

Memorandum

Subject	Assessment of potential impacts to the Percival Palaeovalley by abstraction from the proposed Rimfire borefield		
Date	2 July 2025		
To	Emma McGivern	From	Jordan Forster, Worley Consulting
Project No	311012-01475	Doc No	TM_HG-031_Rev0
Project	Winu Project – Percival Palaeovalley Assessment		

Introduction

Water Balance modelling by Worley Consulting (2025) has determined that the Winu Mine (the Project) will be in a water deficit from year 17 after starting mining, to year 32 at the end of life of mine (LoM). A regional borefield is proposed for development at Rimfire, approximately 30 km east of the main Winu Project, which could supply the Project with water during this water deficit period.

The proposed Rimfire borefield is situated 2 km north of an ancient tributary to the regionally extensive Percival Palaeovalley. The Palaeovalley extent has been revised several times since it was first mapped in 1977 (van der Graff, Crowe, Bunting, & Jackson, 1977). The most common depiction of its extent is derived from the WASANT Palaeovalley Map (Bell, et al., 2012), however recent review of aerial electromagnetic (AEM) survey data by Worley indicates a more limited extent in the vicinity of the Rimfire borefield (Figure 1).

The palaeovalley was identified as a potential terrestrial GDE habitat in the Rimfire H3 Assessment (Worley, 2025) due to the occurrence of *Melaleuca lasiandra* Shrubland over the palaeovalley, and the shallow watertable.

This Memorandum provides an overview of the conceptualisation of the Percival Palaeovalley, and the potential impacts to the palaeovalley in response to groundwater abstraction from the Rimfire borefield.

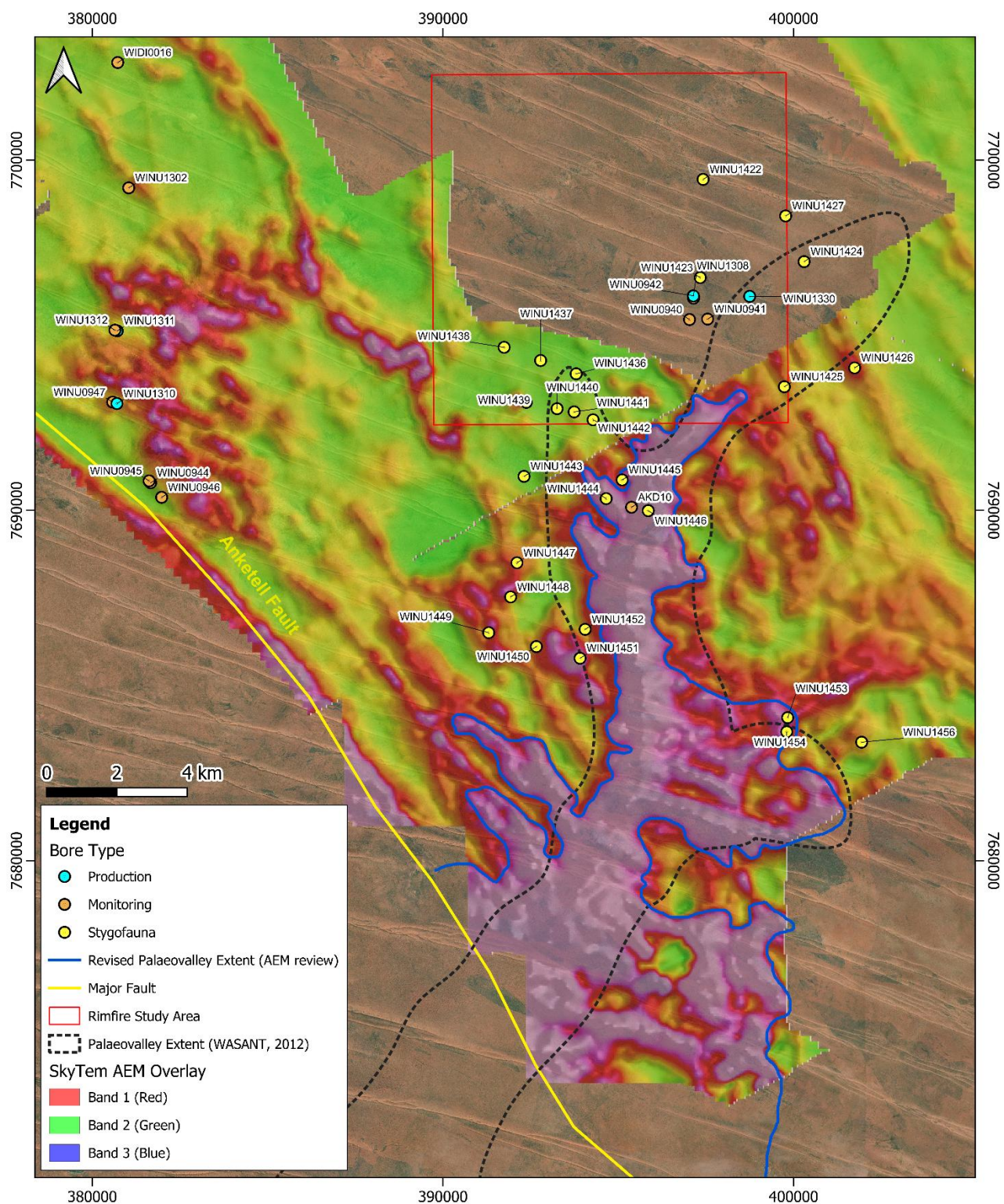


Figure 1 Percival Palaeovalley extent within the Rimfire area, with existing bore locations

Palaeovalley conceptualisation

Geology

The Percival Palaeovalley is a non-glaciogenic palaeovalley of presumed Cenozoic age (English, et al., 2012). The palaeovalley in the south Rimfire area appears to be an infilled tributary valley for a river that once discharged into the main Percival Palaeoriver 40 km to the south. The ancient Percival Palaeoriver flowed west across the Canning Basin to the Indian ocean, and in doing so, incised into the underlying Permian sediments. The Rimfire area however is situated northeast of the Anketell fault (Figure 1), which separates the Anketell Shelf to the east (where Rimfire is located) from the Barnicarndy Graben. The Proterozoic-age metasedimentary bedrock is elevated in this area as a result of the fault displacement, and subcrops beneath shallow Quaternary sediments. The infilled tributary valley at Rimfire incises into this bedrock as a result.

The sedimentary infill geology of the Canning Basin palaeovalleys typically comprises basal gravels and sands deposited under high-velocity flow in the early Cenozoic, which are overlaid by fine-grained fluvial-lacustrine sediments, deposited in the Late Oligocene to Miocene (English, et al., 2012). As conditions became drier in the late Cenozoic, salt lakes and sand dunes formed, resulting in the deposition of calcrete.

Very limited drilling has been completed into the palaeovalley in the south Rimfire area. One historic exploration RC hole (AKD10) has been drilled within the palaeovalley extent, however the lithology data is not available. Lithological logs from the recent Stygofauna monitoring bore drilling program (December 2024) indicate that at WINU1446 the tributary palaeovalley is 40 m deep, overlying micaceous metasandstone and granite. The basal unit of the palaeovalley strata is a 10 metre thickness of fine-grained sand, overlain by highly weathered claystone and sandstone (Appendix A).

Palaeovalley delineation

The tributary palaeovalley extent has been further resolved from the WASANT palaeovalley map (Bell, et al., 2012) using a combination of airborne geophysics and drillhole validation.

Data from an airborne electromagnetic survey undertaken at Rimfire (file: "Paterson_East_xCite_SkyTEM_Merge_Z_dBdt_219_060_SunAngle_HistNorm") shows an area of high conductivity lithology (interpreted as clay infill) within the palaeovalley boundary, comprising a 1.5 km wide main-channel, with elongate branches extending to the east and west (Figure 1).

During a stygofauna monitoring bore installation program between November and December 2024, 12 bores were drilled within the original WASANT palaeovalley

extent, including five (5) bores inside the refined extent inferred from the AEM geophysical survey. The bore locations are shown in Figure 1, and complete lithology logs are provided in Appendix A.

Of the seven (7) bores between the geophysics-inferred extent and the WASANT palaeovalley extent, none intercepted lithology consistent with a palaeovalley. These bores intersected ferricrete, silcrete and sandstone typical of the Rimfire cover sequence.

Inside the geophysics-inferred palaeovalley, WINU1446 was the only bore in which the characteristic palaeovalley sequence of interbedded clay and sandstone was encountered, and is the only bore located within the main channel inferred from the geophysics.

Other bores located within the geophysics-inferred extent and on the branches adjacent to this main channel encountered either outcropping bedrock (WINU1445, WINU1452, WINU1453) or ferricrete and sandstone (WINU1444, WINU1454), consistent with the surrounding cover.

These observations suggest that the actual extent of the palaeovalley is more limited than indicated by the geophysics, and it may potentially be confined only to the main high-conductivity channel area.

Groundwater flow regime

The portion of the main Percival Palaeovalley south of the Rimfire area is reported to drain internally to Lake Waukarlycarly (46 km south of Rimfire), at the centre of the Barnicarndy Graben (English, et al., 2012). Based on this and the southerly palaeoriver flow direction, it is probable that the groundwater flow direction in the tributary palaeovalley is south, although there is currently insufficient field data to verify this. This southerly flow direction differs from the flow direction in the metasedimentary aquifer at Rimfire, which is inferred to be north-northeast away from an elevated region of outcropping bedrock (Worley, 2025).

