



**GISTM REQUIREMENT 15.1  
PUBLIC DISCLOSURE  
WORSLEY ALUMINA**

## 1. Preamble

South32 is committed to improving the transparency and availability of information about tailings storage facilities (TSFs). The *Global Industry Standard on Tailings Management (GISTM)* was established as an international standard for safer tailings management through a process co-convened with the ICMM, United Nations Environmental Programme (UNEP) and the Principles of Responsible Investing (PRI).

GISTM consists of six topic areas, 15 principles, and 77 auditable requirements, covering the entire lifecycle of TSFs, from site selection to closure.

Our overarching approach to tailings management is to achieve stable and dense tailings. This involves understanding tailings behaviour, reducing water content at TSFs, and developing innovative construction techniques for these TSFs. In addition to GISTM, our approach is consistent with the ICMM Tailings Governance Framework, Position Statement on Preventing Catastrophic Failure of TSFs, and the Australian National Committee on Large Dams (ANCOLD) guidelines. These requirements are embedded in our internal dam management standard.

Consistent with GISTM Principle 15, South32 is committed to publishing and regularly updating information regarding its adherence to safe tailings facility management.

This disclosure covers our GISTM 'Very High' consequence TSFs, which comprise the bauxite residue disposal areas (BRDAs) at Worsley Alumina, in Western Australia, including information on our tailings facilities, consequence classification, tailings safety, risk assessments, credible failure outcomes, material impacts of environmental and human exposure, emergency preparedness and response planning and closure.

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## 2. Existing Facilities

### 2.1 Description of the TSFs

Worsley Alumina is an integrated bauxite mining and alumina refining operation in the south-west of Western Australia. The mined bauxite is processed into alumina at the refinery using the four stage Bayer Process involving digestion, clarification, precipitation and calcination. Bauxite process residue is thickened into a slurry and is pumped to the Bauxite Residue Disposal Areas (BRDAs) for storage. Worsley Alumina has four active BRDA's, all of which are considered to be classified as 'Very High' Consequence under the GISTM.

The BRDAs are located on either side of the refinery in two tributary valleys of the Augustus River catchment, referred to as the northern and southern valleys. BRDA 2, BRDA 4 and BRDA 4X are in the Northern Valley and BRDA 5 is in the Southern Valley, as shown in Figure 1, and are the main focus of this disclosure.



Figure 1: Worsley Alumina Refinery Site Overview

The BRDAs are constructed in a similar manner, incorporating various elements including:

- Groundwater underdrainage systems comprising a compacted clay floor with low permeability, and a gravel layer equipped with drainage pipework spanning the entire floor area to capture seepage effectively.
- Structural integrity formed by a starter dam and compacted clay perimeter walls. As the BRDA continues to be raised upstream, compacted clay fill is employed in successive layers.
- Surface water management with each BRDA equipped with an internal decant drainage system.

Collectively, these components contribute to the reliable and efficient operation of the BRDAs.

The BRDAs are planned to increase to their final elevation of RL316m Australian Height Datum (AHD) using ongoing upstream raises, then be capped with a store and release vegetated cover. The height from ground level to RL316m AHD varies for each BRDA and ranges from 57m to 72m.

Monitoring of the BRDAs incorporates a structured combination of visual inspections, monitoring of piezometers installed in embankments, scheduled INSAR and drone surveys, routine shear vane testing, and settlement monitoring.

2.1.1 Northern Valley BRDAs



Figure 2: Northern Valley Configuration

**BRDA 2**

Construction of BRDA 2 commenced in 1987 with a high starter embankment and utilised an upstream raise methodology. The duration between raises is progressively increasing due to the steep valley profile.

