Huntly Bauxite Mine – WQMS Data Review

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Michael Minter		Georgia Duffy		Georgia Duffy	
Name	Michael Minter	Name	Georgia Duffy	Name	Georgia Duffy
Position	Env. Engineer	Position	Chemical Engineer	Position	Chemical Engineer
Date	07/01/2024	Date	07/01/2024	Date	07/01/2024

RARE Environmental Pty Ltd
ABN 41617855017
110/117 Old Pittwater Rd
Brookvale NSW 2100 Australia
P: 0413 223 401
www.rare-enviro.com.au

Infrastructure Sustainability Council MEMBER

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1. Executive Summary

This report, prepared by RARE Environmental Pty Ltd and SciDev Pty Ltd for Alcoa, provides an analysis of turbidity data collected from Water Quality Monitoring Systems (WQMSs) deployed at the Huntly bauxite mining operations during November 2024. The primary objective of this analysis was to evaluate the quality of the data, identify potential "true" turbidity exceedance events, and support Alcoa's compliance reporting obligations under Schedule 1, Division 2, Clause 6 of the **Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023**.

The analysis focused on identifying and classifying turbidity events where levels exceeded 25 nephelometric turbidity units (NTU) for at least one hour. Events were categorized as "true" or "false" based on Alcoa's **Turbidity Event Classification Guidelines**, which distinguish actual turbidity increases (true events) from false readings caused by environmental factors such as debris, air bubbles, or fluctuating water levels.

Key findings include:

- **True Events**: One "true" turbidity exceedance event (Event ID: HUN-2411-047) was identified and further investigated. The event exhibited characteristics consistent with a true event, including a sharp incline and gradual return to baseline turbidity levels. However, it was determined to be unrelated to mining activities.
- **False Events**: Forty-Three false events were identified, primarily attributed to factors such as debris accumulation, sensor obstructions, and water turbulence.
- **Excluded Units**: Sixteen WQMS units were excluded from the analysis due to invalid data caused by equipment faults or environmental interference.

The report also highlights periods of missing data, which occurred due to system log-offs, equipment faults, or unplanned shutdowns. These gaps are detailed in the report to ensure transparency in data handling.

2. Scope

RARE Environmental Pty Ltd and SciDev Pty Ltd were engaged by Alcoa to analyze turbidity data collected from the Huntly Water Quality Monitoring Systems (WQMSs). The primary objective of this engagement is to assess the quality of the collected data and identify potential "true" turbidity events. This analysis supports Alcoa's reporting obligations under *Schedule 1, Division 2, Clause 6 of the Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

3. Introduction

3.1. Background

Alcoa of Australia Ltd (Alcoa) operates two bauxite mines, Huntly and Willowdale, approximately 100 km southeast of Perth, Western Australia. These mining operations are subject to environmental controls mandated by the *Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

Under this Exemption Order, Alcoa is required to implement drainage control measures and monitor effectiveness in water bodies within and downstream of mining operations. Turbidity, a critical water quality parameter, is monitored using Water Quality Monitoring Systems (WQMSs), to detect deviations and identify high-turbidity events.

Alcoa is obligated to report monthly on stream turbidity, including the identification and classification of any “true” high-turbidity exceedance events. (Refer to Appendix B for the site map showing WQMS locations.)

3.2. Monitoring requirements

Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023 specifies that a drainage incident occurs when:

> *a) runoff from a disturbance area enters the surrounding environment, resulting in surface water turbidity of at least 25 NTU for a duration of at least one hour; or*
>
> *b) a discharge from containment infrastructure includes, or may include, environmentally hazardous material.*

Trigger levels for drainage incidents are outlined in *Schedule 1* of the Exemption Order. To meet these requirements, Alcoa has developed "Turbidity Event Classification Guidelines" which define a true turbidity exceedance event as a WQMS recording turbidity levels of at least 25 NTU for a period exceeding one hour.

3.3. Water Quality Management Systems (WQMSs)

During the November 2024 monitoring period, Forty-Two WQMS units were deployed to monitor turbidity levels in streams subject to surface water runoff within and downstream of Huntly mining operations.

Each WQMS unit consists of the following components:

Aquas SMR10 Turbidity Probe

> Positioned at a 90-degree angle to water flow, each probe is equipped with an automatic lens wiper and a guard to protect against larger debris.

Data Taker DT82 Logger

> Records data locally every 6 seconds, with 6-minute averages transmitted via IoT-enabled modems to a cloud-based platform.

Float Switch

Detects whether the sensor is submerged or the stream is dry.

3.4. Purpose

This report aims to analyse turbidity data collected during November 2024, focusing on the identification and classification of "true" turbidity exceedance events based on Alcoa's Turbidity Event Classification Guidelines.

3.5. Exclusions

This report is not intended as:

- An assessment of the WQMS network or Alcoa's compliance with relevant legislation and requirements.
- An evaluation of the suitability of the trigger levels or event classification procedures adopted by Alcoa.

3.6. Abbreviations

	Term
IoT	Internet of Things
NTU	Nephelometric Turbidity Units
WQMS	Water Quality Management System

4. Methodology

4.1. WQMS Locations

A site map showing the WQMSs locations is provided in Appendix B.

4.2. Data Review

Data recorded by the WQMS Units was reviewed and potential events where turbidity levels exceeded 25 NTU for at least one hour. Each potential event was categorised as either 'true 'or 'false'.

4.2.1. True Turbidity Exceedance Events

These events are caused by an actual increase in stream turbidity. Per Alcoa's "Turbidity Event Classification Guidelines" true exceedance events typically exhibit:

- A sharp, sudden incline in turbidity levels.
- A return to baseline turbidity levels in a pattern resembling a normal (Gaussian) distribution.

Figure 1 Typical 'true' exceedance event showing the sharp incline and gradual return to background levels.

4.2.2. False Turbidity Exceedance Events

These events are caused by factors unrelated to actual turbidity increase, such as:

- Organic debris (e.g., leaves, sticks, algae) obstructing the sensor
- Air bubbles or water turbulence near the sensor
- Fluctuating water levels intermittently covering and uncover the sensor lens.

False events typically exhibit sharp inclines and declines without the characteristic bell curve shape of true events.

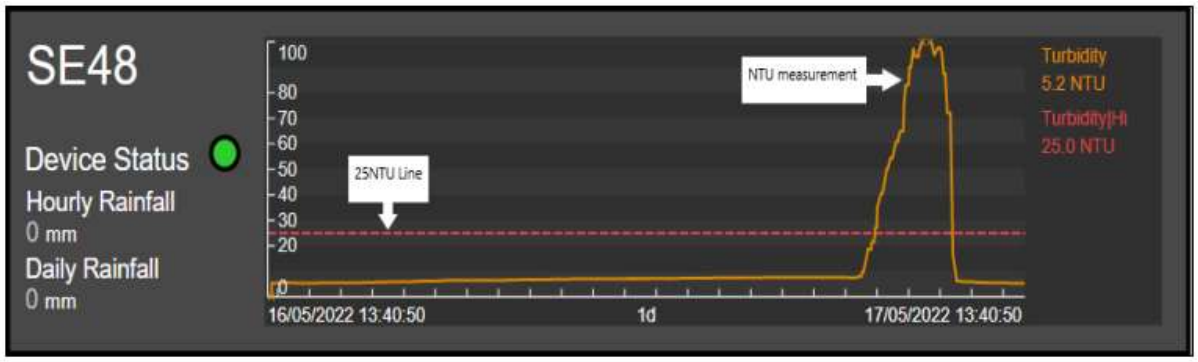


Figure 2 Typical 'false' exceedance event showing both a sharp incline and decline

4.2.3. Missing Data

Missing data occurs when a WQMS unit fails to record information, This can occur from unexpected system log-offs, equipment faults, or unplanned shutdowns.

5. Results and Discussion

5.1. Events

Table 1 provides a summary of identified events. Table 2 offers detailed information about each event.

Table 1 Events Summary

Category	# of events
True	1
False	43

Table 2 Events Details

Event ID	WQMS ID	Event Category	Start	End	Duration	Peak Turbidity (NTU)	Average Turbidity (NTU)
HUN-2411-001	ND06T	'False'	29/11/2024 16:12	29/11/2024 22:42	6 hours, 29 minutes	78.13	57.75
HUN-2411-002	ND06T	'False'	30/11/2024 14:06	30/11/2024 15:36	1 hours, 30 minutes	77.42	54.82
HUN-2411-003	SE01T	'False'	13/11/2024 13:36	14/11/2024 1:42	12 hours, 5 minutes	164.50	74.06
HUN-2411-004	SE01T	'False'	19/11/2024 19:48	20/11/2024 13:06	17 hours, 17 minutes	74.69	35.95
HUN-2411-005	SE03INV1	'False'	25/11/2024 15:12	25/11/2024 21:48	6 hours, 35 minutes	25.18	55.69
HUN-2411-006	SE03INV1	'False'	26/11/2024 14:06	27/11/2024 1:00	10 hours, 53 minutes	25.15	47.56
HUN-2411-007	SE03INV1	'False'	27/11/2024 11:06	28/11/2024 4:12	17 hours, 5 minutes	25.11	143.81
HUN-2411-008	SE03INV1	'False'	28/11/2024 10:24	29/11/2024 15:42	29 hours, 18 minutes	25.68	203.49
HUN-2411-009	SE03INV1	'False'	29/11/2024 16:00	30/11/2024 23:54	31 hours, 54 minutes	25.39	110.76
HUN-2411-010	SE03INV2	'False'	21/11/2024 4:30	21/11/2024 6:12	1 hours, 42 minutes	26.59	25.45
HUN-2411-011	SE03INV2	'False'	21/11/2024 15:00	23/11/2024 14:24	47 hours, 23 minutes	78.23	28.75
HUN-2411-012	SE03T	'False'	30/11/2024 0:03	30/11/2024 1:15	1 hours, 12 minutes	49.15	36.62
HUN-2411-013	SE05T	'False'	28/11/2024 20:22	29/11/2024 1:56	5 hours, 33 minutes	45.53	36.04
HUN-2411-014	SE08T	'False'	14/11/2024 14:24	14/11/2024 15:54	1 hours, 30 minutes	820.91	232.60
HUN-2411-015	SE08T	'False'	14/11/2024 17:18	14/11/2024 18:30	1 hours, 11 minutes	781.60	252.37
HUN-2411-016	SE08T	'False'	15/11/2024 14:36	15/11/2024 17:18	2 hours, 42 minutes	900.44	524.33