Depth to water at AKD10 and WINU1446 is 3-6 m. The level of hydraulic connection between the palaeovalley aquifer and the metasedimentary aquifer has not been sufficiently assessed, although the 30 day constant rate pumping test at WINU1308 (2.8 km north of inferred palaeovalley) induced a drawdown of 0.12 m at AKD10 and suggests a potential hydraulic connection.

Stygofauna occurrence

Haul-net sampling for stygofauna was conducted at Rimfire by Biota Environmental Sciences (Biota) in 2024-2025. The sampling identified stygofauna in 10 bores, including isopod occurrences of the *Microcerberidae* family at WINU1446 and AKD10 within the palaeovalley. The lateral and vertical extent of the stygofauna habitat is currently uncertain.

Potential borefield impacts on the Percival Palaeovalley

In 2025 Worley completed a H3-level hydrogeological assessment of the Rimfire area, and developed a numerical groundwater flow model to assess potential drawdown impacts from the Rimfire borefield (Worley, 2025). The modelling involved simulation of groundwater pumping from a nominal borefield comprising nine (9) production bores. Due to lack of information on the tributary palaeovalley, the palaeovalley was not included in the model as a feature with its own distinct hydraulic properties.

The model simulated a 32-year life of mine (LoM) and subsequent water-level recovery period of 500 years. Forward predictions of groundwater abstraction from the nine production bores showed the nominal borefield is potentially capable of producing 2.8 GL/a (distributed at approximately 8 to 11 L/s, per bore).

The drawdown contours presented assume continuous pumping at 2.8 GL/a (P90 from the Water Balance modelling) from the nominal borefield. This provides a conservative estimate for maximum drawdown over 32 years of borefield operation.

At LoM, the 2 m drawdown isoline extends up to 16 km from the centre of the borefield, and into the inferred tributary palaeovalley extent (Figure 2).

It is noted the predicted drawdown impact is constrained to a minor portion of the tributary only and does not extend to the main Percival Palaeovalley (Figure 3).

The nearest external stakeholder borehole within the Percival Palaeovalley is bore ref. 120511005 on the Telfer Access Road, 60.8 km beyond the 2 m drawdown isoline to the south (Figure 3). As a result, the drawdown is not expected to impact other groundwater users in the region.

Given that the total area of the Percival Palaeovalley system is 34,978 km², the 18 km² area of the palaeovalley that is within the 2 m drawdown radius of the borefield represents 0.05% of the entire system area (Figure 3).

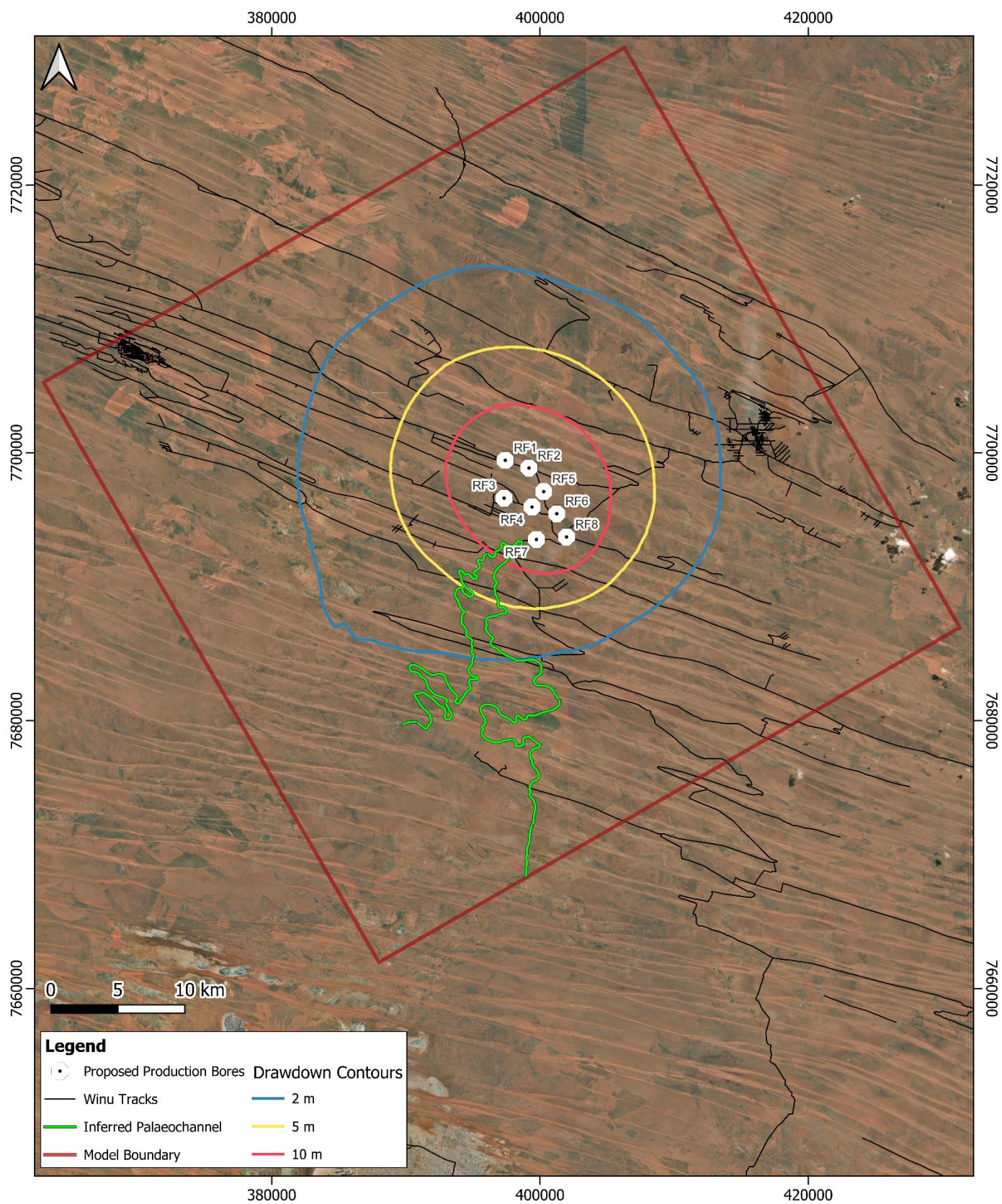


Figure 2: Drawdown at the end of 32-year simulated abstraction at 2.8 GL/a (Worley, 2025)

