forest Agreement |
| **WAO** | Western Australian Operations |
| **WDL** | Willowdale Mine |
| **WC** | Water Corporation |

# Spill Recovery at Serpentine Crossing (HUN)

***SEE PAGE 3 FOR PROCEDURE ON SPILL RECOVERY***

## Background

The Serpentine Causeway is located on Downes Road within the Huntly Mining Region - Myara. The Causeway bridges a tributary of the Serpentine Dam, a drinking water supply dam for the Perth metropolitan area. It is critical that the water quality is not affected by Alcoa's operations, in particular chemicals (hydrocarbons, fire suppressant, coolants etc), sediment or turbid water.




In the event of a chemical spill within the Causeway catchment (see above), Operational use of the Causeway must cease, and the area affected by the spill remediated immediately and disposed at a location approved by the Environment Department. Spill Response Kits located at the Causeway are available for immediate spill response. *Note: the absorbent materials are only effective on hydrocarbons (diesel, oil etc)*.

**SAFETY**

***Care should be taken when handling heavily contaminated hydrocarbon materials to prevent excessive inhalation. Smoking in the area is prohibited.***

### *What this Document Covers*

- Responsibilities and Escalation Process
- How to use spill response products
- How to operate the self-priming pump and oil skimmer
- How to dismantle the equipment and remove contaminated water from site

# Spill Recovery at Serpentine Crossing (HUN)

## *Responsibilities*

*The first person on the scene must:*

- Assess situation and communicate details of spill to Dispatch.
- Immediately cease operations, stop the source, and contain the spill if safe to do so.

*Dispatch*

- Assess situation and notify either Mine Control or Production Supervisor, as specified in escalation process for spills (below flow diagram).

*Mine Control / Emergency Response Officer (ERO):*

- Coordinate the emergency spill response and communication as stipulated in Emergency Response Plan (MIN) and this document.
- Initiate environmental monitoring requirements as stipulated in Emergency Response Plan (MIN) and Serpentine Crossing Water Quality Management (HUN).
- Notify dewatering crew or external vacuum truck operator if the spill is significant and requires a sucker truck, to remove contaminated water from the IBC's.

*Production Supervisor:*

- Coordinate spill response and remediation for spill on the haul road within the Causeway catchment, as per in Manage Spills of Hazardous Materials (MIN) and this document.
- Report to Environmental Department as soon as practicable (within 12 hours).

*Mobile Maintenance Emergency Response Crew*

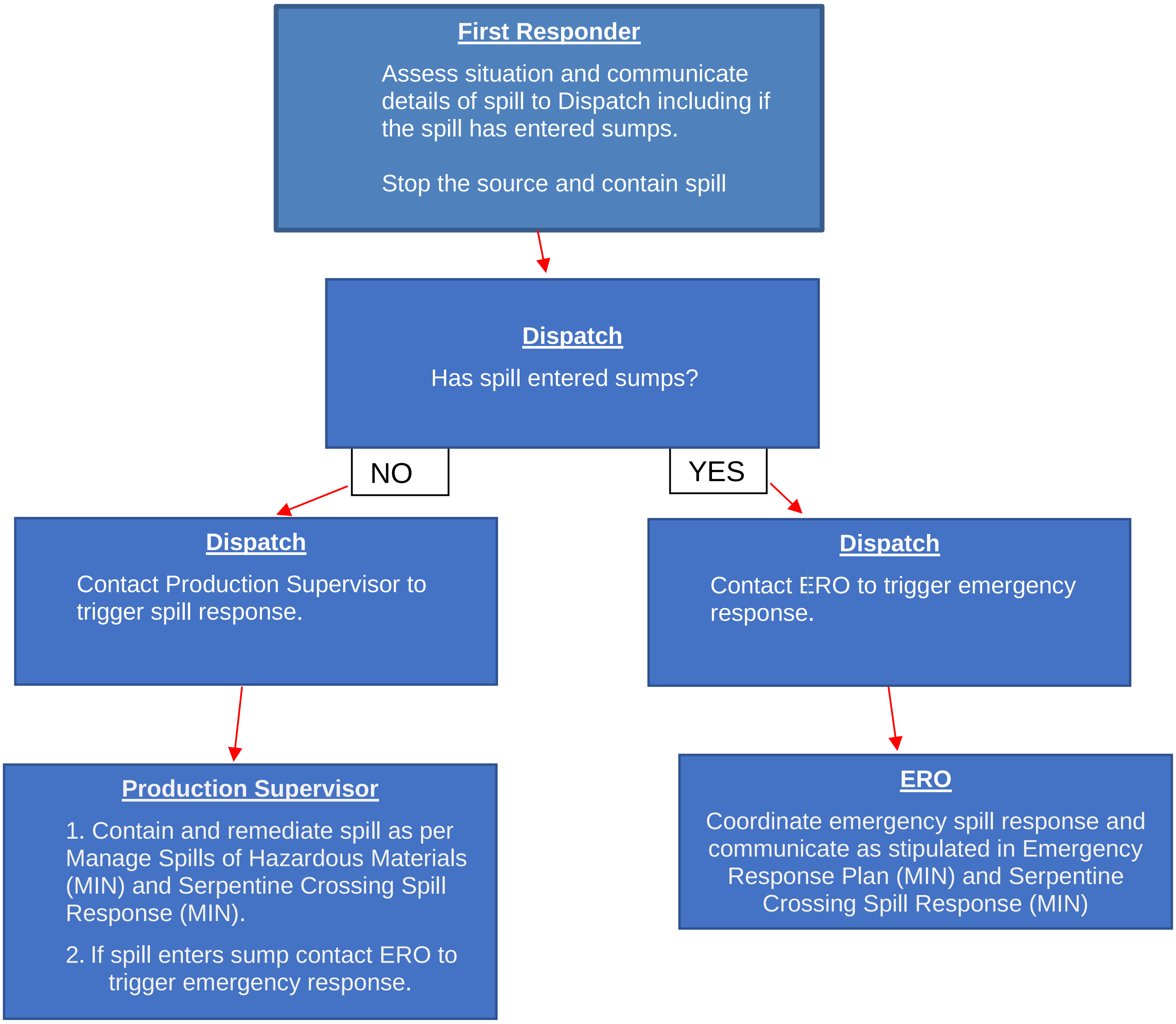
- Set up and operate the oil skimmer and pump to remove the spill.

*Mine Environmental Supervisor*

- Inspect the remediation work and arrange validation sampling to verify clean up sufficient.
- Notify Water Corporation of the occurrence within 24 hours if it hasn't been reported via ERO.
- Coordinate environmental monitoring requirements (Refer to Serpentine Crossing Water Quality Management (HUN))

# Spill Recovery at Serpentine Crossing (HUN)

## Escalation Process for Spill



# Spill Recovery at Serpentine Crossing (HUN)

## Related Documents

- Overview of Serpentine Crossing Sumps (HUN)
- Spill Clean-up and Soil Testing (WAO)
- Serpentine Crossing Water Quality Management (HUN)
- Emergency Response Plan (MIN)

  Manage Spills of Hazardous Materials (MIN)

## Equipment

(SKH1100) 2 x Oil and Fuel Spill Kit, located at each three-stage sump contains:

| | | |
|---|---|---|
| 24m Standard Booms | 2 Absorbent rolls | Drum seal |
| 24m Marine Booms | PVC Gloves | Broom |
| 10 Absorbent Pillows | 20 Disposable Bags | Shovel |
| 100 Absorbent Pads | 20 Cable Ties | Squeegee |
| 4 bags Global Peat | 2 Goggles | Knife |
| 2 bags Floorsorb | Barrier Tape | Rope |

Sea container unit located west of Crossing contains;

- 5m³/h weir type oil skimmer
- Air operated diaphragm pump
- Diesel driven compressor
- 3 x 10 metre and 2 x 5 metre suction hose assemblies
- 4x IBC's to remove and contain oily water

## Procedure

### *Initial Response – using Spill Kit products*

First Responder

1. CEASE operational use of the causeway immediately.

2. ASSESS the situation and communicate details of spill to Dispatch, including if spill has entered any sumps within the Serpentine Causeway Catchment area?

3. ACCESS spill response kit products located at the Serpentine Causeway to contain the spill (if safe to do so), while waiting for the Emergency Response Crew or Production Supervisor to arrive. Ensure PPE; goggles and PVC gloves are utilised.

4. PREVENT contaminated material from entering sumps if possible (boom / block inlets from roadside).

# Spill Recovery at Serpentine Crossing (HUN)

Dispatch

*5.* ASSESS information provider by first responder and notify either Mine Control or Production Supervisor, as specified in escalation process for spills (above flow diagram).