Event ID	WQMS ID	Event Category	Start	End	Duration	Peak Turbidity (NTU)	Average Turbidity (NTU)
HUN-2411-017	SE08T	'False'	16/11/2024 18:12	16/11/2024 19:36	1 hours, 23 minutes	1884.29	531.50
HUN-2411-018	SE12INV	'False'	1/11/2024 0:00	1/11/2024 1:24	1 hours, 23 minutes	5000.00	4796.74
HUN-2411-019	SE12INV	'False'	1/11/2024 9:06	2/11/2024 8:42	23 hours, 36 minutes	5000.00	1485.40
HUN-2411-020	SE12INV	'False'	2/11/2024 12:30	3/11/2024 0:24	11 hours, 54 minutes	5000.00	1771.68
HUN-2411-021	SE12INV	'False'	3/11/2024 11:48	4/11/2024 3:24	15 hours, 36 minutes	5000.00	1462.74
HUN-2411-022	SE12INV	'False'	4/11/2024 10:18	4/11/2024 23:54	13 hours, 36 minutes	4850.27	466.88
HUN-2411-023	SE12T	'False'	1/11/2024 20:24	1/11/2024 23:44	3 hours, 20 minutes	4000.00	967.95
HUN-2411-024	SE12T	'False'	2/11/2024 0:09	2/11/2024 3:11	3 hours, 1 minutes	3076.00	793.64
HUN-2411-025	SE12T	'False'	2/11/2024 5:00	2/11/2024 19:14	14 hours, 14 minutes	3200.62	453.25
HUN-2411-026	SE12T	'False'	5/11/2024 2:12	5/11/2024 4:01	1 hours, 49 minutes	1548.08	335.73
HUN-2411-027	SE12T	'False'	10/11/2024 9:35	10/11/2024 19:35	10 hours, 0 minutes	26.77	25.75
HUN-2411-028	SE12T	'False'	11/11/2024 22:22	12/11/2024 0:23	2 hours, 1 minutes	3449.13	929.11
HUN-2411-029	SE12T	'False'	14/11/2024 0:25	14/11/2024 1:38	1 hours, 12 minutes	3906.94	2082.40
HUN-2411-030	SE12T	'False'	19/11/2024 14:53	19/11/2024 20:02	5 hours, 9 minutes	953.30	52.26
HUN-2411-031	SE12T	'False'	25/11/2024 23:44	26/11/2024 0:50	1 hours, 6 minutes	1820.66	491.45
HUN-2411-032	SE12T	'False'	25/11/2024 23:44	26/11/2024 0:50	1 hours, 6 minutes	1820.66	491.45
HUN-2411-033	SE34T	'False'	1/11/2024 7:20	1/11/2024 9:45	2 hours, 25 minutes	111.08	63.87
HUN-2411-034	SE34T	'False'	2/11/2024 8:11	2/11/2024 15:33	7 hours, 22 minutes	276.66	110.35
HUN-2411-035	SE48T	'False'	1/11/2024 19:49	2/11/2024 2:17	6 hours, 27 minutes	1057.95	142.03
HUN-2411-036	SE51T	'False'	20/11/2024 0:24	20/11/2024 2:54	2 hours, 29 minutes	58.64	39.64
HUN-2411-037	SE60T	'False'	3/11/2024 9:23	3/11/2024 11:13	1 hours, 49 minutes	30.51	27.96
HUN-2411-038	SE62T	'False'	1/11/2024 7:12	1/11/2024 9:13	2 hours, 1 minutes	28.44	26.29
HUN-2411-039	SE62T	'False'	1/11/2024 15:22	1/11/2024 23:58	8 hours, 35 minutes	38.74	32.36

Event ID	WQMS ID	Event Category	Start	End	Duration	Peak Turbidity (NTU)	Average Turbidity (NTU)
HUN-2411-040	SE62T	'False'	2/11/2024 0:22	3/11/2024 8:41	32 hours, 19 minutes	339.93	92.43
HUN-2411-041	SE62T	'False'	8/11/2024 11:56	8/11/2024 13:08	1 hours, 12 minutes	27.65	26.60
HUN-2411-042	SE62T	'False'	8/11/2024 13:57	8/11/2024 16:59	3 hours, 1 minutes	67.02	38.02
HUN-2411-043	SE62T	'False'	15/11/2024 3:14	17/11/2024 13:16	58 hours, 1 minutes	529.69	272.88
HUN-2411-044	**SE62T**	**'True'**	**20/11/2024 20:10**	**21/11/2024 4:03**	**7 hours, 52 minutes**	**197.36**	**81.96**

* End date and time provided by Alcoa

5.2. True Event(s)

1 potential 'true' turbidity event was identified during the reporting period.

5.2.1. HUN-2411-047

This event exhibited a sharp incline followed by a gradual return to baseline levels, characteristic of a true event.

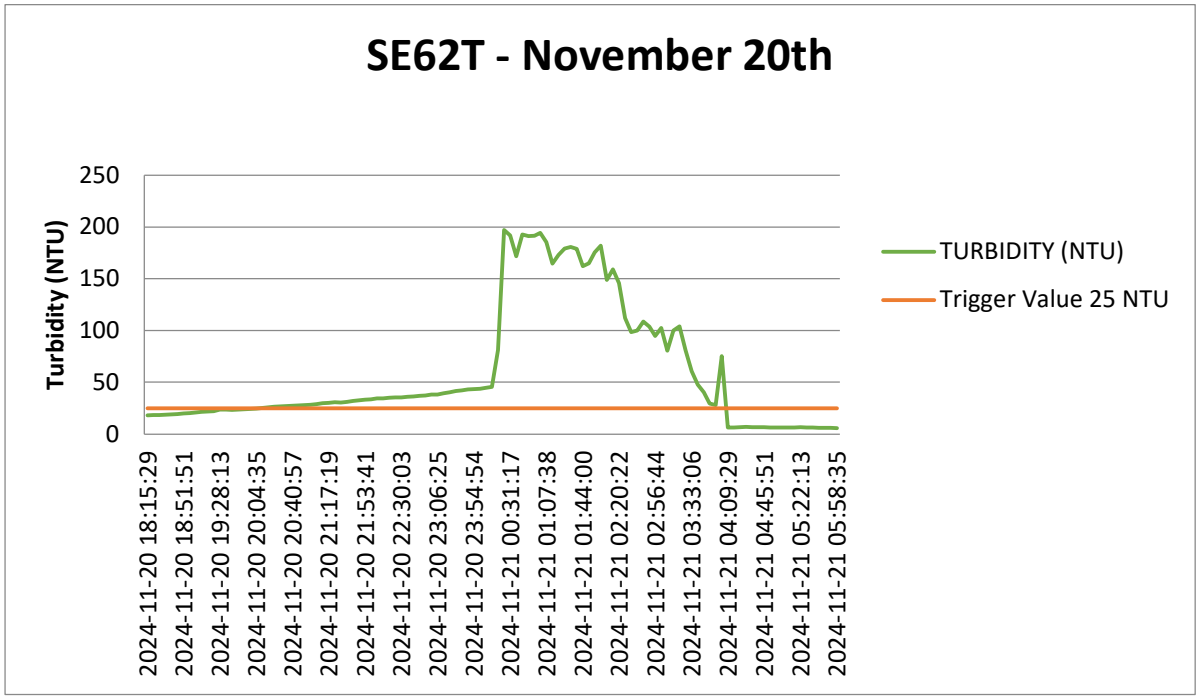


Figure 3 HUN-2411-047

5.3. True Event Investigation(s)

The following investigations were undertaken to classify 'true' events.

Table 3: True Event Investigation Outcomes

Event ID	Event Classification	Alcoa Investigation	Outcome
HUN-2411-047	Non-Mining Related	*Site inspected on 21/11/2024. Stream is stagnant and low. Branch debris lodged around sensor on arrival and film of tannins and pollen on water surface.*	No further investigation is required

5.4. False Event(s)

Forty-three false events were identified during the reporting period. Rationale on potential causes is summarised below.