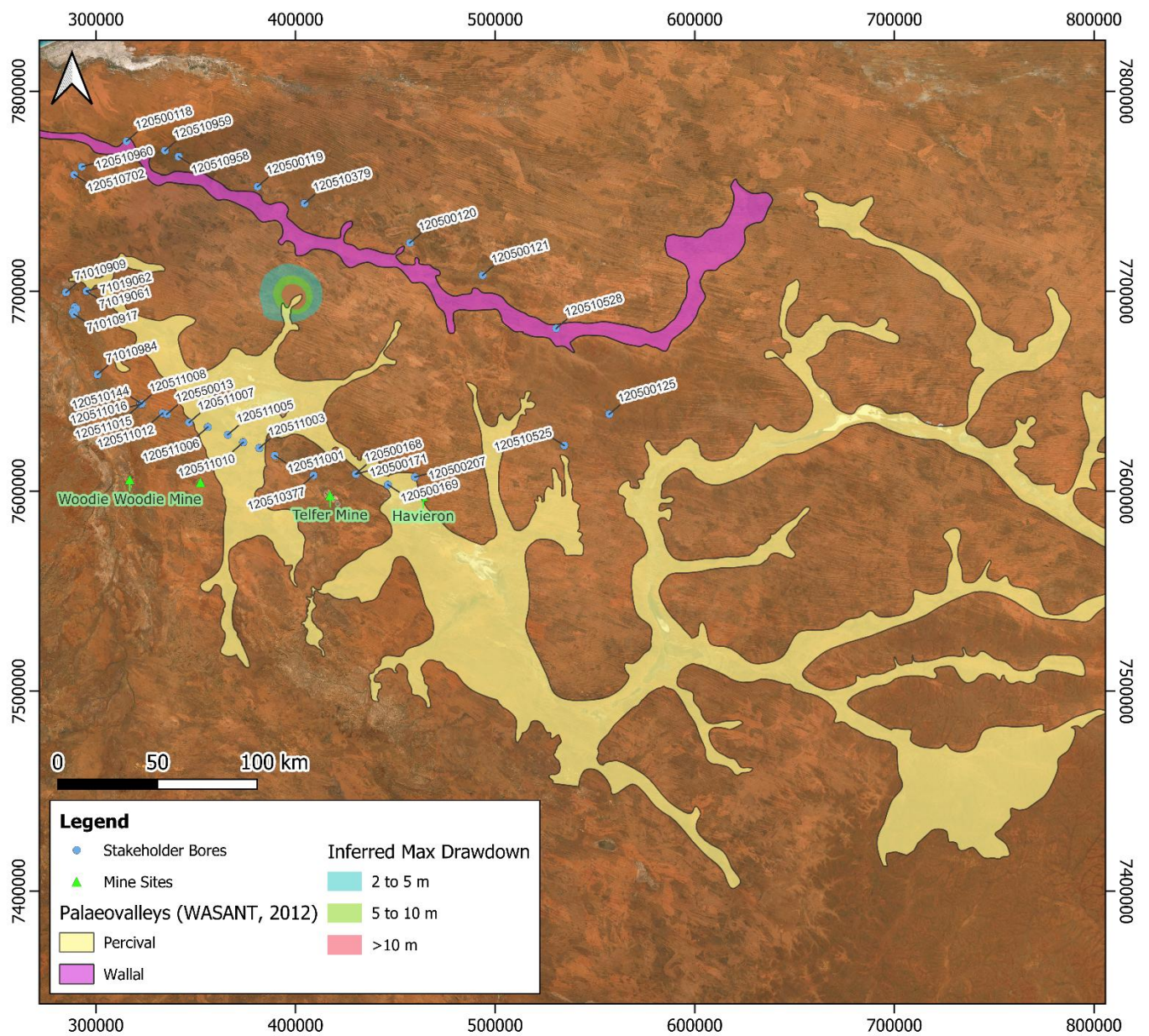


Figure 3: Percival Palaeovalley extent relative to the Rimfire drawdown and nearest external stakeholder boreholes

Potential impacts to stygofauna habitat

The saturated thickness of the palaeovalley tributary is approximately 30 metres near bores AKD10 and WINU1446. Due to limited bore coverage, the saturated thickness in other parts of the tributary is not known, although it is likely to be similar elsewhere towards the main channel.

Assuming hydraulic connectivity exists (conservative) between the palaeovalley and the surrounding regional aquifer, the >2 m predicted drawdown zone extends approximately 8 km into the tributary while the 5–10 m drawdown extends approximately 5 km into the tributary (Figure 2).

As a result, some drawdown within the tributary palaeochannel is likely, with the greatest potential impact expected at the northern tip of the palaeovalley and contained within the tributary.

It is unlikely that drawdown from the nominal borefield would deplete the available groundwater in the palaeochannel and no impact is anticipated in the primary Percival palaeovalley given that the zone of drawdown does not extend to the main palaeovalley (Figure 3).

Recommendations

The palaeovalley system in the south Rimfire area is poorly understood at present and defined by a lack of drilling data and coarse scale geophysics.

To improve the conceptual understanding, we recommend undertaking a **passive seismic survey**, with several transects of the palaeovalley.

Passive seismic is a cost-effective, non-intrusive methodology that is widely used for delineating the subsurface geometry and stratigraphy of palaeovalleys. The methodology is fast (can acquire up to 80 readings a day with two-man crew) and lightweight, which means surveying can be undertaken on foot if required. We propose five transects shown in Figure 4, varying in length from 1 km to 4.7 km. The transects are all located on existing heritage-cleared tracks for ease of access.

The understanding of the palaeovalley would also benefit from a drilling and piezometer installation program targeting the main channel south of WINU1446. Potential drill locations should be based on the results of the passive seismic survey.

It is recommended to install some partially penetrating bores that are selectively screened within individual sandstone strata of the palaeovalley infill, to assess any vertical heterogeneity.

Additional pumping tests at bores near to the palaeovalley would help determine aquifer properties for the palaeovalley as well as the extent of hydraulic connection to the Rimfire borefield aquifer.

Monitoring bores within the palaeovalley should be monitored during the pumping tests planned at WINU1329 and WINU1330, towards this end.

Improvement of the conceptualisation of the palaeovalley provides an opportunity to update the H3 numerical model and improve the assessment of drawdown impacts to the palaeochannel aquifer.

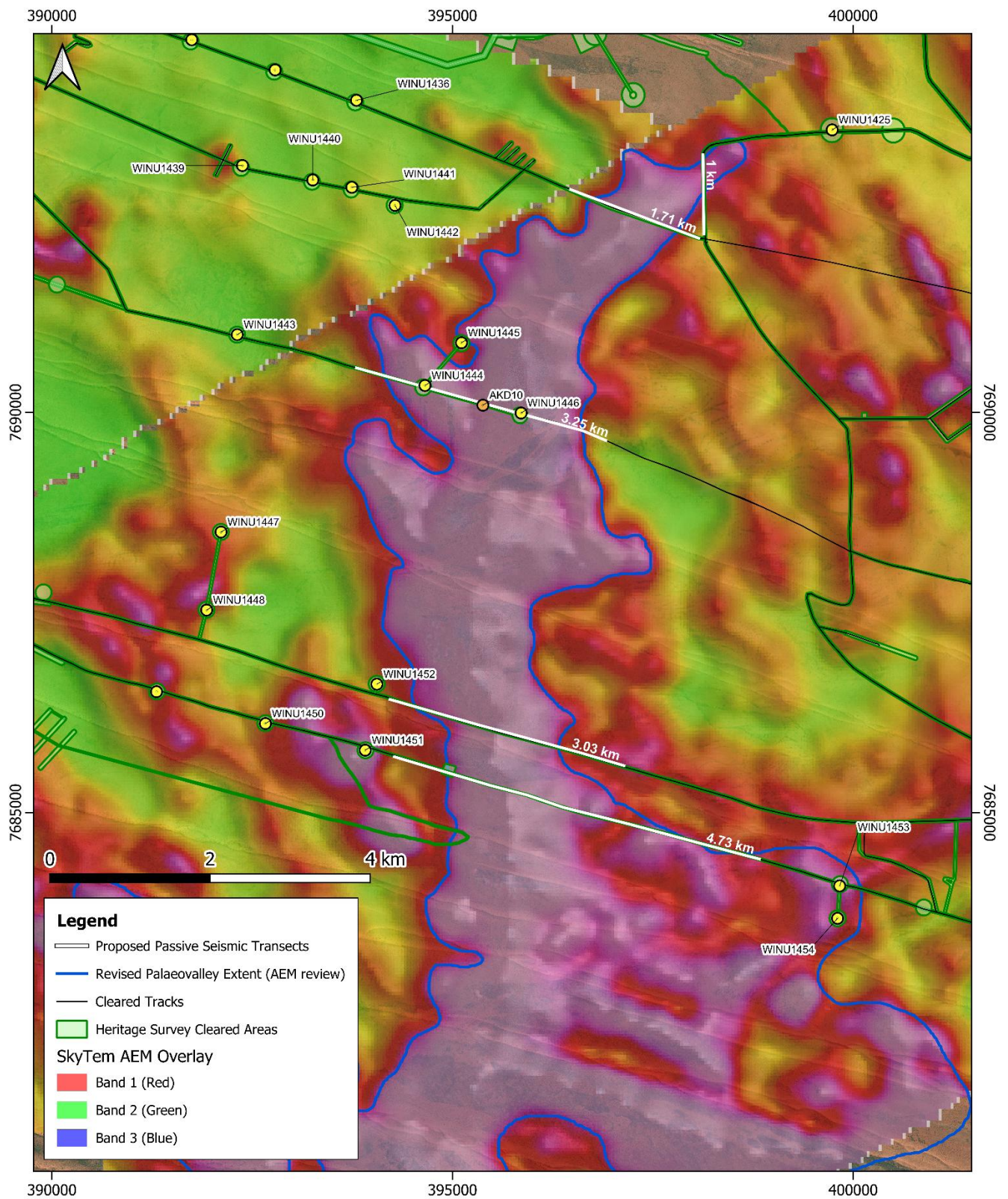


Figure 4 Proposed passive seismic survey transects across inferred palaeovalley

References

- Bell, J., Kilgour, P., English, P., Woodgate, M., Lewis, S., & Wischusen, J. (2012). *WASANT Palaeovalley Map - Distribution of Palaeovalleys in Arid and Semi-arid WA-SA-NT (first edition), scale: 14 500 000*. Canberra: Geoscience Australia.
- English, P., Bastrakov, E., Bell, J., Kilgour, P., Stewart, G., & Woltmann, M. (2012). *Paterson Province Investigation for the Palaeovalley Groundwater Project*. Canberra: Record 2012/07, Geoscience Australia.
- van der Graff, W. E., Crowe, R., Bunting, J., & Jackson, M. (1977). *Relict early Cenozoic drainages in arid Western Australia*. *Zeitschrift für Geomorphologie*. N F 21: 379-400.
- Worley. (2025). *Rimfire H3 Assessment*. Report prepared for Rio Tinto Copper. Document no. Rev 4: REP-HG-31.