*Production Supervisor:*

6. COORDINATE spill response, as per Manage Spills of Hazardous Materials (MIN).
7. DISPOSE of contaminated products in the plastic bags contained in spill kit at the Causeway.
8. REMOVE contaminated soil and dispose as per current guidelines provided by Environmental Department.
9. REPORT to Environmental Department as soon as practicable (within 12 hours).
10. CONTACT ERO to trigger emergency response as per Emergency Response Plan (MIN), if spill enters a sump within Serpentine Causeway Catchment Area.

*Mine Control / Emergency Response Officer:*

11. COORDINATE the emergency spill response and communication as stipulated in Emergency Response Plan (MIN) this document.
12. ESCALATE to Water Corporation IMMEDIATELY in the event an emission occurs beyond the Alcoa boundary (haul road / sumps) that is toward or into the dam. Contact is Water Corporation Metropolitan Surface Water Duty Manager on 9319 6275. If this is unsuccessful call the 24/7 emergency response team on 13 13 75.
13. INITIATE environmental monitoring requirements as stipulated in Emergency Response Plan (MIN) and Serpentine Crossing Water Quality Management (HUN).
14. Notify dewatering crew or external vacuum truck operator if the spill is significant and requires a sucker truck, to remove contaminated water.

*Mobile Maintenance Emergency Response Crew*

15. DEPLOY the marine floating boom and ensure it is containing the floating hydrocarbons away from the T-pipes and towards the spill response unit for equipment access ease. One person will need to be at each end of the boom.
16. INSPECT the second sump to see if any hydrocarbons moved into the second stage, if so, connect the individual standard booms (10x2.4m lengths) and repeat step 1.
17. CONTACT dewatering crew or vacuum truck contractor and determine estimated time of arrival. If more than 2 hours, then continue as per procedure below.

# Spill Recovery at Serpentine Crossing (HUN)

## *Setting up and using oil skimmer and pump*

18. OPEN the shipping container.

19. REMOVE an International Bulk Container (IBC) and place along the fence of the western side of the dam.

20. REMOVE the diesel-powered compressor (Figure 1) and locate it outside the shipping container in the work area.

*Always obtain assistance from others before attempting to lift any object that is too heavy for one person.*

**SAFETY**

***Operate diesel-powered compressors only in a well-ventilated area. Avoid inhaling engine exhaust fumes, and never run a small diesel-powered engine in a closed building or confined area without adequate ventilation. Compressor discharge air may contain hydrocarbons and other contaminants.***

***Never breathe discharged air. The air stream may contain carbon monoxide, toxic vapours, or solid articles.***

***Never point the air stream at any point of your body, other people, or animals.***

***Serious injury may occur from contact with moving parts such as belts, pulleys, flywheels, or fans. Serious burns may result touching any of the exposed hot metal parts during operation over an extended period of time, even after the air compressor has shut down.***


***Figure 1. Compressor***

21. CONDUCT a pre-start on the compressor diesel engine before operating.

22. START the compressor diesel engine.

*Spare diesel is located in a jerry can inside the shipping container if required.*

# Spill Recovery at Serpentine Crossing (HUN)

23. REMOVE the oil skimmer from the shipping container and locate it at the work area.
24. REMOVE the air powered water pump (Figure 2) from the shipping container and locate it at the work area.

***Figure 2. Water Pump***

25. CHECK that the hose and coupling are in good condition then connect the vacuum pipe to the intake port on the pump.
26. CHECK that the hose and coupling are in good condition then connect the delivery pipe to the discharge port on the pump.
27. SECURE the delivery end of the discharge pipe into the top of the IBC outside the shipping container.
28. CONNECT the air supply line between the compressor and the pump.
29. CHECK that the airline is in good condition and all airline connections are in good working order before use to avoid the uncontrolled release of stored energy.
30. CONNECT the draw pipe to the skimmer.
31. DEPLOY the skimmer into the contaminated dam on the upstream side of the marine bunding (Figure 3).
32. PRIME the water pump using water from the bucket using water from the fire truck or water from the 20L water container located in the shipping container.

***Figure 3. Skimmer deployed in sump***

33. TURN the pump on, slowly at first to ensure the draw pipe remains primed.
34. CHECK for contaminants leaking onto the ground from connections.
35. MONITOR the level of contaminant in the IBC and bring another IBC out of the shipping container if required.

***When contaminant is completely removed***

36. TURN OFF the water pump.
37. TURN OFF the compressor.
38. RETRIEVE the skimmer.
39. DISCONNECT draw pipe from skimmer. Wipe skimmer clean and return to storage.
40. DISCONNECT draw pipe from pump. Wipe pipe clean and return to storage.
41. REMOVE the end of the discharge hose from the IBC.
42. DISCONNECT discharge hose from the pump. Wipe clean and return to storage.
43. DISCONNECT the air supply line from the compressor to the pump. Wipe clean and return to storage.
44. RETURN the pump to storage.
45. RETURN the compressor to storage.
46. CHECK all response equipment is stored away.
47. RECORD any consumables used and ensure replaced (Production responsible for restocking consumables)
48. CLOSE the sea container and lock it.
49. REPORT any faults with the equipment or improvements to the hydrocarbon removal process to your fire team or group leader.

# Spill Recovery at Serpentine Crossing (HUN)

***Remediation Verification, Sampling and Notification (Environmental Department)***

50. INSPECT the remediation work and arrange validation sampling to verify clean up sufficient.
51. CONDUCT Environmental Incident investigation, as per Environmental Incident Investigation
52. NOTIFY Water Corporation of the occurrence within 24 hours (spills not already reported by ERO).
53. COORDINATE environmental monitoring requirements (Refer to Serpentine Crossing Water Quality Management (HUN).

Water Science Pty. Ltd.

## Alcoa World Alumina Australia

# Risk Assessment of the Proposed Haul Road Crossing of Serpentine Dam

**Professor Barry Hart**
**Water Science Pty Ltd**
**Echuca, Australia**

**May 2008**

## Executive summary

This report contains an assessment of the risk to water quality in Serpentine Main Dam associated with the construction and operation of a haul-road crossing (causeway) of the southern arm of the dam. A crossing of the southern arm is necessary to allow the Huntly Mine, operated by Alcoa World Alumina Australia (Alcoa), to mine bauxite in the Myara crusher region. It is anticipated that the causeway will be in operation for approximately 10 years (2012-2022).

Two options for the crossing have been identified, with Option 1 located approximately 7 km upstream of the Serpentine Main Dam wall, and Option 2 is located some 4 km further south. Option 1 is preferred by Alcoa for a number of reasons, not the least being that Option 2 would involve significantly increased haulage distances.

The risk to water quality associated with each of the two causeway options was undertaken using the Standards Australia methodology. The main endpoint of the risk assessment was to ensure adequate protection of drinking water quality in the Serpentine Main Dam, and particularly at the off-take to the Pipehead Dam. The main water quality threats assessed were turbidity (suspended solids) and hydrocarbon (diesel) spills.

For these threats, both the likelihood (or probability) of the threat occurring, and the consequences if it did occur, were assessed. These were then combined to provide an estimate of the risk (i.e. risk = likelihood x consequences).

Additionally, the history of Alcoa's operation of the causeway over the Samson Dam was used in this risk assessment to assess the track record of Alcoa in operating such causeways, and to provide assurance that the assumptions made in assessing risks during both construction and operation of the causeway are reasonable.

*For Option 1 during operation*, five possible scenarios were assessed:

1. A minor (or major) spill of ore, dust or hydrocarbons on the causeway,
2. A minor (or major) spill of ore, dust or hydrocarbons on the causeway, during or followed by a rain event that washes material off the causeway and into the sumps,
3. A major accident in which a fully loaded truck goes over the edge of the causeway spilling its entire contents of 190 tonne of ore and 2,000 L of diesel in the dam below. Three scenarios have been assessed:
   (a) The dam below the causeway is dry,
   (b) The dam below the causeway is dry, but there is a major inflow from Big Brook,
   (c) The dam water level extends to the causeway, and there is a major inflow from Big Brook.

The risk that even the 'worst-case' accident (Scenario 3c) at the proposed causeway would result in an elevated turbidity at the Serpentine Main Dam off-take has been assessed to be very low. Further, the risk that such an accident would result in taste and odour problems (from hydrocarbons) at the Main Dam off-take has also been assessed to be very low. The risk of human health problems from elevated concentrations of toxic hydrocarbons from the spilled diesel has been assessed as extremely low.

For scenario 3b, we assess that the risk of hydrocarbons from such an accident causing problems at the Serpentine Main Dam off-take would be extremely low, provided Alcoa's emergency response team were successful in containing the contaminants.

For scenario's 1, 2 and 3a, we assess the risk of water quality problems at the off-take would be very low, provided that all Alcoa's spill management practices are put in place (e.g. sumps, spill booms to contain hydrocarbon spills, annual mock spill event to ensure Alcoa can respond to an emergency in an appropriate timeframe).