Table 4 False Events Rationale

Event ID	Monitor ID	Rationale	Field Notes
HUN-2411-001	ND06T	This event is marked by sporadic peaks indicative of a 'false' event.	ite inspected on 3/12/2024. Stream level has dropped but sensor was still submerged. Minor algae build up on Lens. Data trend indicates false event, sharp incline and decline, potentially debris caught on the sensor
HUN-2411-002	ND06T	This event is marked by a gradual increase and a gradual return to background levels indicative of a 'false' event.	Data trend indicates false event, erratic turbidity values with a rapid decline, likely caused by debris impacting the lens.
HUN-2411-003	SE01T	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 20/11/2024, stream clear and flowing. Stream level low but sensor was sufficiently submerged. Sensor was removed for cleaning, no debris or algae build up was observed. Turbidity value on arrival was 46.1NTU which dropped to 0.2NTU after cleaning and repositioning the sensor. Data trend indicates potentially false event due to the rapid decline of turbidity values after cleaning, however as the sensor was observed mostly clean and turbidity incline coincides with rainfall, a catchment inspection was completed. No drainage issues were observed during catchment inspection. Due to the low stream level and the positioning of the sensor close to the stream bed, as well as the period of dry weather preceding this rain event, the event was potentially caused by the increased stream flow flushing stream bed debris past the sensor.
HUN-2411-004	SE01T	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 23/11/2024. Manual data download due to turbidity exceedance notification. Stream is clear, flowing and cleaned sensor. Sensor impacted by brown algae and contributing to turbidity exceedance. No mining related activity found on this visit.
HUN-2411-005	SE03INV1	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 23/11/2024. Manual data download due to turbidity exceedance notification. Stream is clear, flowing and cleaned sensor. Sensor impacted by brown algae and contributing to turbidity exceedance. No mining related activity found on this visit.

Event ID	Monitor ID	Rationale	Field Notes
HUN-2411-006	SE03INV1	This event is marked by sporadic peaks indicative of a 'false' event.	Stream level drop, sensor out of water. Sensor cleaned and repositioned, stream level very low but sensor is still submerged
HUN-2411-007	SE03INV1	This event is marked by sporadic peaks indicative of a 'false' event.	Stream level drop, sensor out of water. Sensor cleaned and repositioned, stream level very low but sensor is still submerged
HUN-2411-008	SE03INV1	This event is marked by sporadic peaks indicative of a 'false' event.	Stream level drop, sensor out of water. Sensor cleaned and repositioned, stream level very low but sensor is still submerged
HUN-2411-009	SE03INV1	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 23/11/2024. Manual data download due to turbidity exceedance notification. Stream is clear, flowing and cleaned sensor. Sensor impacted by brown algae and contributing to turbidity exceedance. No mining related activity found on this visit.
HUN-2411-010	SE03INV2	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 23/11/2024. Manual data download due to turbidity exceedance notification. Stream is clear, flowing and cleaned sensor. Sensor impacted by brown algae and contributing to turbidity exceedance. No mining related activity found on this visit.
HUN-2411-011	SE03INV2	This event is marked by gradual increase followed by a spike and rapid return to background levels indicative of a 'false' event.	No field notes recorded
HUN-2411-012	SE03T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream level is dropping and stream bed is impacted by algae. Data trend indicates false event, slow incline followed by a rapid decline indicating debris on the lens
HUN-2411-013	SE05T	This event is marked by sporadic peaks indicative of a 'false' event.	unit inspected on 3/12/2024. Stream level has dropped but sensor was still submerged. Minor algae build up on lens. Data trend indicates false event, sharp incline and decline, potentially debris caught on the sensor
HUN-2411-014	SE08T	This event is marked by a sharp increase and a gradual decrease, however the levels do not return to background until after HUN2411-015. The two separate events are	Site inspected on 17/11/2024, stream still flowing and very clear and time of inspection. Stream level is low and sensor is close to the stream bed

Event ID	Monitor ID	Rationale	Field Notes
		clearly linked and indicative of a 'false' event.	
HUN-2411-015	SE08T	This event follows event HUN-2411-015 and is marked by a gradual increase and a rapid return to background levels indicative of a false event.	Site inspected on 17/11/2024, stream still flowing and very clear and time of inspection. Stream level is low and sensor is close to the stream bed
HUN-2411-016	SE08T	This event is marked by a sharp increase and a rapid return to background levels indicative of a 'false' event.	Site inspected on 17/11/2024, stream still flowing and very clear and time of inspection. Stream level is low and sensor is close to the stream bed
HUN-2411-017	SE08T	This event is marked by a sharp increase and a rapid return to background levels indicative of a 'false' event.	Site inspected on 17/11/2024, stream still flowing and very clear and time of inspection. Stream level is low and sensor is close to the stream bed
HUN-2411-018	SE12INV	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-019	SE12INV	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-020	SE12INV	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-021	SE12INV	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-022	SE12INV	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-023	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.

Event ID	Monitor ID	Rationale	Field Notes
HUN-2411-024	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-025	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-026	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing however the water level is very low and sensor is intermittently in and out of water. Sensor is positioned very close to the stream bed causing debris to impact the lens.
HUN-2411-027	SE12T	This event is marked by a sharp increase and a rapid return to background levels indicative of a 'false' event.	Stream is flowing but water level is very low and only just covering the lens. Lense is sitting in sediment in the stream bed. Upstream monitor SE12INV is dry.
HUN-2411-028	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing but water level is very low and only just covering the lens. Lense is sitting in sediment in the stream bed. Upstream monitor SE12INV is dry.
HUN-2411-029	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing but water level is very low and only just covering the lens. Lense is sitting in sediment in the stream bed. Upstream monitor SE12INV is dry.
HUN-2411-030	SE12T	This event is marked by a sharp increase and a rapid return to background levels indicative of a 'false' event.	Stream is flowing but water level is very low and only just covering the lens. Lense is sitting in sediment in the stream bed. Upstream monitor SE12INV is dry.
HUN-2411-031	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing but water level is very low and only just covering the lens. Lense is sitting in sediment in the stream bed. Upstream monitor SE12INV is dry.
HUN-2411-032	SE12T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is flowing but water level is very low and only just covering the lens. Lense is sitting in sediment in the stream bed. Upstream monitor SE12INV is dry.
HUN-2411-033	SE34T	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 3/11/2024 stream level has dropped and sensor is out of water. Turbidity value on arrival 34.66NTU. Sensor cleaned and repositioned mid-depth, turbidity dropped to 0.39NTU.

Event ID	Monitor ID	Rationale	Field Notes
HUN-2411-034	SE34T	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 3/11/2024 stream level has dropped and sensor is out of water. Turbidity value on arrival 34.66NTU. Sensor cleaned and repositioned mid-depth, turbidity dropped to 0.39NTU.
HUN-2411-035	SE48T	This event is marked by sporadic peaks indicative of a 'false' event.	No field notes recorded
HUN-2411-036	SE51T	This event is marked by a gradual increase and a gradual return to background levels indicative of a 'false' event.	Data trend indicates true event, gradual incline and decline coinciding with rainfall. Site inspected on 20/11/2024, stream clear and flowing. Evidence of organic debris in the stream. Sensor was impacted by algae/iron film. SE51T catchment inspection completed, no evidence of mining contribution found. A historic drainage event was found in Ingen 5 rehabilitation, with no evidence of recent sediment mobilisation reaching stream.
HUN-2411-037	SE60T	This event is marked by a gradual increase and a gradual return to background levels indicative of a 'false' event.	Data trend indicates false event. Stream level is dropping, and stream flow is weak. Ponded section of the stream where the sensor is situated is slightly stagnant and there is debris in the stream bed and around the sensor.
HUN-2411-038	SE62T	This event is marked by a sharp increase and a rapid return to background levels indicative of a 'false' event.	Site inspected on 3/11/2024. Stream appears stagnant but may still have some connecting flow as the upstream crossing is flowing. Heavy debris in the stream bed and around the sensor. Algal film on the water surface and impacting the lens. Cleaned and returned mid-depth. NTU on arrival 51.79 which dropped to 7.4NTU after cleaning.
HUN-2411-039	SE62T	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 3/11/2024. Stream appears stagnant but may still have some connecting flow as the upstream crossing is flowing. Heavy debris in the stream bed and around the sensor. Algal film on the water surface and impacting the lens. Cleaned and returned mid-depth. NTU on arrival 51.79 which dropped to 7.4NTU after cleaning.
HUN-2411-040	SE62T	This event is marked by sporadic peaks indicative of a 'false' event.	Site inspected on 3/11/2024. Stream appears stagnant but may still have some connecting flow as the upstream crossing is flowing. Heavy debris in the stream bed and around the sensor. Algal film on

Event ID	Monitor ID	Rationale	Field Notes
			the water surface and impacting the lens. Cleaned and returned mid-depth. NTU on arrival 51.79 which dropped to 7.4NTU after cleaning.
HUN-2411-041	SE62T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is ponded and becoming stagnant, heavy debris in the stream bed and film on the water surface
HUN-2411-042	SE62T	This event is marked by sporadic peaks indicative of a 'false' event.	Stream is ponded and becoming stagnant, heavy debris in the stream bed and film on the water surface
HUN-2411-043	SE62T	This event is marked by gradual increase followed by a rapid return to background levels indicative of a 'false' event.	Stream is ponded and becoming stagnant, heavy debris in the stream bed and film on the water surface

5.5. Excluded WQMS Units

16 WQMS Units were excluded from analysis due to erroneous data. SciDev confirmed the invalidity of data recorded from these units and provided commentary on the condition of each.