Description	Year	Method	Height (Toe to crest) (m)	RL (m)
Starter Embankment	1987		18.0	276.3
Stage 2	1989	Upstream	24.0	282.0
Stage 3	1990	Upstream	28.0	286.0
Stage 4	1994	Upstream	35.5	293.5
Stage 5	1997	Upstream	40.5	298.5
Stage 6	2001	Upstream	45.5	303.5
Stage 7	2006	Upstream	50.5	308.5
Stage 8	2016	Upstream	57.5	315.5

Table 1: BRDA 2 Construction History

**BRDA 4**

Construction of BRDA 4 commenced in 1994, with a starter embankment, utilising upstream raise methodology. BRDA 4 and BRDA 4X are at the same RL elevation and are planned to be raised consecutively to maintain both facilities at the same elevation.

Description	Year	Method	Height (Toe to crest) (m)	RL (m)
Starter Embankment	1994		28.1	273.1
Stage 2	2001	Upstream	33.0	278.0
Stage 3	2005	Upstream	38.0	283.0
Stage 4	2009	Upstream	43.0	288.0
Stage 5	2014	Upstream	49.0	294.0
Stage 6	2018	Upstream	54.0	299.0
Stage 7	2022	Upstream	59.0	304.0

Table 2: BRDA 4 Construction History

**BRDA 4X**

Construction of BRDA 4X commenced in 2002, following a similar design concept to BRDA 4. The design adopted washed laterite gravel for the floor drainage layer, to improve permeability and increase underflow recovery.

Description	Year	Method	Height (Toe to crest) (m)	RL (m)
Starter Embankment	2002		30.6	283.6
Stage 2	2009	Upstream	36.0	289.0
Stage 3	2013	Upstream	41.0	294.0
Stage 4	2015	Upstream	46.0	299.0
Stage 5	2021	Upstream	51.0	304.0

Table 3: BRDA 4X Construction History

**2.1.2 Southern Valley BRDAs**

**BRDA 5**

Construction of BRDA 5 commenced in 1994, with a starter embankment along the west perimeter. The current configuration of BRDA 5 is displayed in Figure 3.



Figure 3: Southern Valley Configuration

Description	Year	Method	Height (Toe to crest) (m)	RL (m)
Starter Embankment	1994		17.0	264.5
Stage 2	2001	Upstream	22.5	270.0
Stage 3	2005	Upstream	27.5	275.5
Stage 4	2009	Upstream	32.5	280.5
Stage 5	2014	Downstream	37.5	285.5
Stage 6	2017	Upstream	42.5	290.5

Table 4: BRDA 5 Construction History

## 2.2 Consequence Classification

The potential impacts of each BRDA's credible failure modes were considered, and compared to potential impacts within the categories specified in the GISTM Consequence Classification Matrix (<https://globaltailingsreview.org/global-industry-standard/>) to determine the "Dam Failure Consequence Classification" across each category. The results of the assessment for each BRDA are summarised in Table 5.

TSF	Overall Consequence Classification	Potential Population at Risk	Potential Loss of Life	Environment	Health, Social and Cultural	Infrastructure and Economics
BRDA 2	Very High	Significant	High	Low	Significant	Very High
BRDA 4	Very High	Significant	High	Significant	Low	Very High
BRDA 4X	Very High	Significant	High	Significant	Significant	Very High
BRDA 5	Very High	Significant	High	Significant	Low	Very High

Table 5: Facility Consequence Classifications

The consequence classification for all BRDA 2, BRDA 4, BRDA 4X and BRDA 5 is 'Very High' as per the GISTM. In addition to GISTM requirements, impact to infrastructure within the site boundary has also been included in the economic assessment. The consequence classification for the BRDAs has been endorsed by the Independent Tailings Review Board (ITRB).

## 3. Tailings Safety

### 3.1 Risk Assessment Findings

A failure modes and effects analysis (FMEA) and quantitative risk assessment (QRA) was completed for each BRDAs.

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

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

The failure modes assessed for the DBA include:

- Static slope instability;
- Seismic slope instability;
- Overtopping;
- Geotechnical piping; and
- Buried structure.

Each BRDA 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.