*For Option 1 during construction* we have assumed that as a minimum Alcoa will adopt their standard construction procedures for crossing perennial creeks. These include: (a) construction operations (likely to take 1-2 months) undertaken in summer only, when the risk of significant rainfall events occurring is low, (b) use of pumps to pump water around the site during the construction phase, thus minimising any potential impacts on water quality, (c) bunding of the construction areas as soon as possible to minimise impacts, (d) use of water trucks to minimise dust from disturbed areas, and (e) construction of the sumps as soon as possible to minimise impacts on water quality in the Dam.

We assess the risk of the construction operations causing water quality problems at the Serpentine Main Dam off-take would be very low for the following reasons: (a) Alcoa has considerable experience, well documented procedures and an excellent track record in constructing causeways across streams,  (b) a range of mitigation techniques (bunds, sumps) will be put in place to trap any contaminants from the site before they enter the Dam, (c) any flow from upstream will be pumped around the construction site, thus reducing the potential for direct contamination of the stream, and (d) on the basis of current water levels (and climate change predictions), it seems unlikely that water in Serpentine Main Dam will extend to the construction site, thus reducing the risk of water quality problems.

*For Option 2*, we used a similar approach to that used for Option 1.  This assessment showed that the risk of water quality problems at the Serpentine Main Dam off-take during both construction and operation would be very low, a conclusion not unexpected given that this option crosses Big Brook further away from the main dam.

In summary, the assessment detailed in this report has shown that there is very low risk to drinking water quality in Serpentine Main Dam from the operation of a haul road causeway either across the Dam (Option 1) or further upstream across Big Brook (Option 2).  The two main contaminants assessed were turbidity and hydrocarbons (from diesel).

The Option 1 causeway, Alcoa's preferred option, has a low risk of producing water quality problems at the off-take, even for the worst case situation of a fully loaded truck going over the edge of the causeway and spilling its entire load of ore and ruptured its fuel tank, and the Dam level being such that there is water under the causeway. Obviously, Option 2 is a lower risk proposal because it is located further away from Dam proper, and upstream of the Dam water level even if the dam is full.

The risk assessment assumed that Alcoa will put in place all the contaminant management procedures outlined in Section 3, and further operate the causeway as well as they have over the past 10 years the causeway over Samson Dam.

There appears to be no case on the basis of risk to the water supply for not building the haul road causeway at the Option 1 location.

## Contents

# 1. Introduction

The Huntly Mine, operated by Alcoa World Alumina Australia (Alcoa), seeks to start mining in the Myara crusher region in 2012, with development works commencing in 2009. The region is located near the Serpentine Dam in the Darling Ranges, Western Australia (see Figure 1a). The mining will take approximately 10 years to complete.

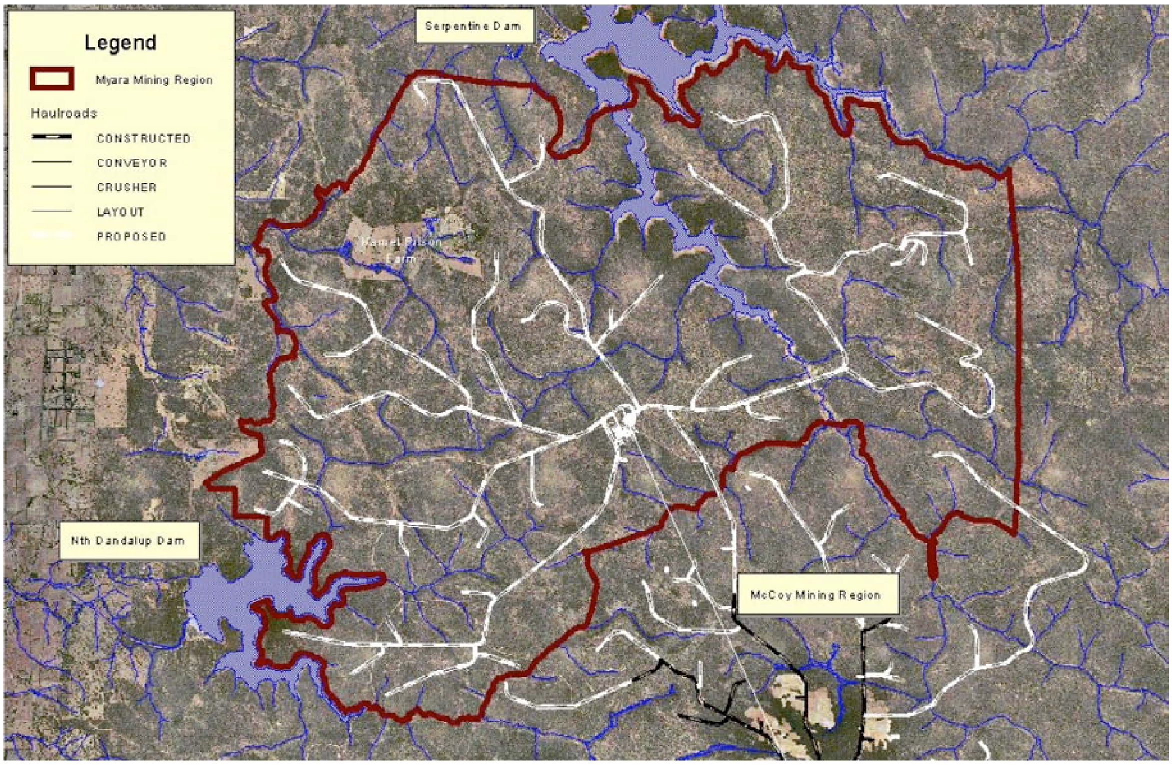
There is a need to cross the southern arm of Serpentine Dam (a drinking water dam) at some point, and two possible locations for this haul road crossing have been identified (see Figure 1b).

The significance of this haul-road crossing proposal is that it will intersect a drinking water dam, and must therefore be shown to pose minimal risk to the quality of that drinking water.

This report contains an assessment of the risk to the water quality in Serpentine Main Dam associated with the two haul-road crossing options. For each of the options, the risk assessment has been focused on two time periods – during construction and when the haul road crossing is in operation.

Additionally, the experiences from Alcoa's operation of a causeway across the Samson Dam, located in the Darling Ranges some 50 km south of Serpentine Dam, have been used to inform the planning of the new crossing over the Serpentine Dam. The causeway (and conveyor alignment) across the Samson Dam, was originally established in the late 1990s and used for access and to transfer heavy machinery back to the workshops. Interestingly, when this crossing was first built the dam was used for irrigation purposes, but is now used for drinking water.

**a**




**b**

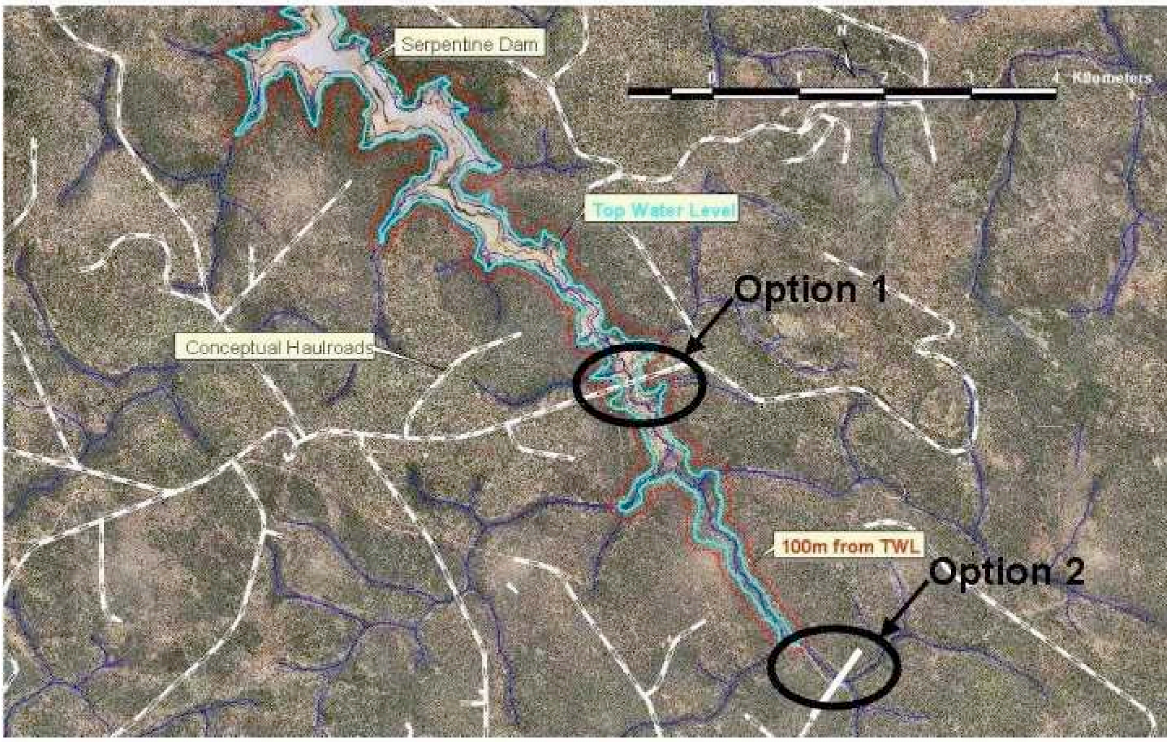



**Figure 1:** **(a) Location of the Myara crusher region**

**(b) Location of the two possible options for crossing the southern arm of the Serpentine Dam**

## 2. Serpentine Dam

The Serpentine Scheme consists of two dams – the Pipehead Dam and the Serpentine Main Dam (Figure 2). The Pipehead Dam, located 7 km upstream of the Serpentine Falls, was opened in 1957. It is 6 km long, has a capacity of 3.14 GL and a surface area of 60.8 ha.