Table 5 Excluded WQMS Units

Unit	Dates	SciDev Comment
DB02T	21/11/2024-22/11/2024	Site inspected on 22/11/2024, stream clear and flowing. On arrival NTU was 50.7128. The sensor is heavily impacted by vegetation growing within the stream. Sensor post clean read NTU of 1.2746.
ND13T	1/11/2024	Stream level drop, sensor partially out of water.
SE02T	8/11/2024-2/12/2024	Site inspected on 9/11, 20/11 and 3/12 stream level is low and the sensor is positioned close to the stream bed. Sensor heavily impacted by algae and debris.
SE03INV3	4/11/2024-30/11/2024	System malfunction, sensor intermittently reading high values and dropping below calibration. Troubleshooting by maintenance contractor is ongoing.
SE03T	28/11/2024-29/11/2024	Stream level dropping. Stream impacted by algae. No rain 24 hours before event.
SE05T	17/11/2024-20/11/2024	Site inspected 18/11 and 20/11 stream clear and flowing. Significant red algae in stream and on sensor. Organic debris present in the stream. SE05T catchment Inspection completed, no evidence of mining impact.
SE07T	11/11/2024-30/11/2024	Stream has ceased flowing, sensor is submerged in ponded water and is stagnant
SE12INV	5/11/2024-30/11/2024	Stream dry as of 5/11/2024
SE15T	4/11/2024-30/11/2024	Stream level has dropped, water has ponded and is stagnant.
SE22T	17/11/2024-30/11/2024	Stream level is very low and sensor is partially out of water
SE24T	6/11/2024-30/11/2024	Stream is dry
SE25T	1/11/2024-30/11/2024	Stream is dry
SE48T	27/11/2024-30/11/2024	Stream level has dropped, sensor out of water and impacted by algae
SE53T	1/11/2024-30/11/2024	Stream level has dropped, sensor is out of water
SE61T	23/11/2024	Sensor fault. Sensor reading high values
SE62T	23/11/2024-30/11/2024	Stream is dry, sensor sitting above stream pond water level

5.6. Missing Data

Periods of missing data are detailed in Table 6.

Table 6 Missing Data Summary

Missing Data ID	Unit	Start	End	Comments
MD-2411-001	FPWR1	06/11/2024	30/11/2024	Data gap due to system malfunction
MD-2411-002	ND04T	01/11/2024	09/11/2024	Sensor Fault
MD-2411-003	ND04T	14/11/2024	20/11/2024	Data loss due to system malfunction
MD-2411-004	SE03INV3	14/11/2024	14/11/2024	Data gap due to system maintenance
MD-2411-005	SE03INV3	21/11/2024	21/11/2024	Data gap due to system maintenance
MD-2411-006	SE06T	12/11/2024	20/11/2024	Data loss due to system malfunction

6. Appendices

Appendix A. Huntly Raw WQMS Data

Date	Huntly WQMS Data - November 2024 - Events with turbidity > 25 NTU for an hour or more																
	DB01T	DB02T	FPWR1	ND04T	ND06T	ND07T	ND12T	ND13T	ND14T	PD01T	SE01T	SE02T	SE03T	SE05T	SE06T	SE07T	SE08T
1/11/2024																	
2/11/2024																	
3/11/2024																	
4/11/2024																	
5/11/2024																	
6/11/2024																	
7/11/2024																	
8/11/2024																	
9/11/2024																	
10/11/2024																	
11/11/2024																	
12/11/2024																	
13/11/2024											**1**						
14/11/2024																	**2**
15/11/2024																	**1**
16/11/2024																	**1**
17/11/2024																	
18/11/2024																	
19/11/2024											**1**						
20/11/2024																	
21/11/2024																	
22/11/2024																	
23/11/2024																	
24/11/2024																	
25/11/2024																	
26/11/2024																	
27/11/2024																	
28/11/2024														**1**			
29/11/2024					**1**												
30/11/2024					**1**								**1**				

Note: False events have been annotated by **black** bold text. True events for further investigation are annotated by **red** bold text

Date	Huntly WQMS Data -November 2024 - Events with turbidity > 25 NTU for an hour or more																
	SE09T	SE10T	SE11T	SE12T	SE12INV	SE15T	SE34T	SE36T	SE48T	SE51T	SE52T	SE53T	SE59T	SE60T	SE61T	SE62T	SN07T
1/11/2024				**1**	**2**		**1**		**1**							**2**	
2/11/2024				**2**	**1**		**1**									**1**	
3/11/2024					**1**									**1**			
4/11/2024					**1**												
5/11/2024				**1**													
6/11/2024																	
7/11/2024																	
8/11/2024																**1**	
9/11/2024																	
10/11/2024				**1**													
11/11/2024				**1**													
12/11/2024																	
13/11/2024				**1**													
14/11/2024																	
15/11/2024																**1**	
16/11/2024																	
17/11/2024																	
18/11/2024				**1**													
19/11/2024																	
20/11/2024										**1**						**1**	
21/11/2024																	
22/11/2024																	
23/11/2024																	
24/11/2024																	
25/11/2024				**2**													
26/11/2024																	
27/11/2024																	
28/11/2024																	
29/11/2024																	
30/11/2024																	

Note: False events have been annotated by **black** bold text. True events for further investigation are annotated by **red** bold text

Date	Huntly WQMS Data - November 2024 - Events with turbidity > 25 NTU for an hour or more																
	SE03IN2	SE22T	SE23T	SE25T	SE24T	SE03INV1	SE03INV3	SE24T									
1/11/2024																	
2/11/2024																	
3/11/2024																	
4/11/2024																	
5/11/2024																	
6/11/2024																	
7/11/2024																	
8/11/2024																	
9/11/2024																	
10/11/2024																	
11/11/2024																	
12/11/2024																	
13/11/2024																	
14/11/2024																	
15/11/2024																	
16/11/2024																	
17/11/2024																	
18/11/2024																	
19/11/2024																	
20/11/2024																	
21/11/2024							**2**										
22/11/2024																	
23/11/2024																	
24/11/2024																	
25/11/2024						**1**											
26/11/2024						**1**											
27/11/2024						**1**											
28/11/2024						**1**											
29/11/2024						**1**											
30/11/2024																	

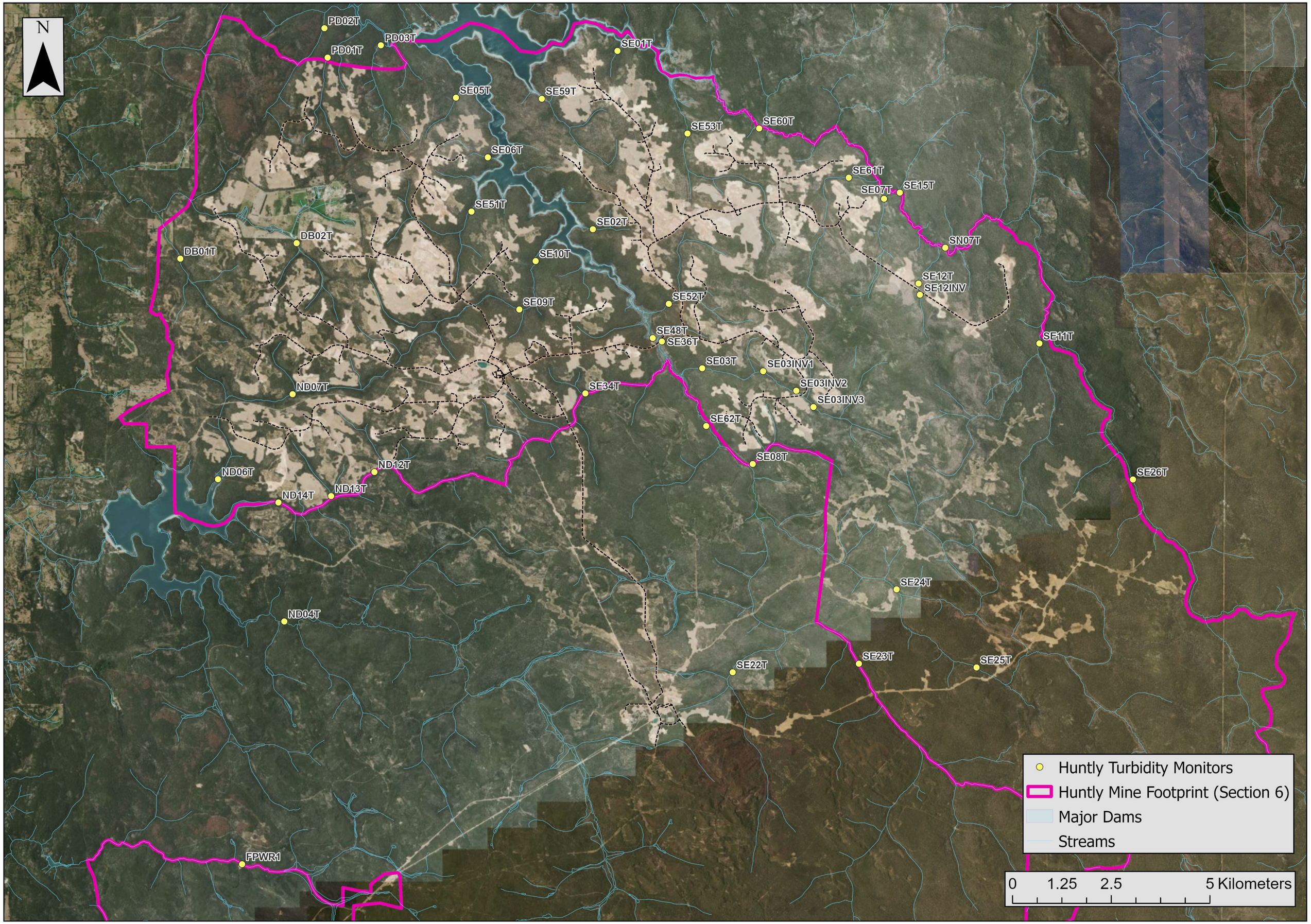
Note: False events have been annotated by **black** bold text. True events for further investigation are annotated by **red** bold text