### 3.2 Credible Flow Failure Risk Assessment Outcomes

In line with international practice, dam break assessments were conducted for two broad scenarios:

- A rainy-day scenario, 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 are likely to be reduced by dilution with the overtopping flood water.
- 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.

Table 6 summarises impact assessments and environmental and human exposure and vulnerability to tailings facility credible flow failure scenarios for each BRDA.

TSF	Credible Flow Failure Scenario	Assessment Outcomes	Environmental and Human Exposure
BRDA 2	Flow slide failure on Eastern Embankment following the initiating faults of: <ul style="list-style-type: none"> <li>– Slope failure due to drains losing flow capacity leading to static slope instability; and</li> <li>– Depression in crest from settlement causing loss of freeboard leading to overtopping.</li> </ul>	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. No off-site impact to wildlife, water sources and plants.
BRDA 4	Flow slide failure on Western Embankment following the initiating faults of: <ul style="list-style-type: none"> <li>– Slope failure due to drains losing flow capacity leading to static slope instability; and</li> <li>– Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.</li> </ul>	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. 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: <ul style="list-style-type: none"> <li>– Slope failure due to drains losing flow capacity leading to static slope instability; and</li> <li>– Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.</li> </ul>	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. Limited-to-no off-site impact to wildlife, water sources and plants.
BRDA 4X	Flow slide failure on North-Western Embankment following the initiating faults of; <ul style="list-style-type: none"> <li>– Slope failure due to drains losing flow capacity leading to static slope instability; and</li> <li>– Slope failure due to unrepresentative geotechnical foundation conditions leading to seismic slope instability.</li> </ul>	The surface water discharge may travel via existing overland flow paths 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. Minimal impact to wildlife, water sources and plants off-site.
BRDA 5	Flow slide failure on the Western Embankment due to the initiating fault of: <ul style="list-style-type: none"> <li>– Overtopping leading to removal of support to the residue above the toe starter embankment causing liquefaction of the residue.</li> </ul>	Modelling indicates that any failure will be contained within the boundaries of the Worsley Alumina refinery site.	Limited-to-no impact to wildlife, water sources and plants off site.

**Table 6: 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).

### 3.3 Material Findings relevant to the Tailings Storage Facility

Material findings from annual performance reviews and dam safety reviews (DSRs) are those that have, a high probability of being a significant dam safety concern where the integrity of the facility is compromised, within 12 months of the findings. Material findings from social and environmental monitoring programs are those that have a significant impact on the community and stakeholders near the facility.

There have been no material findings from the annual performance reviews, the DSRs, or the environmental or social monitoring programs related to the BRDAs.

### 3.4 Dam Safety Reviews

DSRs were conducted for all facilities in 2020. Consistent with GISTM requirements, our DSRs are scheduled to be updated in 2025.

#### 4. Emergency Preparedness and Response Planning

We have provided local authorities and emergency services with relevant information and included them in presentations and emergency simulations as part of our emergency preparedness and response planning.

The Emergency Preparedness and Response Plan (EPRP) covers all TSFs at Worsley Alumina for the credible failure modes.

Emergency management follows the five step process described below.

##### 1. Emergency - Event Detection

An unusual or emergency event may be detected by:

- Observations at or near the TSFs by Worsley Alumina or contract personnel;
- Evaluation and monitoring instrumentation data associated with the TSF;
- Earthquakes felt or reported in the vicinity of the site; and
- Forewarning of conditions that may cause an unusual or emergency event like severe weather or flash flooding.

##### 2. Emergency - Level Determination

When an unusual or emergency event is detected or reported, the Supervisor Production, or their alternative, is responsible for classifying the event, with advice from subject matter experts, into one of the following three emergency levels:

###### Level 1 – Alert Status

Non-emergency, unusual event, slowly developing: This situation is not normal but has not yet threatened the operation or structural integrity of the TSF, but possibly could if it continues to develop.

###### Level 2 – Limited Damage Status

Potential failure situation, rapidly developing: This situation may eventually lead to a failure and flash flooding downstream, but there is not an immediate threat of dam failure.