The Serpentine Main Dam was finished in 1961, and has a capacity of 138 GL. The surface area of the Dam at full capacity is 1067 ha. The Main Dam is supplied by two rivers - the Serpentine River enters the northern arm and Big Brook enters the southern arm. The total catchment area is 664 $km^2$.

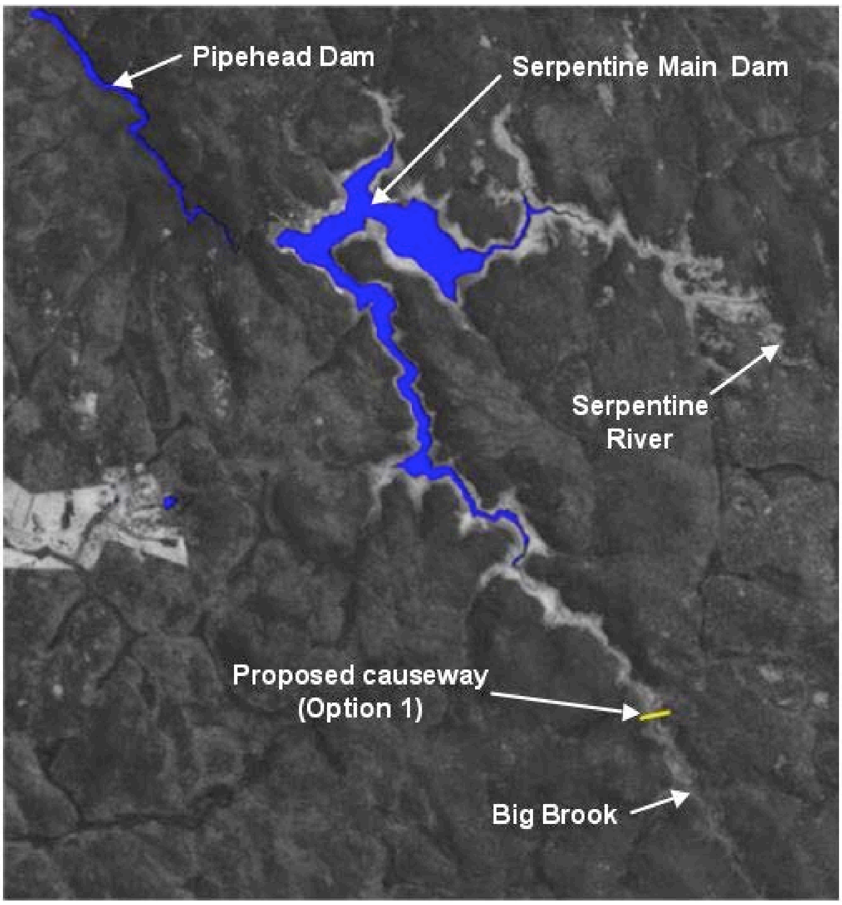



**Figure 2: Satellite image[1] of the Serpentine System showing the Pipehead Dam, the Serpentine Main Dam and the location of the proposed causeway (Option 1).**

Water inflow into the Dam is mostly from surface runoff over the winter months (July-October). The long-term average volume of water entering Serpentine Dam is around 64 GL/year (1912 - 2000). However, since 1975 this has been reduced by almost half to approximately 37 GL/year.

Water from the Serpentine Scheme is piped under gravity to Perth. It is chlorinated at the Serpentine Pipehead before transport. Unfortunately, because flow from the Dam is not recorded, it is not possible to assess the volumes from the Serpentine System that are used annually by Perth.

---

[1] Satellite images provided by Dr Peter Caccetta, Centre for Mathematics & Information Science, CSIRO, Perth. The underlying raw landsat data used in the analysis were drawn from the Landmonitor archive (http://www.landmonitor.wa.gov.au/) and the classification of the extent of the water body was produced by the CSIRO.

The Serpentine Scheme is an important component in the Water Corporation's Metropolitan Integrated Water Supply System, because of its ability to provide a peaking facility. The Metropolitan Water Supply System includes surface reservoirs, groundwater and desalination.

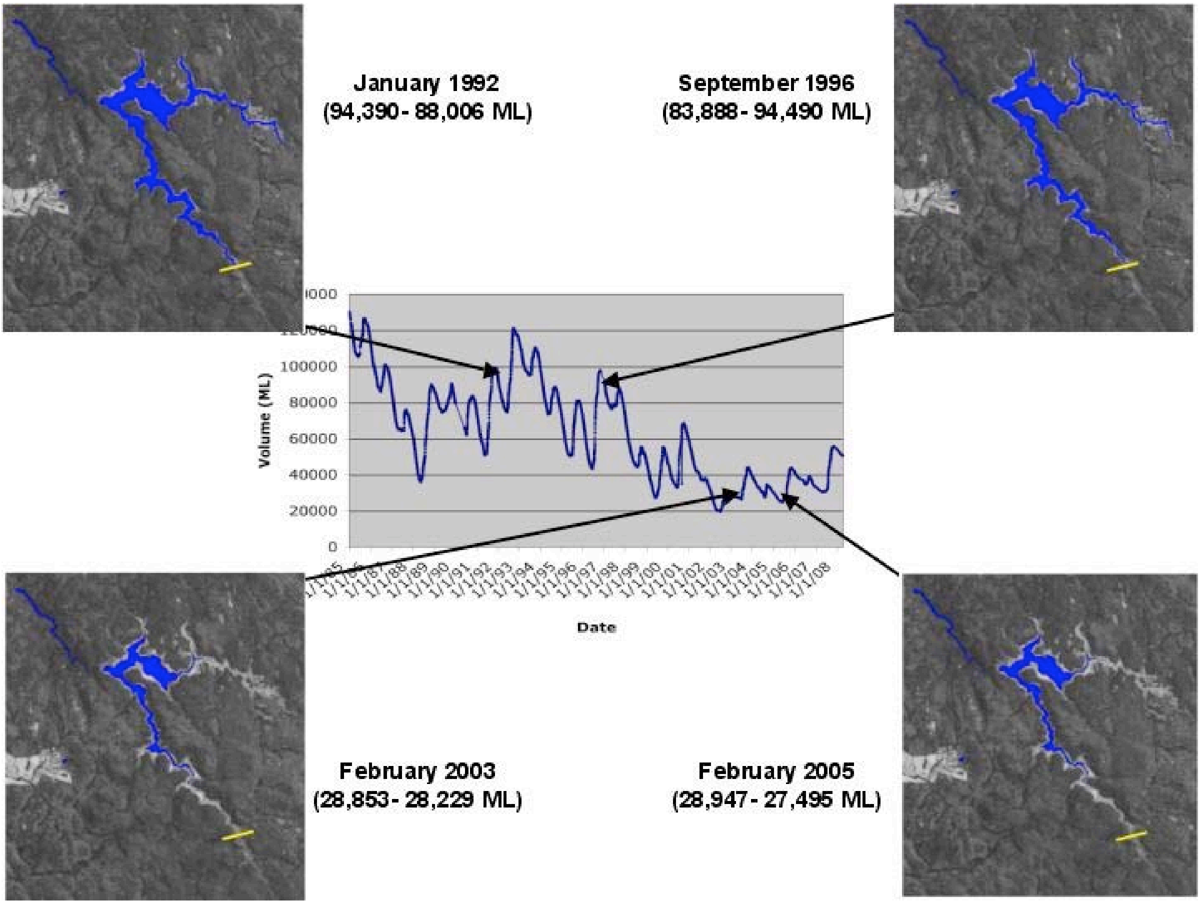



**Figure 3: Daily water level in the Serpentine Main Dam over the period 1 January 1985 to 16 April 2008. Also shown are satellite images of the Main Dam showing the extent of water at four different levels in the Main Dam**

The current strategy allows for water in the Serpentine Pipehead Dam to be augmented with supplies from the North or South Dandalup Dams, thus allowing the Serpentine Main Dam to naturally replenish without being drawn down (Roger Partington, Water Commission, Personal Communication, April 2008). This strategy commenced in 2007 and is expected to continue for the next 5 years. The increased storage level during 2007/08 (see Figure 3) shows the result of this strategy. The Water Corporation expects the level in the Main Dam to increase to well above current levels over the next 5 years.