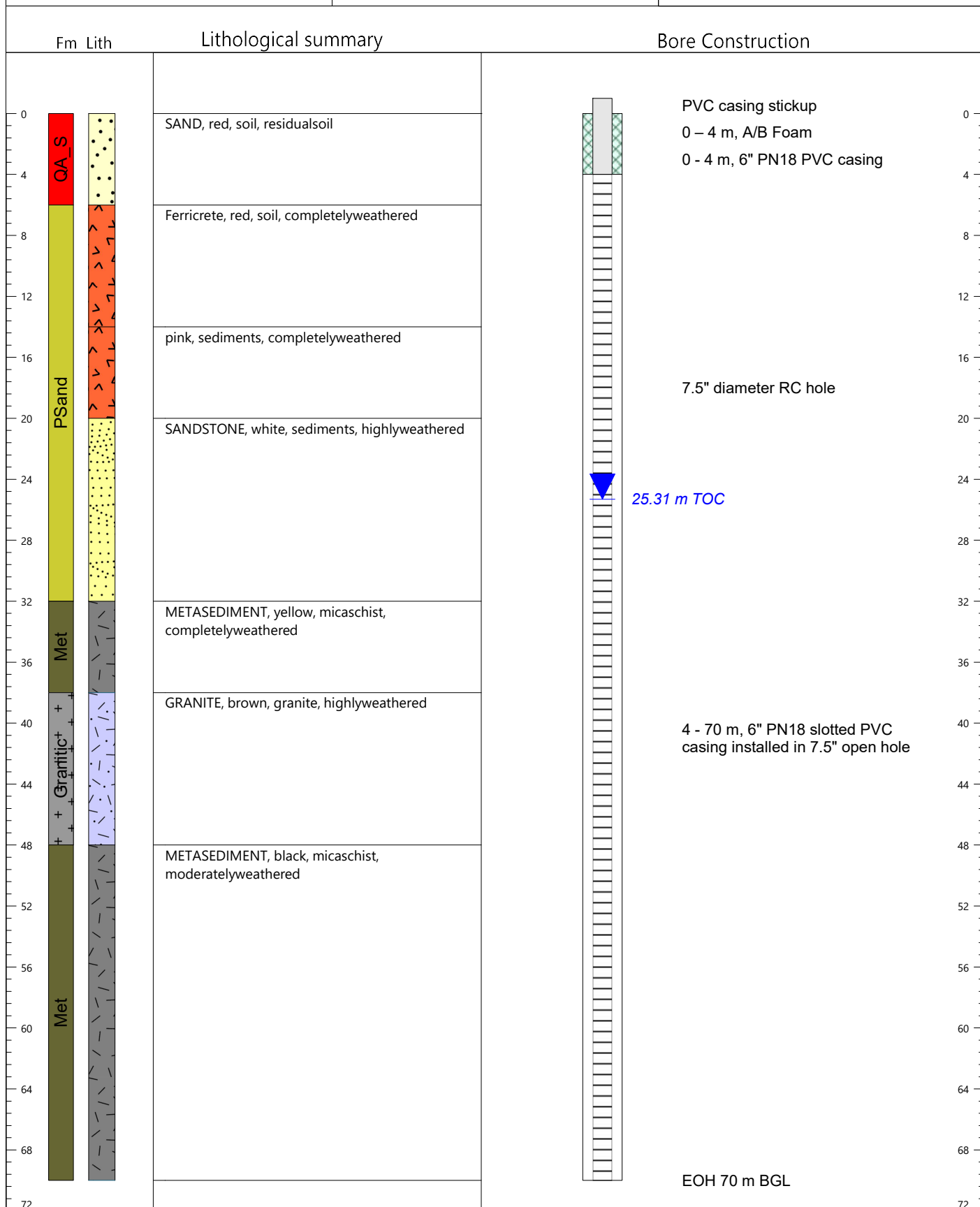
Appendix A. Bore logs

WINU1424 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 400301.45 mE / 7697103.98 mN
Elevation: 256.99 m AHD (RL = TOC)

Construction start date: 23/10/2024
Construction end date: 24/10/2024
Inclination: -90°
Depth drilled: 70 m BGL

Volume Purged: 1645.5 L
EC: 626 µS/cm
pH: 7.37
Temp: 20.8 °C
Static Water Level: 25.31 m TOC



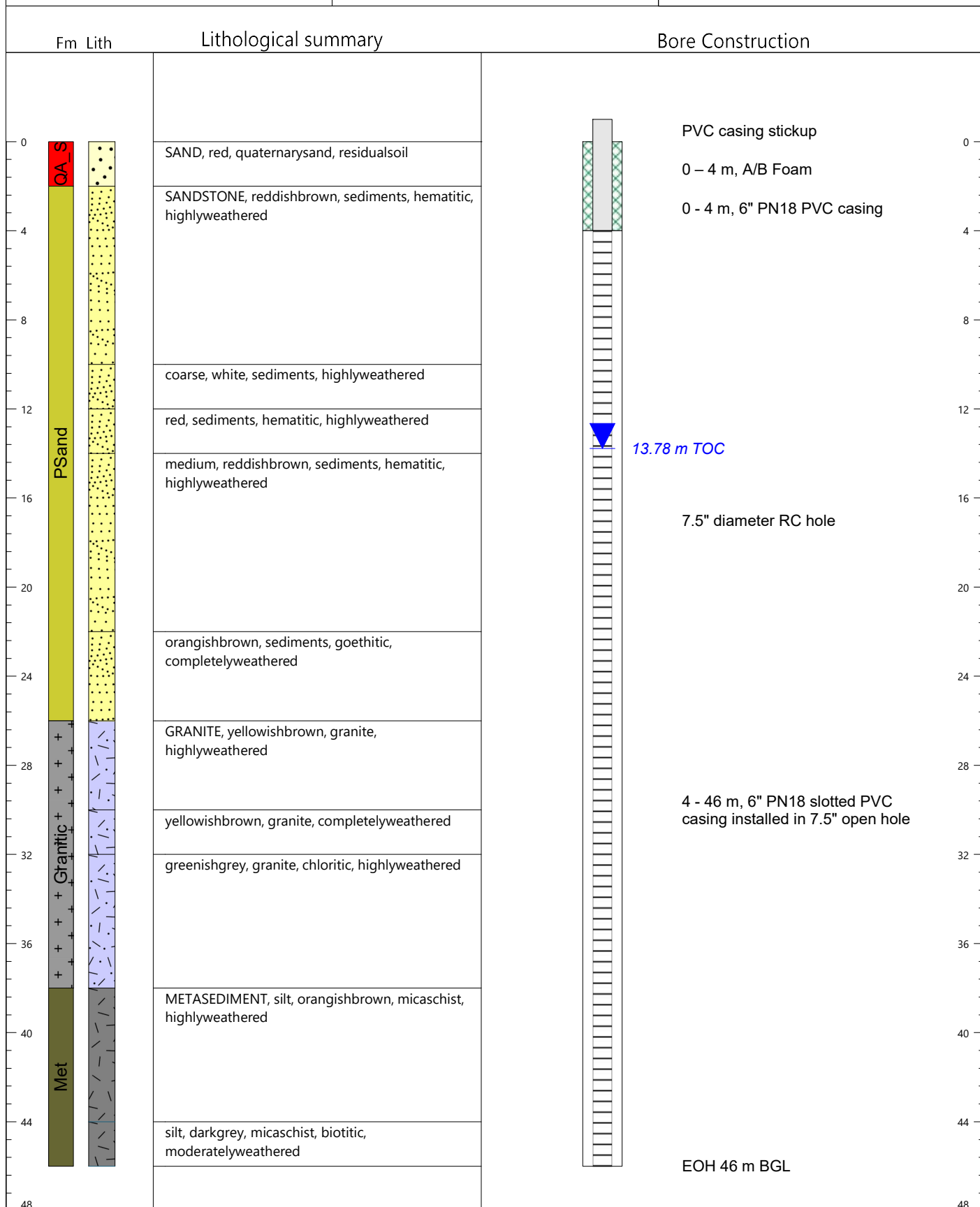
Additional notes:

WINU1425 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 399739.07 mE / 7693531.21 mN
Elevation: 255.42 m AHD (RL = TOC)

Construction start date: 27/10/2024
Construction end date: 27/10/2024
Inclination: -90°
Depth drilled: 46 m BGL

Volume Purged: 1190.0 L
EC: 739 µS/cm
pH: 7.15
Temp: 34.7 °C
Static Water Level: 13.76 m TOC