###### Level 3 – Major Damage or Failure Status

Urgent, failure appears imminent or is in progress: This is an extremely urgent situation when a failure is occurring or obviously is about to occur and cannot be prevented. Flash flooding will occur downstream of the dam. This situation is applicable when flow through the earth spillway is causing downstream flooding of people and roads.

##### 3. Notification and Communication

Once an emergency level has been determined, personnel are notified based on the level of the emergency, which ranges from the Area Superintendent, Vice President Operations and the Chief Operating Officer.

External stakeholder and community engagement regarding a failure will be conducted based on the level and nature of the emergency. External stakeholders that may be notified in a Level 2 and Level 3 emergency are the Shire of Collie, Department of Water and Environmental Regulation (DWER), Department of Mines, Industry Regulation and Safety (DMIRS), Department of Fire and Emergency Services (DFES), Department of Biodiversity, Conservation and Attractions (DBCA), Local Government Bodies and any persons that may be affected downstream of our facilities.

During an emergency an Incident Management Team (IMT) will be formed in accordance with our crisis and emergency management procedures.

Notification charts have been developed for each level of the emergency to allow for the correct personnel to be notified in a timely manner.

##### 4. Expected Actions

Expected actions will be based on the alert level and example lists are included in the EPRP to assist.

###### Level 1 – Alert Status

- Notification of Supervisor Production who conducts inspection and notification of relevant other senior shift personnel or contractors.
- The Responsible Tailings Facility Engineer (RTFE) and Superintendent Execution will be notified and the condition of the TSF or dam will be closely monitored with regular reporting until the event has been rectified or repaired

###### Level 2 – Limited Damage Status

- The RTFE and Superintendent Execution will be notified immediately and corrective actions will be identified.
- Subject matter experts will be contacted to assist in recommending corrective actions.
- Manager Production will be informed, an investigation initiated, and if conditions warrant an emergency an IMT will be formed.
- Deposition into the affected BRDA will cease.
- Ongoing monitoring and complete visual inspections and surveys will occur.

###### Level 3 – Major Damage or Failure Status

- Manager Production, Vice President Operations and Chief Operating Officer (COO) will be notified.
- IMT will be formed.
- Deposition into the affected BRDA will cease and evacuation of downstream areas will be undertaken.
- COO to follow South32 crisis and emergency management procedure.



Ongoing monitoring and a complete visual inspection and survey will occur where it is safe to do so. Emergency remedial action plan will be developed and enacted. These actions range from changing the deposition location and installing temporary pumping to the evacuation and shutdown of operations.

**5. Close Out**

Once the emergency event is over, the emergency must be closed out and follow-up procedures completed.

Assessment of social, environmental, and local economic impacts will be conducted as soon as possible after people are safe and short-term needs have been met.

Worsley Alumina will also facilitate the monitoring and public reporting of post-failure outcomes and work with regulators and affected people towards the development of reconstruction, restoration and recovery plans that address the medium- and long-term social, environmental, and local economic impacts of the failure.

**5. New Tailings Facilities**

**5.1 BRDA 4E**

As part of life of mine planning, a benchmarking study was undertaken to compare Worsley Alumina's current BRDA management practices with various other disposal methodologies and operations both within the alumina industry and against other commodities. As a part of this, an assessment of transitioning to a filtration and stacking methodology was undertaken. The assessment found that the current methodology of thickened tailings disposal, in conjunction with intensive mudfarming (amphirolling), and constant removal of ponded surface water, was comparable to filtration and stacking in terms of performance.

A comprehensive site selection process was undertaken for the development of Worsley Alumina's proposed BRDA 4E, which considered the potential impact to the environment, communities, cultural areas, infrastructure and other factors. The preferred site identified was abutting the existing BRDA 4 and 4X embankments. The footprint of the proposed BRDA 4E is shown in Figure 4: BRDA 4E.