This strategy is important for the current risk assessment, since over the past 10 years the Dam has been less than 50% full, with the dam water not reaching to the proposed Option 1 causeway site (Figure 3). However, the new strategy could mean that the future water level may reach to (and beyond) the proposed causeway site. Details on the expected changes in water level due to this new strategy, coupled with projected climate change impacts, needs to be obtained from the Water Commission as soon as possible.

## 3. The Proposals

The Myara crusher region has a total of around 270 Mt of bauxite, with the Lang sub-region, the focus of this report, containing around 97 Mt of bauxite.

As noted above, access to the Lang region will require the construction and operation of a haul road causeway over the southern arm of the Serpentine Dam to allow bauxite ore to be hauled back to the Myara crusher.

Two options for the crossing have been identified - *Option 1*, preferred by Alcoa, is located approximately 7 km upstream of the Dam wall, while *Option 2* is located some 4 km further south (Figure 1b) and would involve a significant cost penalty.

Alcoa have identified Option 1 as the preferred site on the basis of:

- *Gradient* – approach roads either side of causeway have lower gradient, which will assist with road run-off water control and sump catchment,
- *Length* – reduced cost and time taken to construct,
- *Recent reservoir water levels* – construction will be upstream of what has been the reservoir high water level for the past few years,
- *Reasonable haulage distance* compared to the shortest (optimum) route, which is some 1.25 km further downstream.

Alcoa have estimated that Option 2, which is further to the east and does not cross the reservoir proper, would add an additional haul distance of 13 km and would cost around $65 million extra in haulage and road construction costs over the 10-year mine lifetime (2012-2022). The real cost of this option would be much higher if other environmental impacts such as greenhouse gas emissions or extra clearing for haul roads were considered.

Alcoa have developed very effective techniques for minimising the impact of haul road stream zone crossings (Alcoa 1, 2007). The standard stream zone crossings techniques would apply if Option 2 was adopted. However, Option 1, which crossed the Serpentine Dam itself, would involve more detailed design, construction, operation and mitigation techniques.

Alcoa have advised that the following mitigation measures will be put in place:

| **Mitigation measure** | **Option 1** | **Option 2** |
|---|---|---|
| Sumps | Designed for 1:200 year event | Designed for 1:20 year event |
| Road surface | Sealed | Unsealed |
| Bunding | 2-4 m | 1 m |
| Speed limit on crossing | 35 km/h | 65 km/h |
| Emergency spill response | Specific plan and standby agreement | Standard procedures |
| Minimise clearing | Already cleared as part of dam | Requires additional clearing |

# 4. Methodology

A qualitative risk assessment has been undertaken using the Standards Australia methodology (AS/NZS 2004a,b).

An assessment of the risk to water quality associated with each of the two causeway options has been undertaken, for each of two time periods – during construction and when the causeway is in operation.

The risk assessment has included a comparison of the proposed crossing of Serpentine Dam with extra mitigation measures (Option 1) against a standard haul road stream crossing east of the top water level of Serpentine Dam (Option 2). Details of these two options are provided in Section 2.

A cause-effect conceptual model was developed for each option to link potential threats with adverse water quality effects in the reservoir.

The main endpoint of the risk assessment was to ensure adequate protection of drinking water quality in the Serpentine Main Dam, and particularly at the off-take to the Pipehead Dam.

The main water quality threats assessed were turbidity (suspended solids) and hydrocarbon (diesel) spills.

For these threats, both the likelihood (or probability) of the threat occurring, and the consequences if it did occur, were assessed. These were then combined to provide an estimate of the risk (i.e. risk = likelihood x consequences).

The history of operation of the causeway over the Samson Dam was used in this risk assessment to assess the track record of Alcoa in operating such causeways, and to provide assurance that the assumptions made in assessing risks during both construction and operation of the causeway are reasonable.

# 5. Risk Assessment

## 5.1 Option 1 - Preferred causeway option

### *5.1.1 Operational phase*

*Conceptual model*

A conceptual model for Option 1 is shown in Figure 4. This shows a schematic of:

- the sealed causeway,
- the sumps that will be built to trap any suspended material or hydrocarbons washed off the causeway in a storm event with a frequency of up to 1 in 200 years.
- the Dam water which is the main transport pathway of possible contaminants from the causeway to the main dam off-take some 7 km downstream.

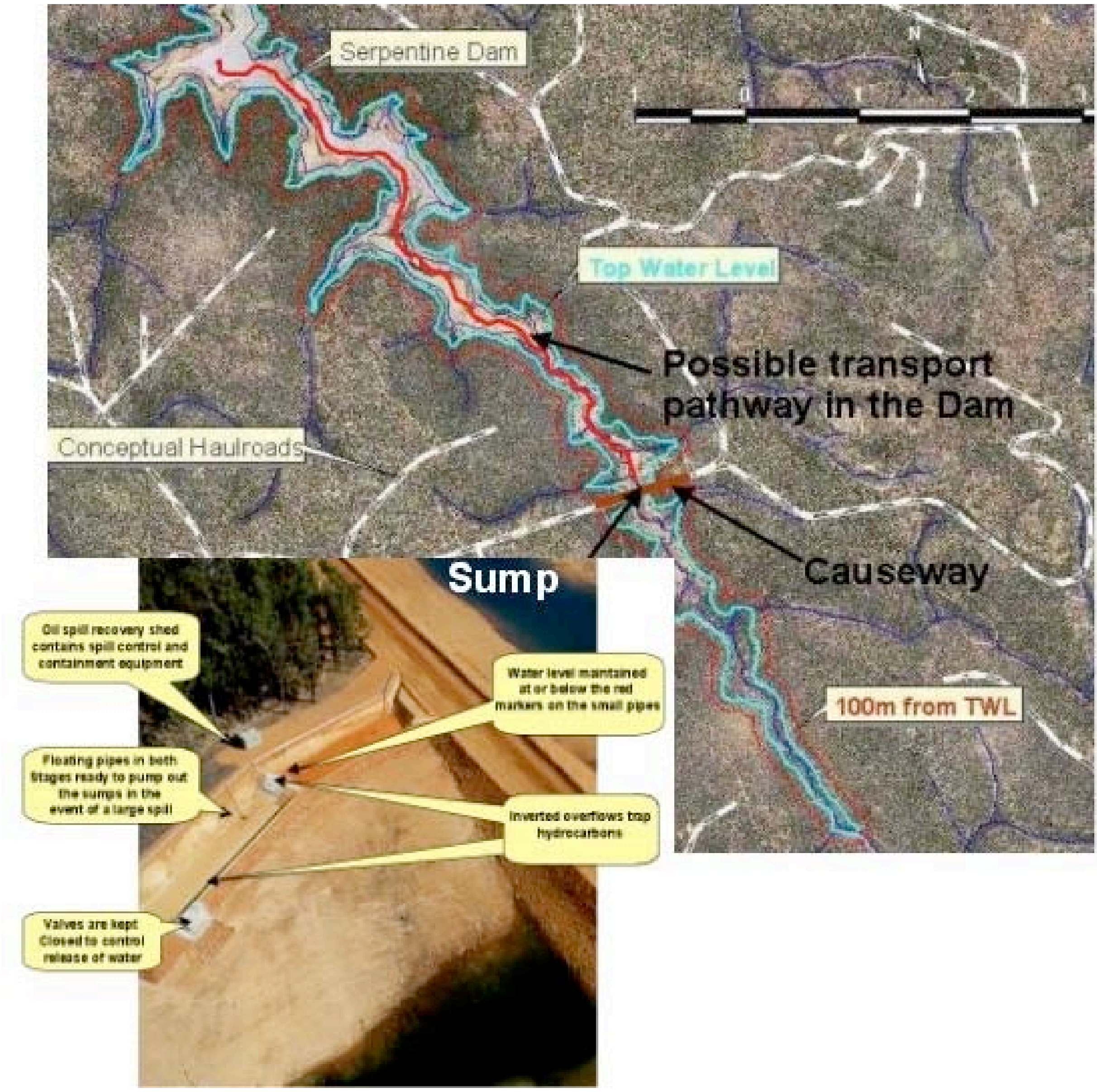



**Figure 4: Schematic conceptual model of the Option 1 crossing showing the proposed causeway location, the sumps that Alcoa will construct, and the pathway by which any contaminants will be transported to the dam wall.**

A key component of this conceptual model is whether water in the Dam will actually extend to the proposed causeway. Certainly if the Dam is near full capacity (138 GL), water would extend to beyond the Option 1 causeway location (see Figure 1b and Figure 3). However, over the past 10 years the Dam has been less than 50% full[2], meaning that the water has not extended to the proposed causeway site during this time.