Date	Huntly WQMS Data - November 2024 - Turbidity (Daily Average, NTU)																
	DB01T	DB02T	FPWR1	ND04T	ND06T	ND07T	ND12T	ND13T	ND14T	PD01T	SE01T	SE02T	SE03T	SE05T	SE06T	SE07T	SE08T
1/11/2024	0.88	1.35	1.06		3.09	13.16	1.54	19.34	1.42	4.51	0.57	3.72	3.56	5.58	0.78	1.23	1.50
2/11/2024	0.89	1.35	1.41		3.21	13.55	1.54	1.75	1.49	4.69	0.73	3.91	2.97	6.74	0.71	1.27	1.05
3/11/2024	0.90	1.35	1.45		2.14	14.33	1.43	1.23	1.36	4.63	0.70	3.95	2.14	5.51	0.82	1.29	1.07
4/11/2024	0.90	1.34	1.19		1.36	14.85	1.49	1.18	1.47	4.76	0.65	4.59	1.83	6.05	1.44	1.30	1.09
5/11/2024	0.89	1.33	4.21		1.50	14.93	1.53	1.17	1.44	4.89	0.74	4.74	2.17	5.99	2.76	1.29	1.17
6/11/2024	0.89	1.41			1.66	15.41	1.58	1.16	1.34	5.00	1.01	5.36	1.84	6.84	0.96	1.32	1.11
7/11/2024	0.91	7.92			1.71	16.14	1.60	1.17	1.37	10.30	0.89	8.90	1.74	5.75	1.05	1.41	1.14
8/11/2024	0.90	10.81			2.05	16.02	2.15	1.17	1.44	5.06	0.72	19.90	1.94	5.51	1.36	1.27	1.13
9/11/2024	0.90	2.51			2.15	15.92	1.62	1.23	1.47	4.25	0.63	12.48	2.14	5.21	2.47	1.24	1.12
10/11/2024	0.91	1.34		0.98	1.83	16.22	2.26	1.20	1.43	4.20	0.67	5.67	2.30	5.72	2.98	1.24	1.16
11/11/2024	0.94	1.54		0.94	1.99	15.93	1.90	1.20	1.46	5.23	1.05	5.49	2.21	7.50	4.48	52.02	1.15
12/11/2024	0.91	1.43		1.09	1.78	16.06	1.78	1.25	1.40	4.36	0.62	4.99	2.45	6.59		180.78	1.16
13/11/2024	0.91	1.42		2.26	1.83	15.70	3.42	1.29	1.56	4.40	35.79	5.92	2.85	6.07		135.99	1.91
14/11/2024	0.91	1.33		0.95	2.03	14.92	2.09	1.29	1.58	4.48	10.24	5.82	3.08	5.52		147.71	31.09
15/11/2024	0.90	1.35			1.96	15.10	1.87	1.48	1.43	4.17	0.57	6.65	3.35	7.37		23.03	62.25
16/11/2024	0.92	2.19			2.01	16.25	1.86	1.40	1.38	4.21	2.80	13.54	3.26	7.71		2707.66	46.32
17/11/2024	0.94	1.98			1.82	16.61	1.88	2.49	1.43	4.27	1.53	43.96	2.78	21.74		4176.02	11.46
18/11/2024	0.93	3.76			1.83	16.03	1.99	1.37	1.44	4.77	1.85	89.91	2.10	12.94		2057.89	0.96
19/11/2024	0.92	7.74			2.80	15.39	2.82	1.44	2.06	4.81	11.47	128.38	2.67	13.84		2857.90	1.18
20/11/2024	0.92	10.04			3.25	15.09	1.78	1.39	2.92	5.05	18.55	61.86	3.61	8.26		2980.25	1.72
21/11/2024	0.93	18.93		1.51	2.43	15.12	1.68	1.29	2.10	4.09	0.44	2.57	2.42	3.72	0.92	0.88	1.04
22/11/2024	1.01	24.46		0.98	2.36	15.75	1.76	1.32	1.41	4.09	0.51	2.51	2.23	4.26	1.00	0.97	1.16
23/11/2024	0.97	1.31		0.85	2.31	15.73	1.82	1.18	1.38	5.59	0.40	2.34	2.19	4.15	1.09	1.19	1.47
24/11/2024	0.99	1.33		0.84	2.52	15.07	1.85	1.20	1.33	4.33	0.98	2.20	2.31	4.71	1.29	13.12	1.02
25/11/2024	1.05	1.58		0.83	2.17	14.95	1.95	1.22	1.33	4.23	3.35	2.32	2.02	5.73	1.30	2617.90	1.05
26/11/2024	1.09	3.70		0.87	2.06	16.34	2.13	1.25	1.39	4.12	5.96	3.75	1.95	7.74	1.38	110.80	1.19
27/11/2024	1.13	2.16		0.86	2.06	16.12	2.29	1.29	5.50	4.11	1.65	7.30	2.06	10.52	2.74	16.51	1.11
28/11/2024	1.13	1.31		0.84	3.20	15.51	3.60	1.32	13.18	4.63	1.24	13.23	26.14	21.41	1.55	14.58	1.09
29/11/2024	1.05	1.31		0.86	19.18	15.43	2.36	1.32	13.29	4.22	1.18	27.01	24.75	9.98	1.34	13.43	1.37
30/11/2024	1.11	3.51		0.81	8.44	14.58	2.38	1.39	13.18	4.71	5.13	54.59	15.41	7.35	1.48	13.35	1.09

Date	Huntly WQMS Data - November 2024 - Turbidity (Daily Average, NTU)																
	SE09T	SE10T	SE11T	SE12T	SE12INV	SE15T	SE34T	SE36T	SE48T	SE51T	SE52T	SE53T	SE59T	SE60T	SE61T	SE62T	SN07T
1/11/2024	0.96	1.64	6.79	144.15	521.28	5.12	16.90	0.69	33.54	0.72	7.00	18.92	6.13	3.93	238.80	26.45	1.53
2/11/2024	0.96	1.66	6.69	418.44	2044.43	4.98	37.90	5.85	10.49	0.88	3.24	109.05	6.87	1.30	317.79	91.24	1.43
3/11/2024	0.97	1.65	9.29	22.04	353.50	5.19	0.44	0.66	1.79	0.87	1.21	254.58	7.31	6.25	212.57	35.53	1.51
4/11/2024	0.98	1.68	11.79	42.16	969.00	24.53	0.48	1.09	1.72	0.73	3.16	310.90	7.33	1.59	193.85	2.34	1.71
5/11/2024	0.97	1.69	11.34	48.55	1403.02	30.12	0.53	0.66	1.74	0.75	3.75	126.21	6.51	1.42	220.77	2.74	1.54
6/11/2024	1.05	1.71	9.56	17.97	2054.59	27.57	0.60	1.22	1.80	0.68	4.02	2.09	5.49	3.73	229.22	3.74	1.81
7/11/2024	0.98	1.74	7.16	12.16	961.77	72.96	0.72	0.73	1.90	0.63	4.50	2.21	4.82	1.44	112.76	6.18	1.45
8/11/2024	0.98	1.74	6.89	24.62	706.61	6.49	0.84	0.77	1.93	0.72	4.51	2.00	5.16	1.95	3.79	15.62	1.43
9/11/2024	0.98	1.75	7.01	39.85	1729.17	7.14	0.99	1.03	1.95	0.76	3.02	2.35	5.16	2.27	3.67	5.55	1.43
10/11/2024	0.99	1.77	15.63	24.82	358.34	11.20	1.17	0.82	2.03	0.66	2.23	0.79	6.31	16.93	3.52	3.53	1.43
11/11/2024	0.97	1.74	18.29	111.96	312.14	35.43	1.31	0.99	1.94	0.80	4.57	2.10	5.21	1.41	3.61	3.75	1.41
12/11/2024	0.99	1.78	6.97	36.33	313.63	32.35	1.51	1.27	2.01	0.84	4.83	0.48	3.71	2.56	3.79	5.30	1.42
13/11/2024	0.97	1.77	6.88	22.73	307.35	25.79	1.04	1.30	2.09	0.99	4.99	0.35	4.00	1.76	3.78	5.85	1.45
14/11/2024	1.02	1.80	6.78	133.83	302.28	21.52	0.56	1.13	2.20	0.83	4.80	0.50	4.35	2.08	3.99	38.80	1.41
15/11/2024	0.97	1.86	6.95	18.64	307.59	23.20	0.58	2.38	2.06	0.82	5.05	0.42	4.77	4.82	4.52	91.85	1.50
16/11/2024	0.97	1.98	7.17	12.67	311.01	44.37	0.63	6.28	2.28	0.70	4.91	0.81	4.56	1.30	4.28	328.11	4.10
17/11/2024	0.99	2.14	7.17	16.15	308.70	73.77	0.58	0.68	2.05	0.72	5.58	1.19	4.73	1.27	4.20	255.35	4.30
18/11/2024	1.22	2.10	21.74	14.17	302.14	23.58	0.54	1.03	2.13	0.73	7.56	1.92	5.02	1.18	5.15	3.23	3.29
19/11/2024	0.99	1.89	16.60	34.60	293.23	57.47	0.62	1.64	2.94	1.85	7.61	4.06	7.67	1.11	7.00	4.80	1.53
20/11/2024	1.06	2.44	4.80	18.39	296.33	22.84	0.87	1.14	2.57	7.62	7.34	7.67	6.48	4.26	6.41	14.23	1.60
21/11/2024	0.98	1.91	5.57	27.64	305.66	25.05	1.00	0.87	6.53	0.77	6.18	11.29	5.15	1.13	6.78	25.34	1.77
22/11/2024	0.99	2.20	7.00	11.90	308.31	26.32	1.26	1.10	2.17	0.69	6.32	13.99	5.19	2.35	5.72	3.63	1.80
23/11/2024	1.00	2.46	6.26	15.86	304.39	24.78	1.44	1.76	2.09	0.60	8.69	15.27	4.86	1.17	5.35	105.58	1.67
24/11/2024	0.99	9.76	6.53	33.87	301.29	23.09	1.45	2.59	2.12	0.64	13.33	18.66	5.07	1.17	5.24	74.78	1.76
25/11/2024	0.98	2.58	6.92	21.66	310.46	25.04	1.36	0.91	2.14	0.56	11.47	18.79	5.43	5.50	5.69	4.84	1.74
26/11/2024	1.22	2.77	6.94	95.70	312.91	104.80	1.43	0.97	2.87	0.38	0.51	15.92	5.45	16.04	5.52	4.77	1.70
27/11/2024	1.12	2.45	6.83	10.72	310.11	53.59	1.34	0.85	11.99	0.47	0.53	15.86	5.54	2.21	5.73	5.33	1.63
28/11/2024	1.02	2.22	16.40	15.44	306.11	23.33	1.35	5.09	34.86	0.47	0.52	17.55	5.69	1.30	5.46	4.95	1.75
29/11/2024	1.12	2.57	6.31	13.77	308.44	19.11	1.36	1.31	50.56	0.51	0.61	21.03	6.04	2.00	5.47	4.92	1.88
30/11/2024	1.11	2.12	6.21	15.68	301.38	17.21	1.32	1.46	294.46	0.51	0.65	23.97	6.22	1.32	5.71	3.56	1.98