Figure 4: BRDA 4E

General dimensions of the proposed BRDA 4E are provided in Table 7.

Feature/Component	Approximate Dimension
Footprint Area	208ha
Starter Dam Height	25m
Embankment Height (final)	110m
Embankment Crest Elevation (final)	RL 345mAHD
Residue Surface Level (at final height)	RL 344.5mAHD
Crest Length (at final height)	3,340m
Batter Slope (each raise)	1 in 2.2
Batter Slope (overall)	1 in 4.3
Residue Surface Area (at final height)	160ha

Table 7: BRDA 4E General Dimensions

The design of BRDA 4E is in the pre-feasibility study phase. The findings of groundwater and visual impact assessments completed are:

1. No significant groundwater or surface water contamination has been identified at the site since the start of operations in 1984;
2. New hydrogeological monitoring bores are to be installed to extend the current monitoring network to incorporate the proposed new facility; and
3. Visual impact of BRDA 4E has been assessed from a range of observation points surrounding Worsley Alumina. Negligible visual impact was identified.

### 5.2 BRDA 4E Consequence Classification

As BRDA 4E is an extension of the existing BRDAs 4 and 4X in the Northern Valley, an initial GISTM consequence classification of Very High has been adopted to align with these existing BRDAs.

This GISTM consequence classification will be reviewed during the feasibility study phase.

## 6. Closure

At the date of this disclosure South32 has adequate financial capacity (including insurance to the extent commercially reasonable) to cover estimated costs of planned closure, early closure, reclamation, and post-closure of the TSFs and its appurtenant structures.

Closure estimates are reviewed at least annually for changes in laws, key site changes, changes in current disturbance areas and exchange, discounting and inflation rates. Estimates are also rebuilt from first principles every three years.

## 7. Public Requests for Information

We are committed to responding in a systematic and timely manner to requests from interested and affected stakeholders for additional information material to public safety and the integrity of our TSFs.

Key contact information and our enquiry form can be found at [www.south32.net](http://www.south32.net).

We also encourage people to Speak up when our values and standards are not being followed through our Speak Up Policy and EthicsPoint Reporting Hotline which can be found at [www.south32.net](http://www.south32.net).

## 8. Transparency

We are committed to cooperating in credible global transparency initiatives and do this primarily through our approach to sustainability, which can be found at [www.south32.net](http://www.south32.net).

## 9. ICMM Conformance Protocols

In accordance with the ICMM Conformance Protocols, South32 has self-assessed its alignment of BRDAs 2, 4, 4X and 5 as having met the 15 Principles and all underlying Requirements of the Global Industry Standard on Tailings Management as published by the International Council of Mining and Metals. South32 has engaged KPMG to provide limited assurance over this self-assessment. KPMG's assurance opinion is available in Appendix A.

## Appendix A : KPMG Assurance Opinion



# Independent Limited Assurance Report to the Directors of South32 Limited

## Conclusion

Based on the evidence we obtained from the procedures performed, we are not aware of any material misstatements in the Information Subject to Assurance, described below, which has been prepared by South32 Limited (South32) in accordance with Principles 1 to 15 and the underlying Requirements of the Global Industry Standard on Tailings Management (GISTM) as published by the International Council on Mining and Metals (ICMM), the United Nations (UN) Environment Programme, and the Principles for Responsible Investment (PRI) and presented in South32's GISTM Requirement 15.1 Public Disclosure Worsley Alumina dated 4 August 2023 available on South32's website at <https://www.south32.net/sustainability/environment/waste-and-tailings>.

## Information Subject to Assurance

The Information Subject to Assurance comprised South32's statement that South32 has self-assessed its alignment of BRDAs 2, 4, 4X and 5 as having met the 15 Principles and all underlying Requirements of the Global Industry Standard on Tailings Management as published by the International Council on Mining and Metal, the United Nations Environment Programme, and the Principles for Responsible Investment, presented in South32's GISTM Requirement 15.1 Public Disclosure Worsley Alumina dated 4 August 2023 available on South32's website at <https://www.south32.net/sustainability/environment/waste-and-tailings>.