A more detailed conceptual model of the possible situations that could lead to water quality problems is shown in Figure 5. This shows five possible scenarios:

1. A minor (or major) spill of ore, dust or hydrocarbons on the causeway, which are rapidly cleaned up by the Alcoa maintenance crew,
2. A minor (or major) spill of ore, dust or hydrocarbons on the causeway, during or followed by a rain event that washes material off the causeway and into the sumps, from where the contaminants are rapidly cleaned up by the Alcoa maintenance crew,
3. A major accident in which a fully loaded truck goes over the edge of the causeway spilling its entire contents of 190 tonne of ore and 2,000 L of diesel in the dam below. Three scenarios have been assessed:
   (a) The dam below the causeway is dry, in which case the spill would be rapidly cleaned up by the Alcoa maintenance crew,
   (b) The dam below the causeway is dry, but there is a major inflow from Big Brook,
   (c) The dam water level extends to the causeway, and there is a major inflow from Big Brook.

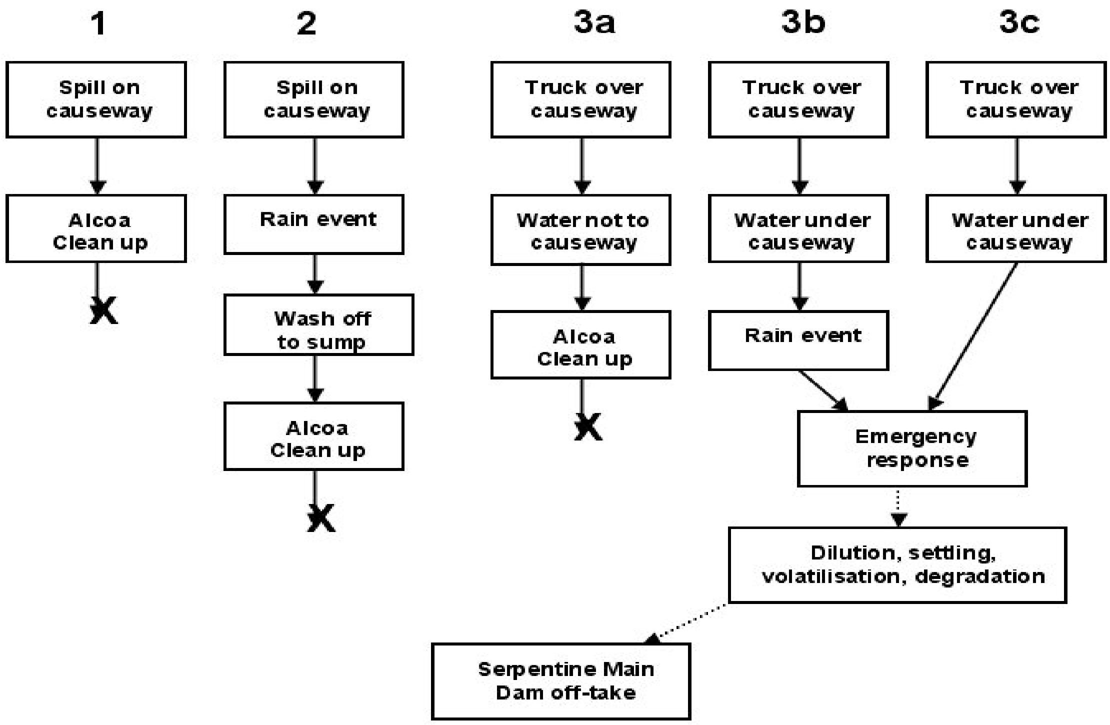



**Figure 5: Schematic conceptual model of the Option 1 crossing showing five possible scenarios for contaminant spillage.**

2 In the 10-year period between March 1998 and March 2008, the water level in Serpentine Dam fluctuated between a maximum of 59 GL (1 March 1998) and a minimum of 20 GL (10 July 2002).

In the analysis below, most effort has been spent on Scenario 3c as this is the 'worst case'. Scenario 3b is the next worst case, but it would be possible for Alcoa to activate an emergency action plan to significantly mitigate the contaminants entering the dam proper. Scenarios 1, 2 and 3a have been assessed as low risk to water quality.

*Scenario 3c (worst case)*

<u>Consequences</u>

The consequences of excessive levels of turbidity and hydrocarbons on drinking water quality (and hence human health) were obtained from the NH&MRC Drinking Water guidelines (NH&MRC, 2004).

- Turbidity

  NH&MRC (2004) recommend that turbidity in drinking water supplied should be less than 5 NTU on the grounds of aesthetics, and less than 1 NTU if disinfection is to occur.

  Given that water from the Serpentine Scheme is chlorinated at the outlet from the Pipehead Dam before entering the pipeline to Perth, a turbidity level of <1 NTU should be maintained in the Dam to ensure compliance with the Australian guidelines.

  Currently, the surface water median turbidity in the Serpentine Main Dam complies with this guideline. Median turbidity, at a site close to the Dam wall, is 0.6 NTU (10%ile 0.4 NTU, 90%ile 0.8 NTU, n=53, sampling between 2003 & 2007 – data supplied by the Water Corporation – March 2008).

- Hydrocarbons

  Diesel is the most likely source of hydrocarbon contamination associated with the proposed causeway. The following information on the composition and stability of diesel was provided by Dr Syed Hasnain from the Centre for Environmental Sciences, EPA Victoria.

  > *Fresh diesel fuels contain a mixture of normal alkanes (linear hydrocarbons) in the approximate carbon range C6-C20 and it is composed of about 76% saturated hydrocarbons (primarily paraffins including n-, iso- and cyclo-paraffins), 4% isoprenoids (n-pristane and n-phytane) and 20% aromatic hydrocarbons (including naphthalenes and alkylbenzenes).*
  >
  > *The different type of hydrocarbons in diesel fuel biodegrade at different rates:*
  >
  > - *n-alkanes (degrade fastest – smaller alkanes degrade faster than larger alkanes),*
  > - *iso-alkanes and cyclo-alkanes (degrade slower but still quite rapidly),*
  > - *isoprenoids (degrade very slowly),*
  > - *aromatics (mainly benzene, alkylated benzenes, naphthalenes, phenanthrenes and fluorenes - are the most soluble and generally rapidly degraded).*
  >
  > *Diesel fuel is considered a non-persistent oil (as compared to a heavier bunker or crude oil product) in even the calm aquatic environments, as it*

*will lose 40% of its volume due to rapid evaporation within 48 hours even in cold weather. Adverse weather will disperse the sheen into smaller slicks creating a greater surface area for evaporation.*

*Diesel fuel can penetrate sediments since its viscosity is so low, with the extent of penetration depending on the sediment type. However, in the Serpentine Dam it is likely that only small amounts of the higher molecular weight compounds would end up in the sediments, as the lower molecular weight compounds being more soluble would remain in the water column (where they would be broken down or evaporated).*

In summary, diesel fuel is regarded as a non-persistent oil that is relatively soluble in water, rapidly evaporated and also relatively rapidly degraded in the water column. The compounds in diesel are not prone to form stable emulsions, although some have relatively high toxicity to aquatic organisms.

The Australian drinking water guidelines make no recommendation for hydrocarbons (NH&MRC, 2004).

For this risk assessment, we have assumed that the main issues if excessive concentrations are transported to the Main Dam off-take[3] will be: (a) possible taste (and perhaps odour) problems, and (b) possible toxic effects.

Unfortunately, the Australian guidelines provide little information on possible concentrations of diesel that would result in taste problems. However, NH&MRC (2004) do provide some guidance on specific compounds likely to be present in diesel. For example, for toluene they suggest taste and odour problems may occur if the concentration is greater than 0.025 mg/L, and if benzene concentrations are greater than 0.001 mg/L.

Regarding toxicity, we have assumed that benzene will be the compound in diesel likely to be most toxic to aquatic organisms (ANZECC, 2000) and to humans (NH&MRC, 2004). NH&MRC (2004) do not recommend a safe level for benzene, but suggest the level in drinking water should be less than 0.001 mg/L. For toluene, they recommend that to avoid human health problems the concentration should be less than 0.8 mg/L.

Likelihood (probability)

The likelihood of the various threats occurring at the Main Dam off-take were first assessed for the worst-case situation (Scenario 3c), on the assumption that if this worst-case situation resulted in a very low risk then no further situations would need to be assessed.

For the operational phase, the worst-case situation for turbidity and hydrocarbons was assumed to be a haul truck loaded with 190 tonne of ore driving through the bund when the Dam water level extended to the causeway, spilling 2,000 L of fuel and oil and the 190 tonne of ore, followed by (or during) a major storm event that reduced the time taken for water to travel from the accident to the Dam off-take.

