WORSLEY ALUMINA TAILINGS FACILITY RISK

Risk Assessment Findings (GISTM Requirement 15.1 B3)

A failure modes and effects analysis (FMEA) and quantitative risk assessment (QRA) was completed for each of the Bauxite Residue Disposal Areas (BRDAs) and the temporary tailings storage facilities (TSFs) i.e. Solar Evaporation Ponds (SEPs).

To inform the FMEA and consequence classification assessment, a semi-QRA and a probabilistic analysis approach was undertaken. The four primary tools used in the analysis were:

- Fault tree analysis;
- Liquefaction leading to a flow slide event;
- Dam break analysis (DBA); and
- Event tree analysis.

The credible failure modes assessed for the DBA include:

- Static instability;
- Dynamic (seismic) slope instability;
- Overtopping;
- Geotechnical piping; and
- Buried structure.

Each BRDA and SEP was assessed for the probability of failure against each of these failure modes. The FMEA workshops were conducted with a range of expertise from the environmental, social, finance, engineering, and operational fields.

Credible Flow Failure Risk Assessment Outcomes (GISTM Requirement 15.1 B4)

Dam break assessments were conducted for two broad scenarios in line with international practice:

- A rainy day or overtopping scenario, which may cause the erosion of the supporting embankment and may also result in the release of a large volume of contaminated water. This water would entrain some residues as it erodes the embankment and would behave as a non-Newtonian fluid. Thus, the erosion of the supporting embankment could result in either a flow slide (if the residue liquefies), or a slump (if the residue fails due to its residual shear strength without liquefying). The solids concentration of the liquefied residues from the BRDAs are likely to be reduced by dilution with the overtopping flood water; and
- A sunny day scenario, which refers to a situation where the cause of removal of the supporting embankment would be by any mechanism other than overtopping erosion. Within this scenario, either a slump or flow slide may occur.

The table below summarises the impact assessments and environmental and human exposure and vulnerability to tailings facility credible flow failure scenarios for each BRDA and SEP.

TSF	Credible Flow Failure Scenario	Assessment Outcomes	Environmental and Human Exposure
BRDA 1 (Active Closure State)	Flow slide failure on western embankment following the initiating faults of: - Slope failure due to excessive overland flow leading to static slope instability; and - Slope instability towards SEP2A causing loss of freeboard leading to	Inundation mapping shows that the residue and water outflow would be contained within the Worsley Alumina refinery site.	The potential for human exposure is limited to within the operation. There is no off-site impact to wildlife, water sources and plants.

TSF	Credible Flow Failure Scenario	Assessment Outcomes	Environmental and Human Exposure
	overtopping of SEP2A into SEP1, SEP3 releasing tailings to RCL.		
BRDA 2	Flow slide failure on eastern embankment following the initiating faults of: - Slope failure due to drains losing flow capacity leading to static slope instability; and - Depression in crest from settlement causing loss of freeboard leading to overtopping.	Inundation mapping shows that the residue and water outflow would be contained within the Worsley Alumina refinery site.	The potential for human exposure is limited to within the operation. There is no off-site impact to wildlife, water sources and plants.
BRDA 4	Flow slide failure on western embankment following the initiating faults of: - Slope failure due to drains losing flow capacity leading to static slope instability; and - Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.	Inundation mapping shows that the residue and water outflow would be contained within the Worsley Alumina refinery site.	The potential for human exposure is limited to within the operation. There is limited-to-no off-site impact to wildlife, water sources and plants.
BRDA 4X	Flow slide failure on western embankment following the initiating faults of: - Slope failure due to drains losing flow capacity leading to static slope instability; and - Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.	The surface water discharge may travel via existing overland flow paths estimated up to 17 kilometres downstream, however any residue would be contained within the Worsley Alumina refinery site.	Any surface water released will be highly diluted and will be in contact with slightly acidic soils. There would be minimal off-site impact to wildlife, water sources and plants.
BRDA5	Flow slide failure on north-western embankment following the initiating faults of; - Slope failure due to drains losing flow capacity leading to static slope instability; and - Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.	Inundation mapping shows that the residue and water outflow would be contained within the Worsley Alumina refinery site.	Limited-to-no impact to wildlife, water sources and plants off site.

TSF	Credible Flow Failure Scenario	Assessment Outcomes	Environmental and Human Exposure
SEP1	Flow slide failure over the high-density polyethylene (HDPE) lined pond on western embankment towards SEP3 following the initiating faults of; - Slope failure due to embankment overtopping leading to static slope instability; and - Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.	Inundation mapping shows that the tailings and water outflow would be contained within the Worsley Alumina refinery site.	The potential for human exposure is limited to within the operation. There is limited-to-no off-site impact to wildlife, water sources and plants.
SEP2A	Flow slide failure over the HDPE lined pond on southern embankment towards SEP1, SEP3 and RCL and WB1 following the initiating faults of; - Slope failure due to embankment overtopping leading to static slope instability; and - Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.	Inundation mapping shows that the tailings and water outflow would be contained within the Worsley Alumina refinery site.	The potential for human exposure is limited to within the operation. There is limited-to-no off-site impact to wildlife, water sources and plants.
SEP3	Flow slide failure over the PVC lined pond spillway on western embankment towards RCL following the initiating faults of; - Slope failure due to embankment overtopping leading to static slope instability; and - Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.	Inundation mapping shows that the tailings and water outflow would be contained within the Worsley Alumina refinery site.	The potential for human exposure is limited to within the operation. There is limited-to-no off-site impact to wildlife, water sources and plants.
SEP4	Flow slide failure over the HDPE lined pond spillway on western embankment towards SEP1, SEP3 and RCL following the initiating faults of; - Slope failure due to embankment overtopping leading to static slope instability; and - Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.	Inundation mapping shows that the tailings and water outflow would be contained within the Worsley Alumina refinery site.	The potential for human exposure is limited to within the operation. There is limited-to-no off-site impact to wildlife, water sources and plants.

Table 1: Credible Flow Failure Risk Assessment Outcomes

Review of the credible failure modes and potential causes indicate that the risks are well understood and managed with appropriate controls. The risk assessment outcomes have been agreed and reviewed with the Engineer of Record (EoR) and Independent Technical Review Board (ITRB).