Date	Huntly WQMS Data - November 2024 - Turbidity (Daily Average, NTU)																	
	SE22T	SE23T	SE24T	SE25T	SE26T	SE03INV1	SE03INV2	SE03INV3										
1/11/2024	5.64	10.15	3.59	37.46	10.60	2.44	0.01	0.01										
2/11/2024	7.69	10.07	4.39	51.41	10.42	2.11	0.01	0.01										
3/11/2024	4.15	10.33	6.56	58.98	11.44	2.08	0.01	0.01										
4/11/2024	5.66	10.38	8.50	6.21	11.67	2.13	0.01	22.47										
5/11/2024	9.51	10.33	8.74	7.41	11.56	2.22	0.01	0.01										
6/11/2024	9.77	10.38	28.93	7.96	11.77	2.41	1.38	0.01										
7/11/2024	6.12	10.44	18.76	17.75	11.77	13.99	1.36	0.01										
8/11/2024	12.70	10.32	21.05	8.46	11.67	2.65	1.40	0.01										
9/11/2024	14.95	10.41	44.69	8.84	11.68	2.77	1.48	0.01										
10/11/2024	11.86	10.45	46.18	54.87	11.74	2.30	1.56	0.01										
11/11/2024	3.41	10.22	40.08	8.27	11.70	2.45	1.88	3.50										
12/11/2024	1.52	10.12	24.05	8.30	11.84	28.87	2.11	0.01										
13/11/2024	2.24	9.84	30.73	7.74	11.57	2.62	2.59	182.37										
14/11/2024	2.09	9.66	28.19	7.45	11.46	2.63	3.57											
15/11/2024	1.60	9.93	56.49	8.12	11.71	3.67	4.95	84.58										
16/11/2024	1.76	10.10	81.05	9.00	11.97	3.27	7.20	85.86										
17/11/2024	11.96	10.11	11.99	8.84	11.86	30.81	10.05	194.92										
18/11/2024	9.71	9.43	9.85	7.90	11.27	8.98	12.56	272.21										
19/11/2024	2.51	8.00	8.18	6.56	11.04	4.88	17.32	108.15										
20/11/2024	1.37	9.55	8.78	9.17	8.85	2.22	21.45	85.89										
21/11/2024	1.69	11.50	9.36	10.39	11.65	2.18	25.23											
22/11/2024	2.00	12.67	10.10	11.75	12.15	2.24	28.41	6.72										
23/11/2024	2.48	12.36	9.99	11.61	12.05	2.71	19.32	5.60										
24/11/2024	1.07	12.17	9.84	11.31	11.91	5.52	1.44	146.52										
25/11/2024	12.67	12.61	10.42	12.07	12.22	13.55	1.51	237.43										
26/11/2024	11.38	12.93	10.58	12.92	12.42	21.13	1.74	323.40										
27/11/2024	17.63	12.56	15.59	12.52	12.33	30.08	2.16	447.52										
28/11/2024	27.08	12.26	9.08	12.12	12.20	34.59	3.88	488.24										
29/11/2024	33.20	12.40	8.72	12.10	12.25	34.96	8.03	456.71										
30/11/2024	16.91	12.10	8.00	11.49	11.84	39.64	11.70	468.12										

Appendix B. Huntly WQMS Locations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PD03T
PD01T
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SE05T
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SE60T
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SE02T
DB02T
DB01T
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SN07T
SE12T
SE12INV
SE52T
SE09T
SE48T
SE36T
SE11T
SE03T
SE03INV1
SE03INV2
SE03INV3
ND07T
SE34T
SE62T
SE08T
ND12T
ND06T
ND13T
ND14T
SE26T
SE24T
ND04T
SE23T
SE25T
SE22T
FPWR1
Huntly Turbidity Monitors
Huntly Mine Footprint (Section 6)
Major Dams
Streams
0
1.25
2.5
5 Kilometers

Appendix C. WQMS General Arrangement

ANTENNA

SOLAR PANEL

DATA TRANSMISSION TO IOT

DATA OUTLET

POWER INLET

40 X 60 MM CABLE DUCT

20 AMP MPPT
SOLAR CHARGER

40 X 60 MM CABLE DUCT

SIERRA WIRELESS FX30

40 X 60 MM CABLE DUCT

12 V, 120 AH LI-ION BATTERY

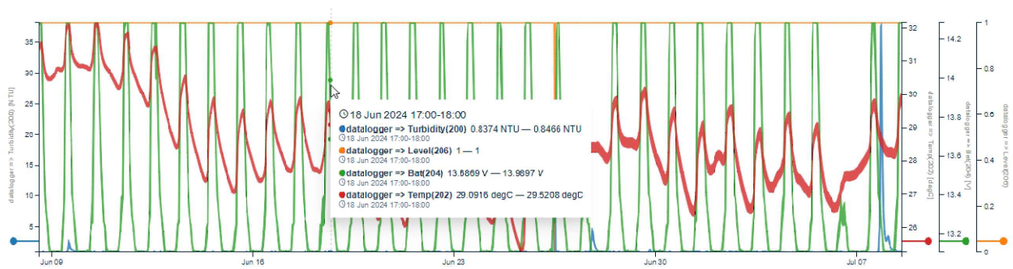
DATA INLET

SENSOR

STREAM DRY

SENSOR

STREAM FLOWING



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(08) 6245 9843
waterservices@scidev.com.au
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TITLE
IOT TURBIDITY MONITORING STATION
SITE LAYOUT
GENERAL ARRANGEMENT