The likelihood (probability) of a truck accident occurring has been assessed to be extremely low for the following reasons.

- First, while there are expected to be around 647,000 loaded truck movements over the causeway during the 10-years of mining, a truck would need to break through a 2-4 m bund to go over the causeway and the experience with 10 years

[3] Note: the water still needs to travel through the Pipehead Dam before it is taken off to Perth's water supply.

operation of the causeway at Samson Dam is that no such accidents have occurred. Given these data, we have assumed that 2 accidents might occur during the time of mining, giving a low probability of 0.0003%.

- Second, the likelihood of the Dam being full enough for there to be water below the causeway is low, and based on climate change predictions, runoff from the Serpentine River and Big Brook will be insufficient to add more than around 35-40 GL/yr to the Dam. Certainly, over the past 10 years, the water level in the southern arm of Serpentine Main Dam has not been close to the proposed causeway[4], Note that if there was no water below the causeway at the time of an accident, Alcoa standard procedures would allow the spilled ore and diesel to be relatively easily removed.

In addition to the probability of a truck accident, the other aspects we considered in assessing the likelihood of the main contaminants (turbidity or hydrocarbons) reaching the Main Dam off-take are (a) the time of travel, and (b) the attenuation of the contaminant concentrations in travelling from the causeway to the off-take.

- *Travel time* – we estimate that the minimum time for contaminants dissolved or suspended in the water column to travel from the proposed causeway to the Main Dam wall would be in excess of 10-15 days[5].
- *Attenuation* processes – three processes will occur that can reduce the concentration of contaminants reaching the off-take.
  - Dilution (bauxite & hydrocarbons) – if the water level is to the causeway, the volume in the west arm of Serpentine Dam is estimated to be around 32 GL[6]. Assuming then that complete mixing occurred and there were no other loss mechanisms (highly unlikely), the dilution would be very large. For example, if 0.5% of the 2,000 L of spilled diesel was benzene (i.e. 10 L) and this was mixed with 32 GL of reservoir water, the final concentration would be 0.0003 mg/L, which is below the recommended safe level by the NH&MRC (2004) – and this assumes no benzene is lost by volatilisation or microbial decomposition.
  - Settling (bauxite) – assuming the 190 tonne of bauxite ore enters the Dam and is not able to be cleaned up, we estimate that most will settle to the bottom within 1 km of the accident site. Note that for the turbidity to exceed 1 NTU (assume this equates to 0.5 mg/L) at the off-take around 32 tonne of the ore would need to remain in the water column and be transported to the off-take. This is highly unlikely given the known settling rate of bauxite[7].
  - Degradation (hydrocarbons) – as noted above, diesel fuel is regarded as a non-persistent oil that is relatively soluble in water, rapidly evaporated and also relatively rapidly degradation in the water column. Without actual field tests, it is difficult to estimate precisely what proportion of hydrocarbons would be degraded within the water column. However, on the basis of the evidence available, it seems that a large proportion (80-90%) would be volatilised or

---

4 On the basis of satellite images (see Figure 2 & 3 for examples), we estimate that the Main Dam water level would need to be in excess of 85-90 GL for the water in the southern arm to extend to the proposed causeway.

5 This assumes a storm inflow of around 300 ML/d, average cross section 500 $m^2$ and a travel distance of 7 km.

6 Assume total volume is 80 GL with around 40% in southern arm.

7 Tests by Alcoa show that bauxite ore settles very rapidly and contains a very small colloidal fraction.

degraded within the 10-15 days travel time, even under the most extreme conditions.

<u>Assessment</u>

The risk to drinking water quality at the Serpentine Main Dam off-take for the 'worst-case' situation (Scenario 3c) has been assessed for both turbidity and hydrocarbons by combining the likelihood the high concentrations will get to the off-take and the consequences if this occurs.

The risk that even the 'worst-case' accident at the proposed causeway (Option 1) would result in an elevated <u>turbidity</u> at the Main Dam off-take has been assessed to be very low. Further, the risk that such an accident would result in <u>taste and odour</u> problems at the Main Dam off-take has also been assessed to be very low. The risk of human health problems from elevated concentrations of <u>toxic hydrocarbons</u> from the spilled diesel has been assessed as extremely low.

*Scenario 3b*

Under this scenario, it is assumed that at the time of the accident the dam below the causeway is dry, and that there is storm event that results in flow in Big Brook at the time of the accident.

In the event that this happens, Alcoa have indicted that they would activate the emergency response team to build a bund across the river downstream of the spill and to activate large pumps to pump the flow in Big Brook around the spill area. This would then allow the response team to clean up the spilled contaminants.

Any contaminants (most likely hydrocarbons) in water that escaped downstream of the bund would be volatilised and diluted as it flowed downstream into the dam proper.

<u>Assessment</u>

We estimate that risk of hydrocarbons from such an event causing problems at the Serpentine Main Dam off take would be extremely low, provided Alcoa's emergency response team were successful in containing the contaminants.

*Scenario 3a*

Under this scenario, it is assumed that at the time of the accident the dam below the causeway is dry and there is no rain or flow in Big Brook.

In this case, Alcoa would activate its emergency response team to rapidly clean up the spilled materials.

<u>Assessment</u>

We estimate that the risk of a scenario 3a event causing problems at the Serpentine Main Dam off take would be extremely low.

*Scenarios 1 and 2*

For spills occurring on the causeway, we have assumed that all Alcoa's spill management practices will be put in place (e.g. sumps, spill booms to contain hydrocarbon spills, annual mock spill event to ensure Alcoa can respond to an emergency in an appropriate timeframe). An overview of the Samson Causeway sumps is provided in Alcoa 3 (2006) and the management procedures for spill recovery at this location are contained in Alcoa 5 (2006).

In the event of a hydrocarbon spill on the causeway, drains running the length of the road will capture and contain the spill. All flow from the drains will be directed into one of the three 2-stage sumps located on the perimeter of the Dam.

Alcoa then has an emergency response process to ensure that this contaminated water does not enter the Dam (Alcoa 5, 2006). This involves first containing the spill within the sump, and then removing the contaminated water from the sump using a Vacuum Loading Contractor.

Assessment

Alcoa's proposed spill management and recovery procedures (same as those currently used for the Samson Dam causeway) should ensure that the risk to the drinking water supply is extremely low.

### *5.1.2 Construction phase*

Obviously, before any approval to proceed with Option 1 is given, Alcoa will need to provide design and construction details for the causeway, as well as details on the operation of the causeway and techniques to mitigate any potential spills.

For this risk assessment, we have assumed that as a minimum the standard construction procedures for crossing perennial creeks will be followed. These are detailed in Alcoa 1 (2007), and include:

- construction operations (likely to take 1-2 months) undertaken in summer only, when the risk of significant rainfall events occurring is low,
- use of pumps to pump water around the site during the construction phase, thus minimising any potential impacts on water quality,
- bunding of the construction areas as soon as possible to minimise impacts,
- use of water trucks to minimise dust from disturbed areas,
- construction of the sumps as soon as possible to minimise impacts on water quality in the Dam.

We assess the risk of water quality problems occurring during construction to be very low for the following reasons:

- Alcoa has considerable experience, well documented procedures and an excellent track record in constructing causeways across streams,
- a range of mitigation techniques (bunds, sumps) will be put in place to trap any contaminants from the site before they enter the Dam,
- any flow from upstream will be pumped around the construction site, thus reducing the potential for direct contamination of the stream,
- on the basis of current water levels (and climate change predictions), it seems unlikely that water in Serpentine Main Dam will extend to the construction site, thus reducing the risk of water quality problems.

A possible worst-case situation would be if a 1:200 year storm event occurred during the construction phase, and before the sumps were put in place. The probability of such an event occurring is very low, and the possible water quality effects would be quite dependent upon whether the Dam water level was up to the construction site or below it.

If the Dam water level was downstream of the construction site, and a 1:200 year storm event occurred, the main risk would be from the erosion of bare ground causing increased turbidity in the Dam.

Under this scenario, any site runoff would enter a dry riverbed, since the upstream flow will be pumped around the construction site. To ensure this is the case, Alcoa would need to activate larger pumps to pump the increased volume of water around the construction area. Then any contaminated water that escaped downstream would be diluted as it flowed into the stream.

Thus, we estimate that even under this highly unlikely scenario, there is a very low probability that turbidity would exceed the compliance levels[8] at the monitoring site downstream of the causeway.

If the water level was up to the crossing site, it is most likely that Alcoa would delay construction or move the site further upstream. However, as discussed above, the likelihood of water being at this level is very low.

*Conclusions regarding risk*

This assessment has shown that the risk of water quality problems occurring during construction of a causeway across the Serpentine Dam is very low, provided Alcoa put in place their standard construction procedures for crossing perennial creeks.