## Criteria Used as the Basis of Reporting

The criteria used as the basis of reporting includes Principles 1 to 15 and all underlying Requirements of the Global Industry Standard on Tailings Management as published by the International Council on Mining and Metals ("the criteria").

## Basis for Conclusion

We conducted our work in accordance with Australian Standard on Assurance Engagements ASAE 3000 *Assurance Engagements other than Audits or Reviews of Historical Financial Information* (Standard). In accordance with the Standards we have:

- used our professional judgement to plan and perform the engagement to obtain limited assurance that we are not aware of any material misstatements in the Information Subject to Assurance, whether due to fraud or error;
- considered relevant South32 internal controls when designing our assurance procedures, however we do not express a conclusion on their effectiveness; and
- ensured that the engagement team possess the appropriate knowledge, skills and professional competencies.

## Summary of Procedures Performed

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Our limited assurance conclusion is based on the evidence obtained from performing the following procedures:

- interviews with senior management and relevant corporate staff at South32 corporate office, including enquiries with relevant South32 personnel to understand the internal controls, governance structure and reporting processes in relation to the Information Subject to Assurance;
- a visit to and interviews with senior management and relevant staff at the South32 Worsley Alumina Refinery site, including enquiries with relevant South32 personnel to understand the internal controls, governance structure and reporting processes in relation to the Information Subject to Assurance;
- review on a sample basis of source documentation to support South32's statement that South32 has self-assessed its alignment of BRDAs 2, 4, 4X and 5 as having met the 15 Principles and all underlying Requirements of the GISTM;
- walkthrough of self-assessment documentation with senior management, relevant corporate and asset staff at South32 corporate office;
- assessment of the suitability and application of the criteria in respect of the Information Subject to Assurance; and
- evaluation of the design and implementation of the key systems, processes and controls for collecting, managing and reporting the Information Subject to Assurance.

#### **How the Standard Defines Limited Assurance and Material Misstatement**

The procedures performed in a limited assurance engagement vary in nature and timing from and are less in extent than for a reasonable assurance engagement. Consequently, the level of assurance obtained in a limited assurance engagement is substantially lower than the assurance that would have been obtained had a reasonable assurance engagement been performed.

Misstatements, including omissions, are considered material if, individually or in the aggregate, they could reasonably be expected to influence relevant decisions of the Directors of South32.

#### **Use of this Assurance Report**

This report has been prepared for the Directors of South32 for the purpose of providing an assurance conclusion on the Information Subject to Assurance and may not be suitable for another purpose. We disclaim any assumption of responsibility for any reliance on this report, to any person other than the Directors of South32, or for any other purpose than that for which it was prepared.

#### **Management's responsibility**

South32 are responsible for:

- determining that the criteria is appropriate to meet their needs;
- preparing and presenting the Information Subject to Assurance in accordance with the criteria;
- establishing internal controls that enable the preparation and presentation of the Information Subject to Assurance that is

#### **Our Responsibility**

Our responsibility is to perform a limited assurance engagement in relation to the Information Subject to Assurance presented in South32's GISTM Requirement 15.1 Public Disclosure Worsley Alumina dated 4 August 2023, and to issue an assurance report that includes our conclusion.

#### **Our Independence and Quality Control**

We have complied with the independence and other relevant ethical requirements of the



free from material misstatement, whether due to fraud or error;

- telling us any known and/or contentious issues relating to the information subject to assurance; and
- maintaining integrity of the [website](#).

*Code of Ethics for Professional Accountants (including Independence Standards)* issued by the Australian Professional and Ethical Standards Board, and complied with the applicable requirements of Australian Standard on Quality Management 1 to design, implement and operate a system of quality management.



KPMG



Julia Bilyanska

Partner

Melbourne

4 August 2023