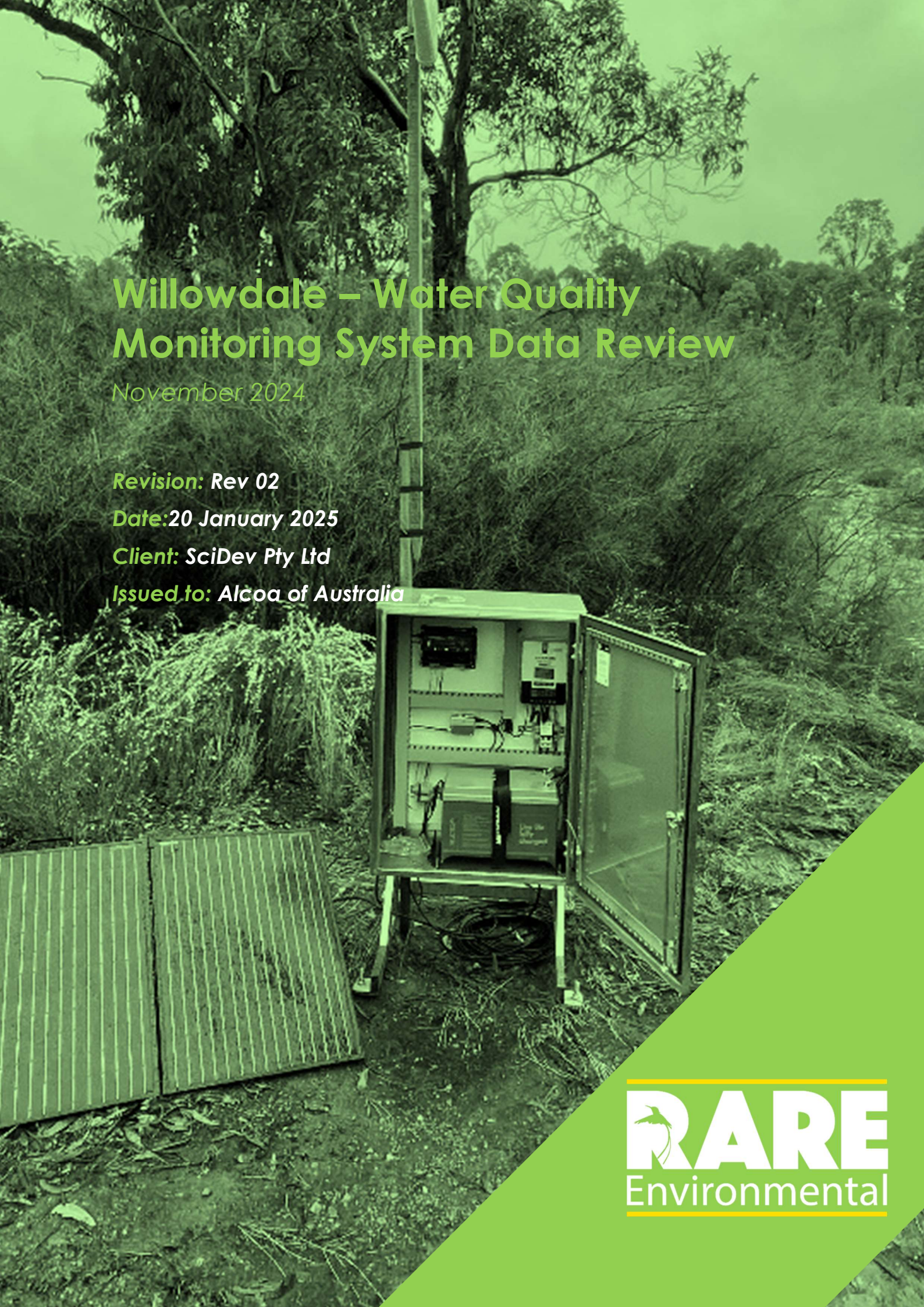
SHEET 1 OF 2

SCALE NTS OR AS SHOWN

DRAWING NO.
HI0090 - ALCOA WQMS

SHEET SIZE
A3

REV.
1



Willowdale – Water Quality Monitoring System Data Review

November 2024

Revision: ***Rev 02***

Date: ***20 January 2025***

Client: ***SciDev Pty Ltd***

Issued to: ***Alcoa of Australia***

RARE Environmental

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01	31/12/24	Issued to client	MM	GD	GD	Alcoa
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Prepared by		Technical Review		Approved for Issue	
Michael Minter		Georgia Duffy		Georgia Duffy	
Name	Michael Minter	Name	Georgia Duffy	Name	Georgia Duffy
Position	Env. Engineer	Position	Chemical Engineer	Position	Chemical Engineer
Date	20/01/2025	Date	20/01/2025	Date	20/01/2025

RARE Environmental Pty Ltd
ABN 41617855017
110/117 Old Pittwater Rd
Brookvale NSW 2100 Australia
P: 0413 223 401
www.rare-enviro.com.au

Infrastructure Sustainability Council MEMBER

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1. Executive Summary

This report, prepared by RARE Environmental Pty Ltd and SciDev Pty Ltd for Alcoa, provides an analysis of turbidity data collected from Water Quality Monitoring Systems deployed at the Willowdale bauxite mining operations during November 2024. The primary objective of this analysis was to evaluate the quality of the data, identify potential 'true' turbidity exceedance events, and support Alcoa's compliance reporting obligations under Schedule 1, Division 2, Clause 6 of the **Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023**.

The analysis focused on identifying and classifying turbidity events where levels exceeded 25 nephelometric turbidity units (NTU) for at least one hour. Events were categorized as 'true' or 'false' based on Alcoa's **Turbidity Event Classification Guidelines**, which distinguish actual turbidity increases ('true' events) from 'false' readings caused by environmental factors such as debris, air bubbles, or fluctuating water levels.

Key findings include:

- **'True' Events**: Zero 'true' turbidity exceedance events.
- **'False' Events**: Zero 'false' events were identified.
- **Excluded Units**: Two WQMS units were excluded from the analysis due to invalid data caused by equipment faults or environmental interference.

The report also highlights periods of missing data, which occurred due to system log-offs, equipment faults, or unplanned shutdowns. These gaps are detailed in the report to ensure transparency in data handling.

2. Scope

RARE Environmental Pty Ltd and SciDev Pty Ltd were engaged by Alcoa to analyze turbidity data collected from the Willowdale Water Quality Monitoring Systems (WQMSs). The primary objective of this engagement is to assess the quality of the collected data and identify potential 'true' turbidity events. This analysis supports Alcoa's reporting obligations under *Schedule 1, Division 2, Clause 6 of the Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

3. Introduction

3.1. Background

Alcoa of Australia Ltd (Alcoa) operates two bauxite mines, Huntly and Willowdale, approximately 100 km southeast of Perth, Western Australia. These mining operations are subject to environmental controls mandated by the *Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

Under this Exemption Order, Alcoa is required to implement drainage control measures and monitor effectiveness in water bodies within and downstream of mining operations. Turbidity, a critical water quality parameter, is monitored using WQMSs, to detect deviations and identify high-turbidity events.

Alcoa is obligated to report monthly on stream turbidity, including the identification and classification of any 'true' high-turbidity exceedance events. (Refer to Appendix A for the site map showing WQMS locations.)

3.2. Monitoring requirements

Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023 specifies that a drainage incident occurs when:

> *a) runoff from a disturbance area enters the surrounding environment, resulting in surface water turbidity of at least 25 NTU for a duration of at least one hour; or*
>
> *b) a discharge from containment infrastructure includes, or may include, environmentally hazardous material.*

Trigger levels for drainage incidents are outlined in *Schedule 1* of the Exemption Order. To meet these requirements, Alcoa has developed "Turbidity Event Classification Guidelines" which define a 'true' turbidity exceedance event as a WQMS recording turbidity levels of at least 25 nephelometric turbidity units (NTU) for a period exceeding one hour.

3.3. Water Quality Management Systems (WQMSs)

During the November 2024 monitoring period, 4 turbidity monitors were deployed monitoring section 6 areas within and downstream of Willowdale mining operations.

Each WQMS unit consists of the following components:

Aquas SMR10 Turbidity Probe

> Positioned at a 90-degree angle to water flow, each probe is equipped with an automatic lens wiper and a guard to protect against larger debris.

Data Taker DT82 Logger

> Records data locally every 6 seconds, with 6-minute averages transmitted via IoT-enabled modems to a cloud-based platform.

Float Switch

Detects whether the sensor is submerged or the stream is dry.

3.4. Purpose

This report aims to analyse turbidity data collected during November 2024, focusing on the identification and classification of 'true' turbidity exceedance events based on Alcoa's Turbidity Event Classification Guidelines.

3.5. Exclusions

This report is not intended as:

- An assessment of the WQMS network or Alcoa's compliance with relevant legislation and requirements.
- An evaluation of the suitability of the trigger levels or event classification procedures adopted by Alcoa.

3.6. Abbreviations

	Term
IoT	Internet of Things
NTU	Nephelometric Turbidity Units
WQMS	Water Quality Management System

4. Methodology

4.1. WQMS Locations

A site map showing the WQMSs locations is provided in Appendix A.

4.2. Data Review

Data recorded by the WQMS Units was reviewed and potential events where turbidity levels exceeded 25 NTU for at least one hour. Each potential event was categorised as either 'true' or 'false'.

4.2.1. 'True' Turbidity Exceedance Events

These events are caused by an actual increase in stream turbidity. Per Alcoa's "Turbidity Event Classification Guidelines" 'true' exceedance events typically exhibit:

- A sharp, sudden incline in turbidity levels.
- A return to baseline turbidity levels in a pattern resembling a normal (Gaussian) distribution.

Figure 1 Typical 'true' exceedance event showing the sharp incline and gradual return to background levels.

4.2.2. 'False' Turbidity Exceedance Events

These events are caused by factors unrelated to actual turbidity increase, such as:

- Organic debris (e.g., leaves, sticks, algae) obstructing the sensor
- Air bubbles or water turbulence near the sensor
- Fluctuating water levels intermittently covering and uncover the sensor lens.

'False' events typically exhibit sharp inclines and declines without the characteristic bell curve shape of 'true' events.

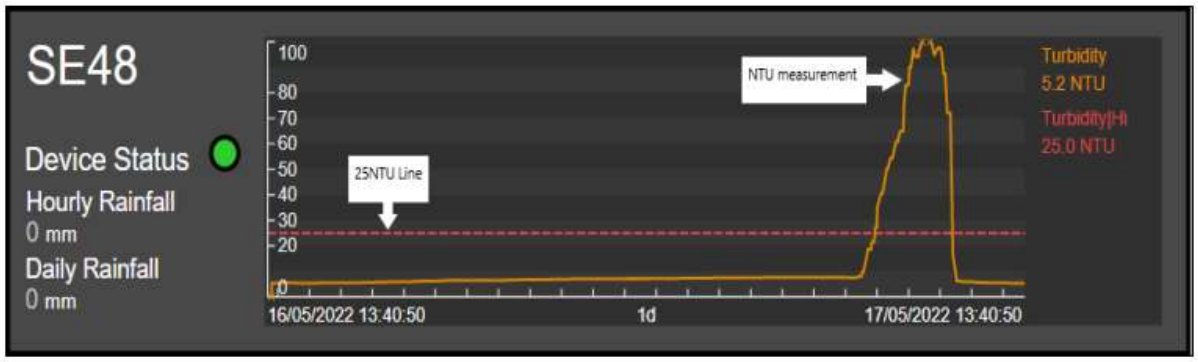

Figure 2 Typical 'false' exceedance event showing both a sharp incline and decline

4.2.3. Missing Data

Missing data occurs when a WQMS unit fails to record information, This can occur from unexpected system log-offs, equipment faults, or unplanned shutdowns.

5. Results and Discussion

5.1. Events

Table 1 provides a summary of identified events.

Table 1 Events Summary

Category	# of events
'True'	0
'False'	0

5.2. 'True' Event(s)

Zero potential 'true' turbidity events were identified during the reporting period.