This assessment has assumed that the water level in the Dam is well downstream of the causeway site during construction, and that construction takes place during the summer months when the likelihood of a major storm event is very low.

## 5.2 Option 2 - Southern causeway option

### *5.2.1 Operational phase*

*Conceptual model*

The conceptual model for Option 2 would be similar to that shown in Figure 4 and Figure 5 for Option 1. However, important differences are: (a) the causeway will be unsealed, (b) the sump will be designed to trap storm events with a frequency of up to 1 in 20 years, and (c) the water level in the Serpentine Main Dam will never reach this causeway (Figure 1).

Possible risk scenarios are 1, 2, 3a and 3b in Figure 5, with scenario 3b the 'worst case' situation.

*Scenario 3b*

<u>Consequences</u>

The consequences are the same as discussed in Section 4.2.1 for Option1.

<u>Likelihood</u>

As for Option1, we have assessed the likelihood of the 'worst-case' situation, on the assumption that if this worst-case situation resulted in a very low risk then any other possible situations would have even less risk.

Again we have assumed that the worst-case situation for <u>turbidity</u> and <u>hydrocarbons</u> (diesel) during the operational phase, would be a haul truck loaded with 190 tonne of

---

8 *significant event* – turbidity >25 NTU for greater than 2 hours, *moderate event* - turbidity >25 NTU for greater than 1 hour, but less than 2 hours.

ore driving through the bund, spilling 2,000 L of fuel and oil and the 190 tonne of ore, followed by (or during) a major storm event.

For this situation, the emergency spill response procedure similar to that already developed for Samson causeway would be activated. This would involve using floating containment structures to ensure the hydrocarbons did not escape the sumps and then sucking the hydrocarbons out of the sumps.

If the spill occurred in the stream, and the contaminants were not captured in the containment sumps, Alcoa have advised that they would attempt to intercept them downstream by first pumping water around the spill and then constructing a bund wall to contain as much contamination as possible. Rapid cleanup of the contaminants would then need to occur. Hydrocarbons would be sucked out of the water retained by the bund, and the spilled ore removed from the stream immediately. However, it is possible that some of the ore would be mobilised and transported downstream to the bund where it would be trapped. Even if some of this escaped the bund, it would be highly diluted by flows from the high rainfall event, and would be further degraded and volatilised as it travelled through the dam.

Assessment

For Option 2, the risk to drinking water quality at the Serpentine Main Dam off-take for the 'worst-case' situation (Scenario 3b) has been assessed for both turbidity and hydrocarbons by combining the likelihood the high concentrations will get to the off-take and the consequences if this occurs.

Our assessment is that the risk that even the 'worst-case' accident at the proposed causeway would result in an elevated turbidity or taste, odour or toxicity problems due to hydrocarbons at the Main Dam off-take has been assessed to be very low.

*Scenarios 1, 2 and 3a*

These scenarios are essentially the same as covered in Section 5.1.1, with one major difference - there will be a greater opportunity to ensure no contaminants enter the dam proper because the Option 2 causeway is further away.

We have assessed that the risk of water quality problems at the Serpentine Main Dam off-take from spillages or major accidents on the Option 2 causeway will be very low.

This assessment assumes that all Alcoa's spill management practices will be put in place (e.g. sumps, spill booms to contain hydrocarbon spills, annual mock spill event to ensure Alcoa can respond to an emergency in an appropriate timeframe).

### 5.2.2 Construction phase

We have assessed the risk of water quality problems occurring during construction of a causeway across Big Brook (Option 2), some way upstream of the Serpentine Main Dam, is extremely low.

This assessment is based on the assumption that Alcoa put in place their standard construction procedures for crossing perennial creeks. These have been detailed in Section 5.1.2.

# 6. Comparison between Option 1 and Option 2

The assessment detailed in this report has shown that there is very low risk to drinking water quality in Serpentine Main Dam from the operation of a haul road causeway either across the Dam (Option 1) or further upstream across Big Brook (Option 2). The two main contaminants assessed were turbidity and hydrocarbons (from diesel).

The Option 1 causeway, Alcoa's preferred option, has a low risk of producing water quality problems at the off-take, even for the worst case situation of a fully loaded truck going over the edge of the causeway and spilling its entire load of ore and ruptured its fuel tank, and the Dam level being such that there is water under the causeway. Obviously, Option 2 is a lower risk proposal because it is located further away from Dam proper, and upstream of the Dam water level even if the dam is full.

The risk assessment assumed that Alcoa will put in place all the contaminant management procedures outlined in Section 3, and further operate the causeway as well as they have over the past 10 years the causeway over Samson Dam.

The only remaining issue is to determine from the Water Corporation the implications of their new operational strategy for Serpentine Main Dam. This strategy involves transferring water from both North and South Dandalup Dams to the Serpentine Pipehead Dam, thus allowing the Serpentine Main Dam to naturally replenish without being drawn down. This could mean that the future water level may reach to (and beyond) the proposed Option 1 causeway site, rather than not reaching this site as has been the case for the past 10 years, with the Dam less than 50% full. If dam water does not reach the Option 1 site, the risk would be even less than estimated for the worst case situation.

There appears to be no case on the basis of risk to the water supply for not building the haul road causeway at the Option 1 location.

## 7. Acknowledgements

I am very grateful to Rodger Partington and Jeff Doust from the WA Water Corporation for the information on Serpentine Dam, to Dr Sayed Hasnain from EPA Victoria for information on diesel, and to Dr Peter Casccetta, CSIRO for the satellite images of Serpentine Main Dam.

## 8. References

Alcoa 1 (2007). *Design and construction of haul roads (MIN),* AOA Document No. 63836, Version 7, Alcoa of Australia, Mining Group, December 2007, 29 pp.

Alcoa 2 (2005). *Working arrangements between Alcoa World Alumina Australia, the Department of Environment and the Water Corporation covering Alcoa's mining operations in the Darling Ranges,* Version 7, Alcoa of Australia, Mining Group, June 2005, 48 pp.

Alcoa 3 (2006). *Overview of Samson Causeway Sumps (WDL),* AOA Document No. 35085, Version 4, Alcoa of Australia, Mining Group, December 2006, 2 pp.

Alcoa 4 (2005). *Samson Dam Causeway Crossing (WDL),* AOA Document No. 47133, Version 2, Alcoa of Australia, Mining Group, February 2005, 2 pp.

Alcoa 5 (2006). *Spill Recovery at Samson Dam Causeway (WDL),* AOA Document No. 44907, Version 3, Alcoa of Australia, Mining Group, March 2006, 6 pp.

ANZECC (2000). *Australian and New Zealand Water Quality Guidelines*, Australia and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

AS/NZS (2004a). *Risk Management (AS/NZS 4360: 2004),* Standards Australia International, Sydney.

AS/NZS (2004b). *Risk Management Guidelines (HB 436:2004),* Standards Australia International, Sydney.

NH&MRC (2004). *Australian drinking water guidelines*, National Health & Medical Research Council, Canberra.

Huntly

# Serpentine Crossing Visual Inspection Checklist (HUN)

Checklist to be completed when a 'Red Alert' is issued for Huntly.

**Date:**
**Inspected by:**
**Red Alert rainfall event due:**

| Aspect | Observation | Further action required |
|---|---|---|
| Are water levels in the 3-stage sumps below the 'storm ready state'?<br>*Storm ready state - yellow marker on the small pipe in the third sump* | Below **/** Above* | **If water level is above the 'storm ready state' markers contact MES to determine if a sample is required.* |
| Visually inspect for contamination in the sumps | Sumps water looks clean **/** sumps water looks suspicious and testing required* | **If sump water looks like hydrocarbons or contamination may be present, inform MES to determine if a sample is required.* |
| Are discharge valves in closed position and locked to prevent unauthorised discharge? | Yes / No* | **If discharge valves are in open position, close and lock and inform MES* |
| Inspect sealed surface of causeway for sediment build up | Sediment on bitumen is minimal **/** Sediment build up is significant, cleaning required* | **If cleaning of causeway is required report to Assistant Operations Manager to arrange road sweeper or bobcat if sizeable rocks on the crossing* |
| Check contents of spill kits against product list | Spill kits complete **/** product requires restock* | **If restock is required, additional products are housed in the Environmental shed at Myara otherwise supplied through COVS Supplies (on the Alcoa Mall)* |
| Check sump liner is intact – are there any visible signs of punctures or deterioration? | HDPE liner in sump stage 1&2 is intact **/** damage noted to liner* | **Report any damage of HDPE liner to MES immediately to organise repair* |
| Water in third stage of sump appears clean and turbid free | Water appears clean **/** water appears turbid* | **If water appears turbid a sample of the release water should be taken for testing to confirm the turbidity level (NTU)* |
| Check inlets to upslope sumps are open and unobstructed | Inlets open / inlet(s) blocked* | **Notify Production GL to organise grader to open up inlets* |

¤