5.3. 'False' Event(s)

Zero 'false' events were identified during the reporting period.

5.4. Excluded WQMS Units

2 WQMS Units were excluded from analysis due to erroneous data. SciDev confirmed the invalidity of data recorded from these units and provided commentary on the condition of each.

Table 2 Excluded WQMS Units

Unit	Dates	SciDev Comment
HV07T	12/11/2024	Stream inspected on 12/11/2024 at 8:00am. Stream is no longer flowing and monitor is sitting in a stagnant puddle with a large amount of insect larvae and scum on the surface. Scum had built up on the sensor lens. The probe was cleaned and returned to the puddle. Turbidity immediately returned to approximately 2NTU. Monitor will be placed in a sealed bucket of deionised water to prevent future false turbidity events until the stream starts flowing again.
RHB2	1/11/2024-3/11/2024	Stream inspected on 03/11/2024 at 9:00am. Stream was flowing and the water was clear at the time of the inspection. Stream is drying out, probe was covered in mud and detritus accumulating around the probe. Probe was cleaned and repositioned in the water, however stream depth is lower than the width of the probe (not fully submerged).

5.5. Missing Data

Periods of missing data more than 1 day are detailed in Table 5.

Table 3 Missing Data Summary

Missing Data ID	Unit	Start	End	Comments
MD2411-01	RHB2	26/11/2024 11:48:00 PM	30/11/2024 11:54:00 PM	No data available between 26/11/2024 and 2/12/2024 due to data cable connection issues.
MD2411-02	RHB3	1/11/2024 12:00:00 AM	2/11/2024 11:54:00 PM	Data records missing
MD2411-03	RHB3	14/11/2024 9:00:00 PM	24/11/2024 6:54:00 PM	No data available between 14/11/2024 and 24/11/2024 due to faulty equipment.

6. Appendices

Appendix A. Willowdale Raw WQMS Data

Date	Willowdale WQMS Data - November 2024 - Events with turbidity > 25 NTU for an hour or more			
	HV07T	HV49T	RHB2	RHB3
1/11/2024				
2/11/2024				
3/11/2024				
4/11/2024				
5/11/2024				
6/11/2024				
7/11/2024				
8/11/2024				
9/11/2024				
10/11/2024				
11/11/2024				
12/11/2024				
13/11/2024				
14/11/2024				
15/11/2024				
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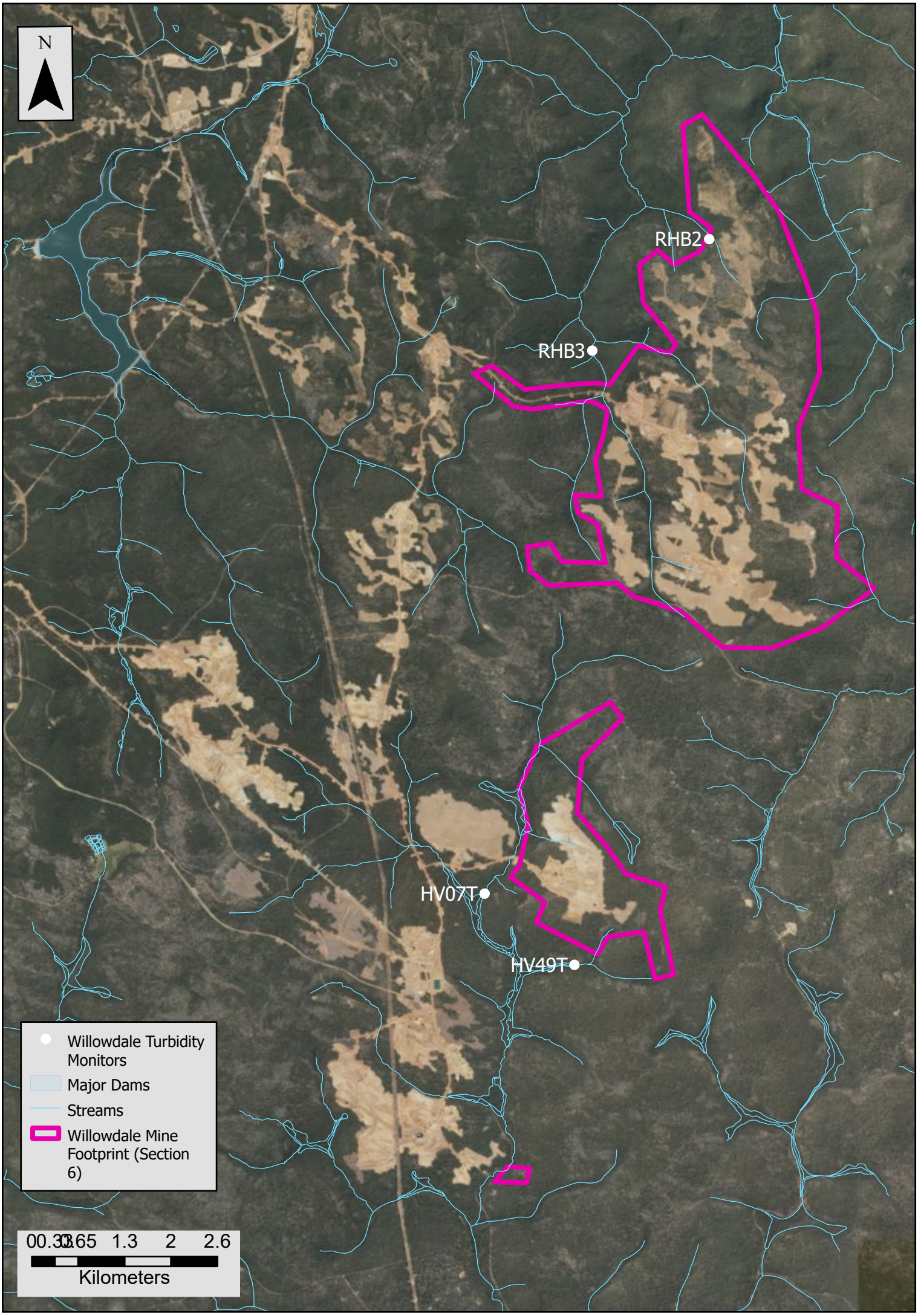
17/11/2024				
18/11/2024				
19/11/2024				
20/11/2024				
21/11/2024				
22/11/2024				
23/11/2024				
24/11/2024				
25/11/2024				
26/11/2024				
27/11/2024				
28/11/2024				
29/11/2024				
30/11/2024				

Note: 'False' events have been annotated by **black** bold text. 'True' events for further investigation are annotated by **red** bold text.

Date	Willowdale WQMS Data - November 2024 – Daily Average Turbidity (NTU)			
	HV07T	HV49T	RHB2	RHB3
1/11/2024	1.28	0.96	35.72	
2/11/2024	1.32	0.96	42.44	
3/11/2024	1.19	1.04	20.70	4.80
4/11/2024	1.23	0.91	0.01	2.34
5/11/2024	1.22	0.89	0.01	2.12
6/11/2024	8.47	1.03	2.21	2.47
7/11/2024	4.30	0.92	4.14	4.92
8/11/2024	1.14	0.90	4.63	2.96
9/11/2024	1.38	0.91	4.25	2.89
10/11/2024	3.37	0.96	4.54	3.16
11/11/2024	4.68	1.02	4.35	2.71
12/11/2024	15.38	1.21	4.23	2.82
13/11/2024	3.41	1.08	3.89	3.92
14/11/2024	2.05	1.07	3.29	3.01
15/11/2024	2.10	1.04	2.49	
16/11/2024	2.50	1.18	2.41	
17/11/2024	3.25	1.47	6.02	
18/11/2024	2.73	1.36	5.42	
19/11/2024	3.43	2.28	7.07	
20/11/2024	4.21	17.94	6.47	
21/11/2024	4.24	3.28	5.34	
22/11/2024	5.17	2.93	5.37	
23/11/2024	4.93	2.81	4.97	
24/11/2024	4.61	2.83	5.02	0.31
25/11/2024	4.47	2.66	4.66	0.35
26/11/2024	4.36	2.75	4.95	0.36
27/11/2024	4.61	2.70		0.36
28/11/2024	4.98	2.80		0.34
29/11/2024	3.75	2.96		0.32
30/11/2024	4.11	3.21		0.32

Note: Grey shading indicates no data available for that day at that unit.

Appendix B. Willowdale WQMS Locations


N
RHB2
RHB3
HV07T
HV49T
Willowdale Turbidity Monitors
Major Dams
Streams
Willowdale Mine Footprint (Section 6)
0 0.33 0.65 1.3 2 2.6
Kilometers

Appendix C. WQMS General Arrangement

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SOLAR CHARGER

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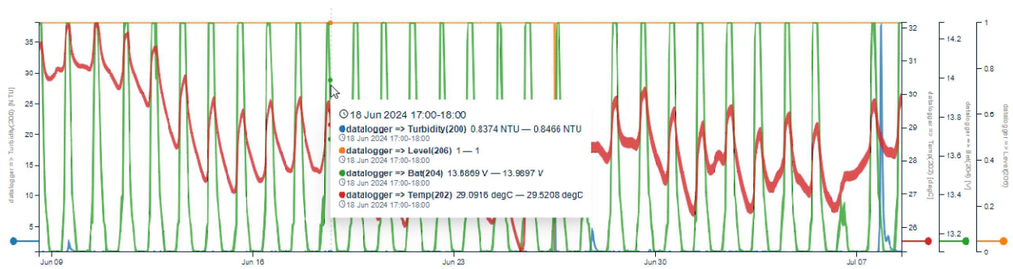

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