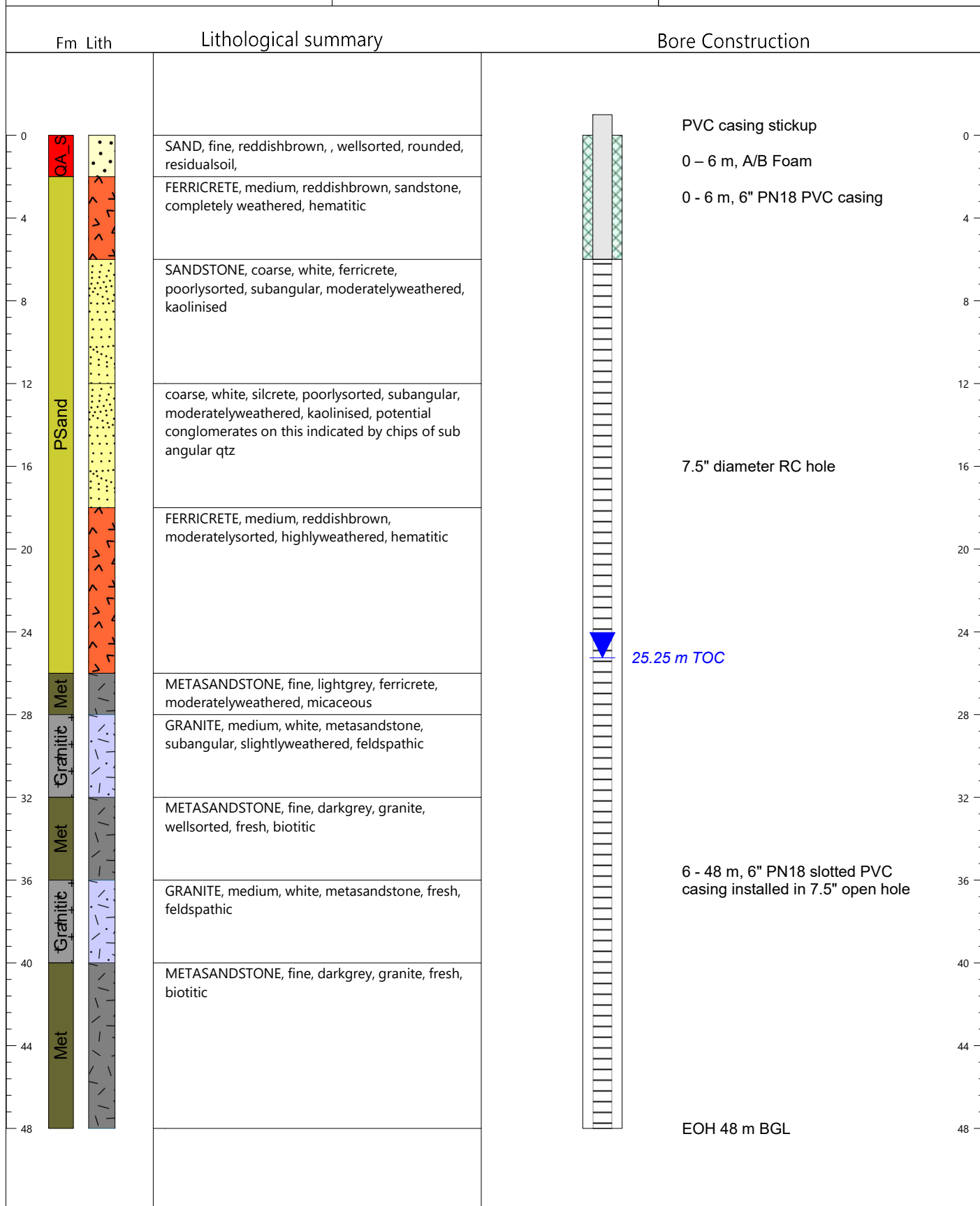
Additional notes:

WINU1436 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 393802.12 mE / 7693901.40 mN
Elevation: 268.72 m AHD (RL = TOC)

Construction start date: 25/11/2024
Construction end date: 26/11/2024
Inclination: -90°
Depth drilled: 48 m BGL

Volume Purged: 980.0 L
EC: 1464 µS/cm
pH: 7.87
Temp: 40.9 °C
Static Water Level: 25.25 m TOC



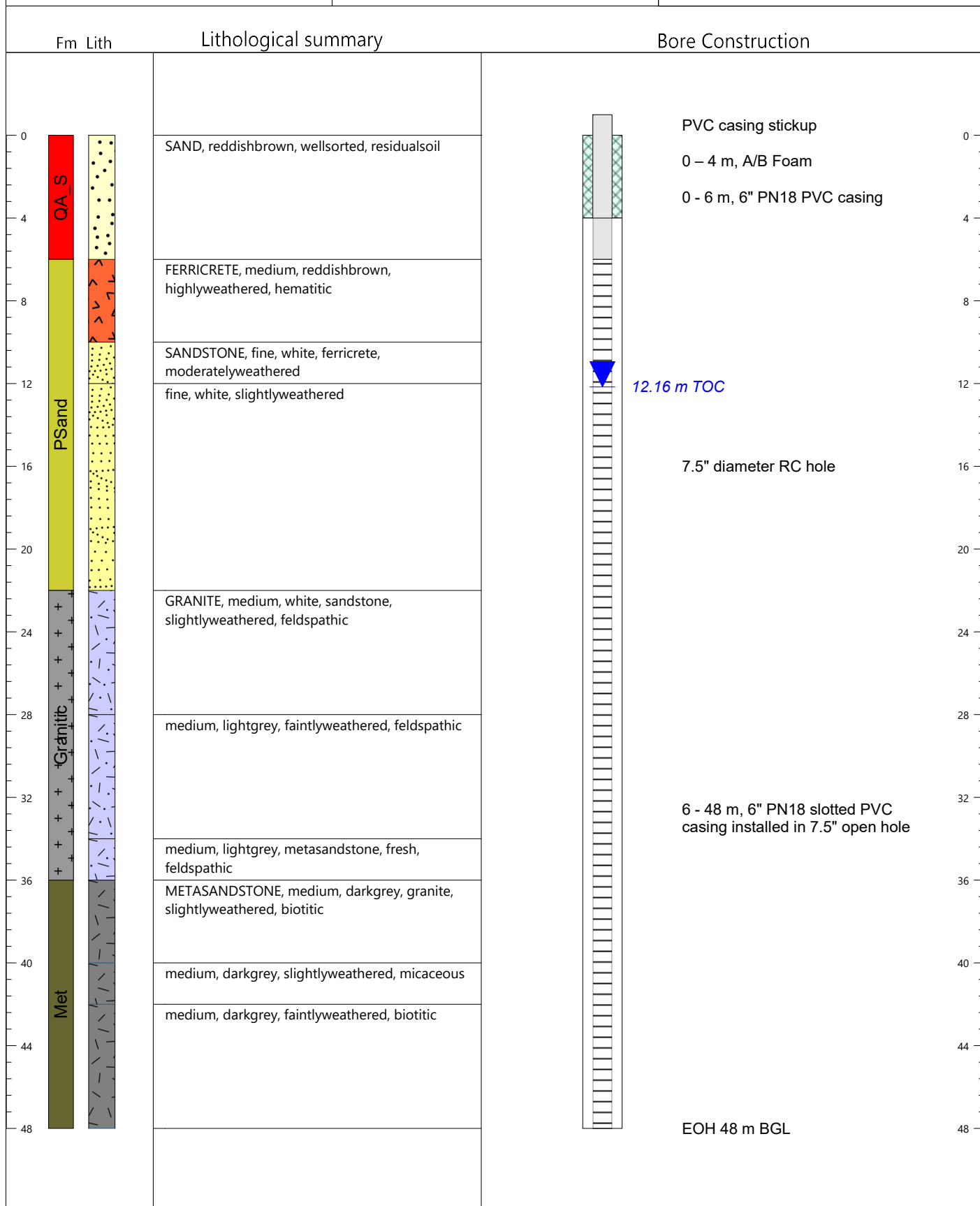
Additional notes:

WINU1440 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 393256.85 mE / 7692905.22 mN
Elevation: 257.01 m AHD (RL = TOC)

Construction start date: 27/11/2024
Construction end date: 29/11/2024
Inclination: -90°
Depth drilled: 48 m BGL

Volume Purged: 1540.0 L
EC: 1273 µS/cm
pH: 7.58
Temp: 39.5 °C
Static Water Level: 12.16 m TOC



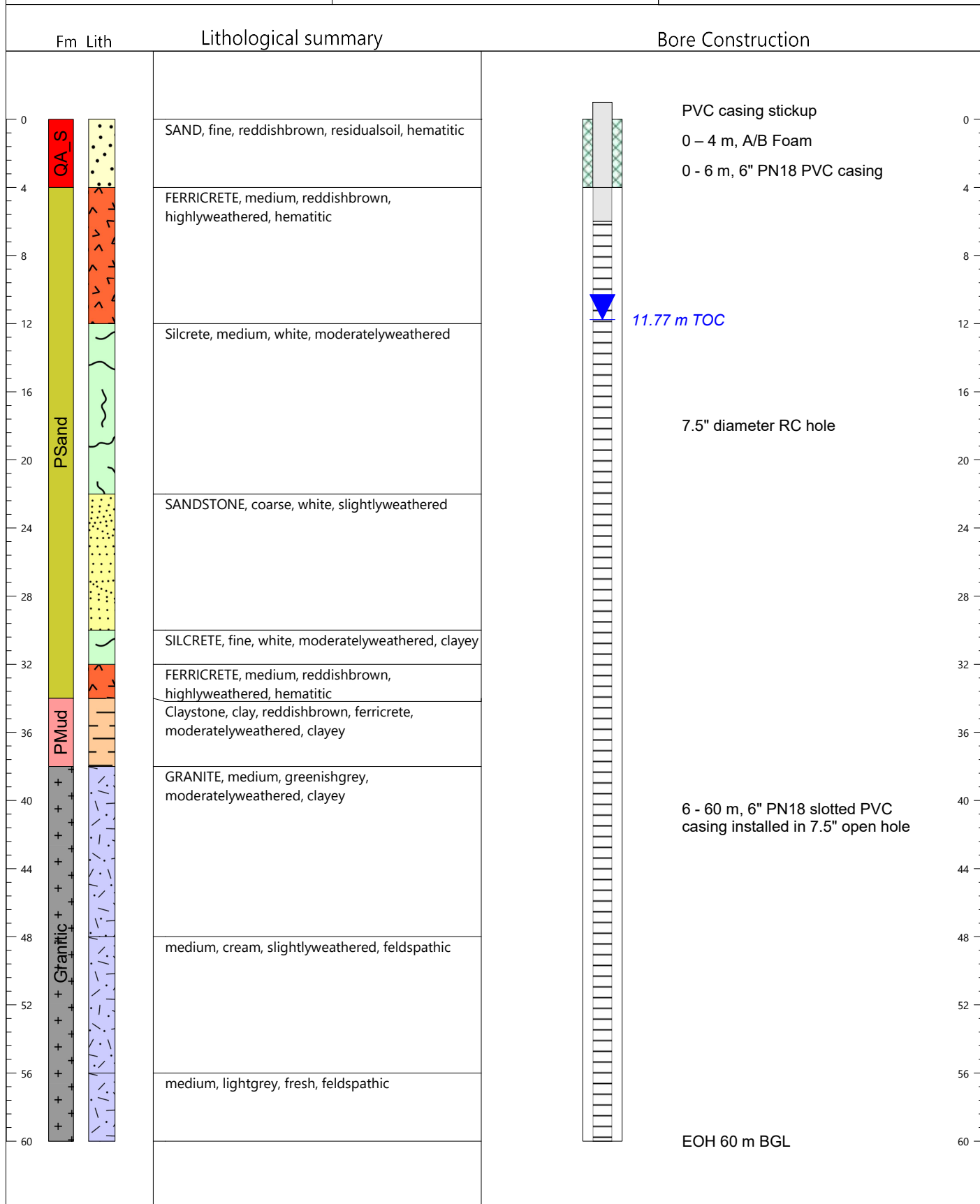
Additional notes:

WINU1441 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 393744.18 mE / 7692813.98 mN
Elevation: 257.56 m AHD (RL = TOC)

Construction start date: 26/11/2024
Construction end date: 26/11/2024
Inclination: -90°
Depth drilled: 60 m BGL

Volume Purged: 2072.0 L
EC: 1787 µS/cm
pH: 7.36
Temp: 39.6 °C
Static Water Level: 11.77 m TOC



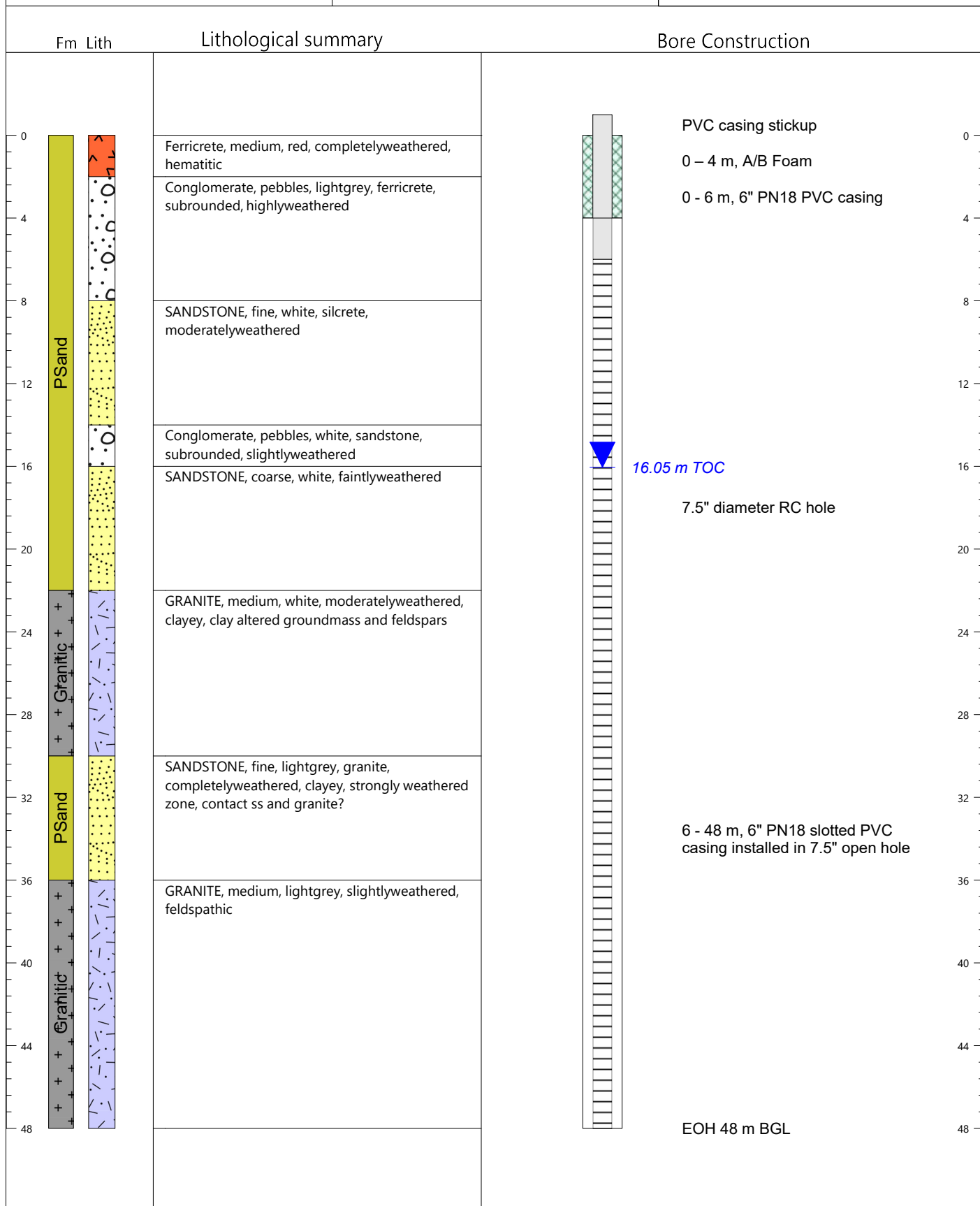
Additional notes:

WINU1442 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 394283.51 mE / 7692587.33 mN
Elevation: 263.04 m AHD (RL = TOC)

Construction start date: 26/11/2024
Construction end date: 27/11/2024
Inclination: -90°
Depth drilled: 48 m BGL

Volume Purged: 1386.0 L
EC: 2314 µS/cm
pH: 7.32
Temp: 38.5 °C
Static Water Level: 16.05 m TOC



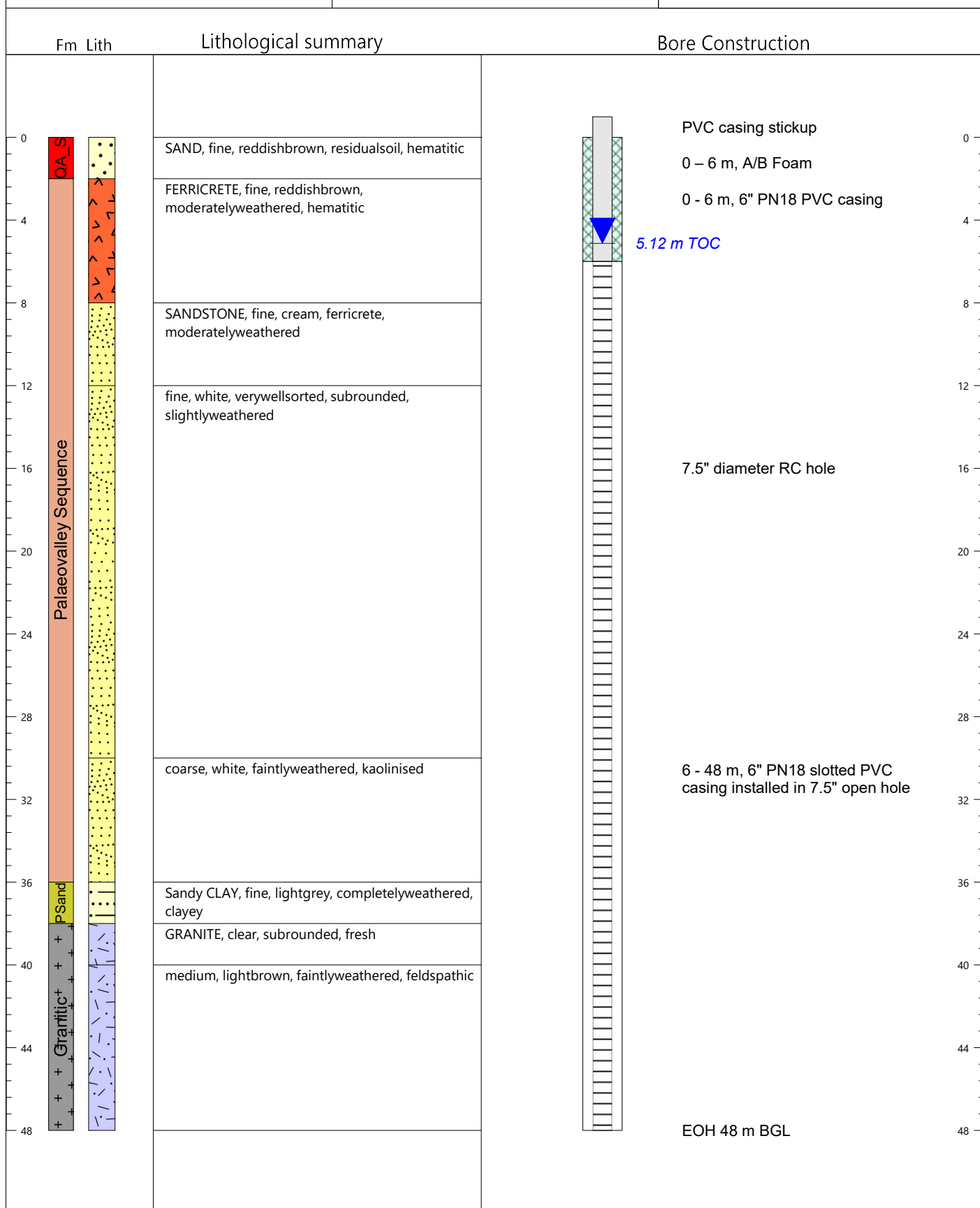
Additional notes:

WINU1444 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 394656.87 mE / 7690337.45 mN
Elevation: 251.51 m AHD (RL = TOC)

Construction start date: 30/11/2024
Construction end date: 01/12/2024
Inclination: -90°
Depth drilled: 48 m BGL

Volume Purged: 1862.0 L
EC: 4094 µS/cm
pH: 7.24
Temp: 35.6 °C
Static Water Level: 5.12 m TOC



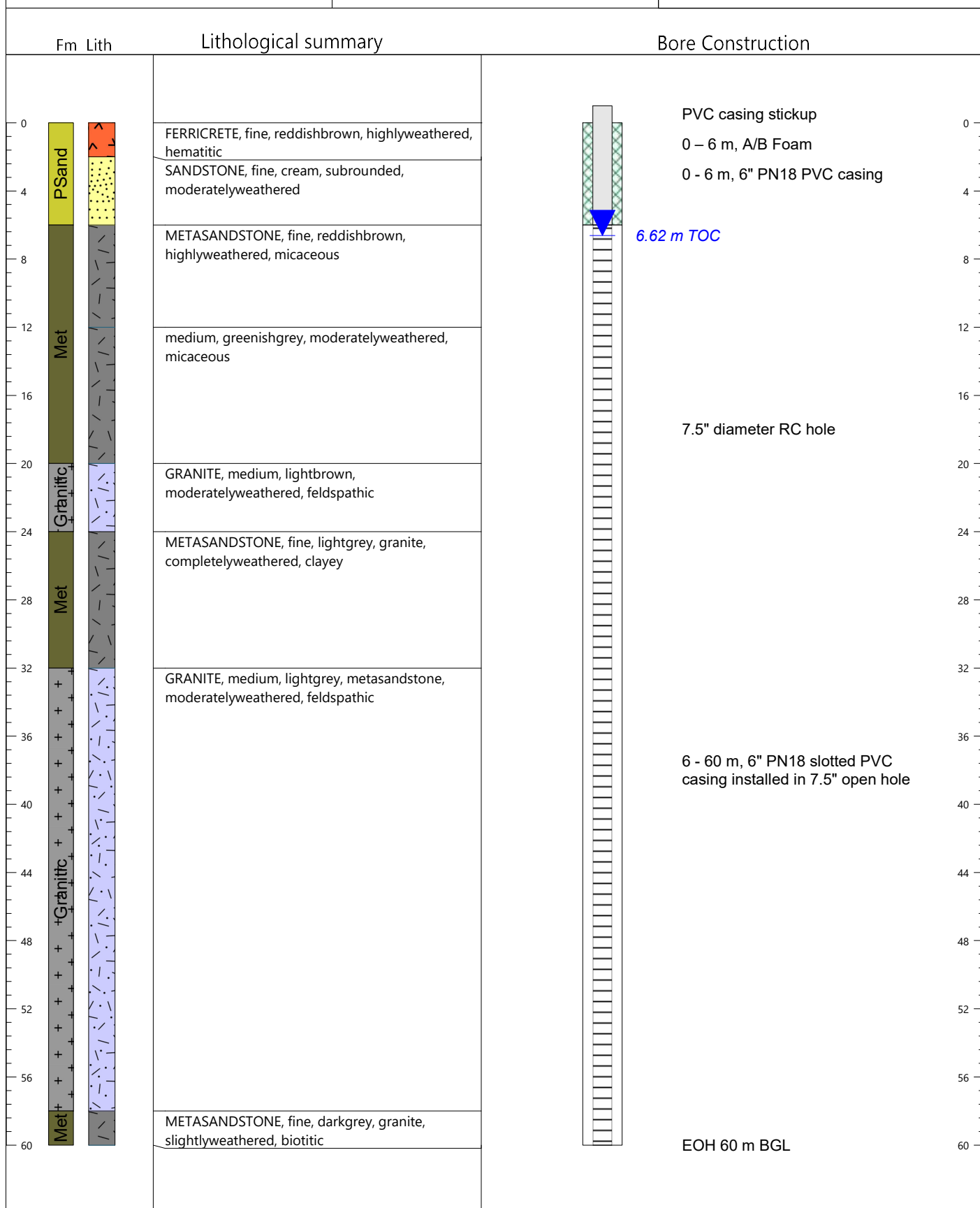
Additional notes:

WINU1445 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 395112.99 mE / 7690871.61 mN
Elevation: 252.90 m AHD (RL = TOC)

Construction start date: 01/12/2024
Construction end date: 01/12/2024
Inclination: -90°
Depth drilled: 60 m BGL

Volume Purged: 2338.0 L
EC: 2751 µS/cm
pH: 7.35
Temp: 32.8 °C
Static Water Level: 6.62 m TOC



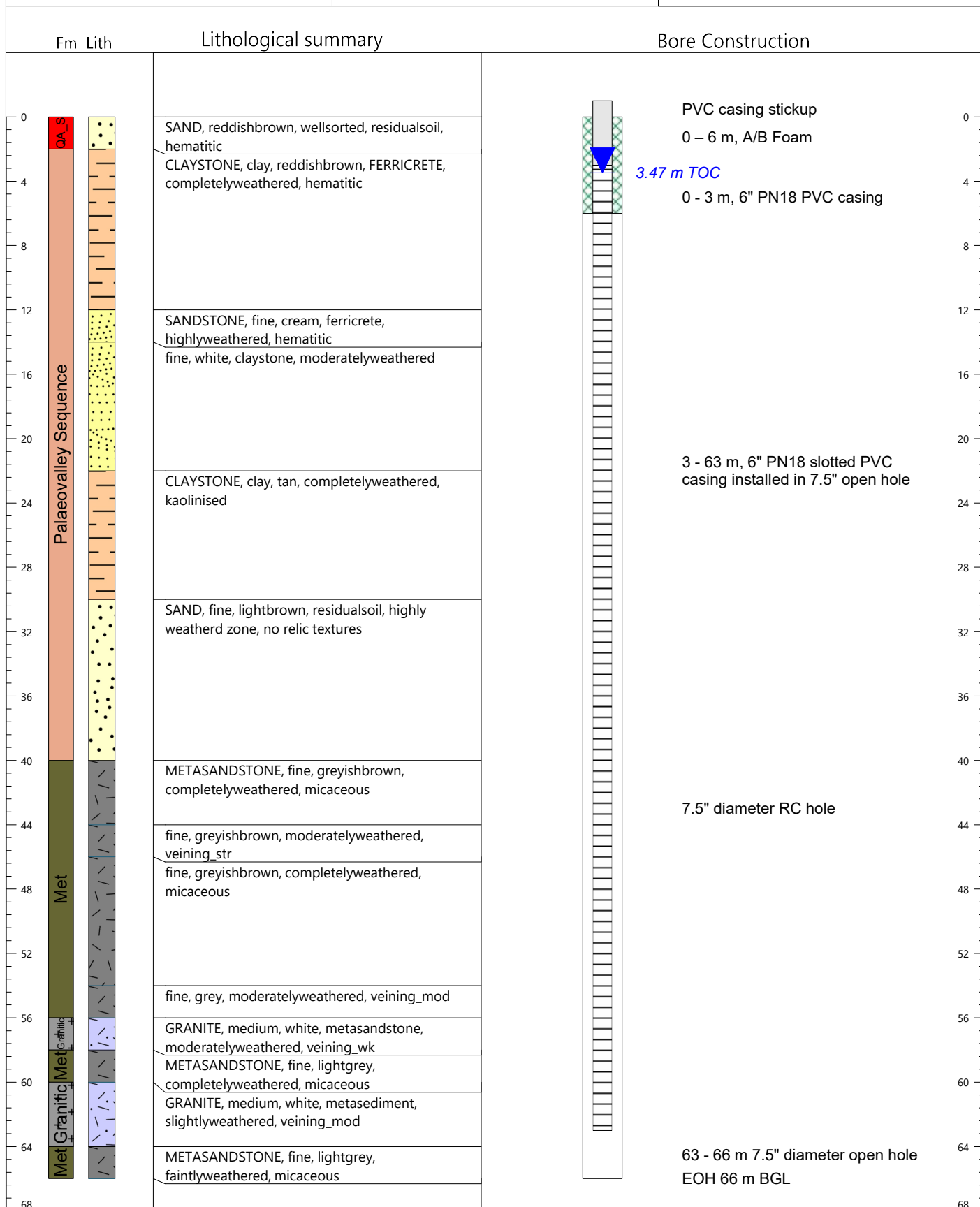
Additional notes:

WINU1446 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 395856.78 mE / 7689993.45 mN
Elevation: 250.05 m AHD (RL = TOC)

Construction start date: 29/11/2024
Construction end date: 30/11/2024
Inclination: -90°
Depth drilled: 66 m BGL

Volume Purged: 2716.0 L
EC: 4983 µS/cm
pH: 7.48
Temp: 33.4 °C
Static Water Level: 3.47 m TOC



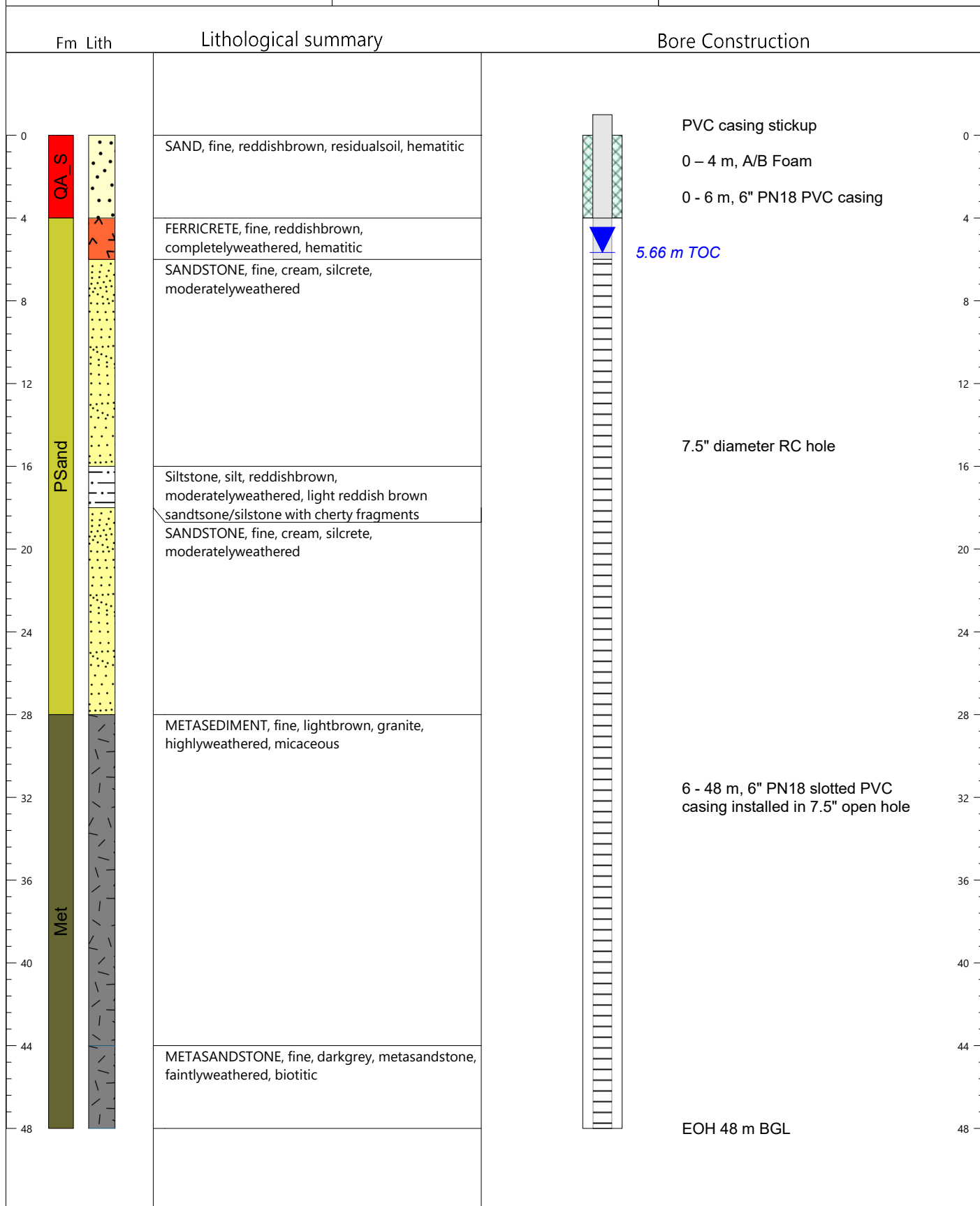
Additional notes:

WINU1451 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 393911.29 mE / 7685779.57 mN
Elevation: 255.28 m AHD (RL = TOC)

Construction start date: 06/12/2024
Construction end date: 07/12/2024
Inclination: -90°
Depth drilled: 48 m BGL

Volume Purged: 1820.0 L
EC: 804 µS/cm
pH: 7.31
Temp: 35.2 °C
Static Water Level: 5.66 m TOC



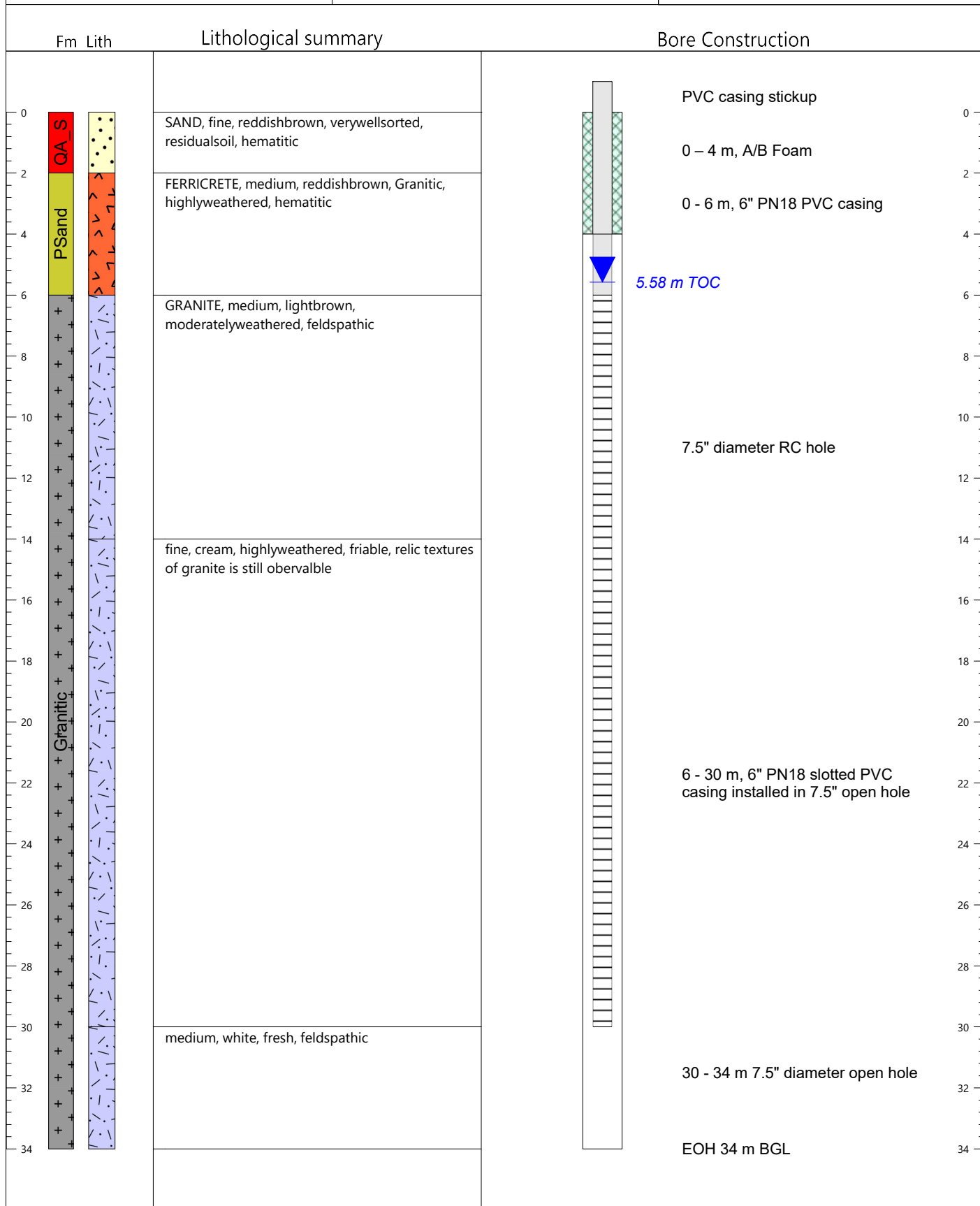
Additional notes:

WINU1452 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 394057.01 mE / 7686604.79 mN
Elevation: 255.12 m AHD (RL = TOC)

Construction start date: 04/12/2024
Construction end date: 05/12/2024
Inclination: -90°
Depth drilled: 34 m BGL

Volume Purged: 1316.0 L
EC: 580 µS/cm
pH: 7.85
Temp: 35.6 °C
Static Water Level: 5.58 m TOC



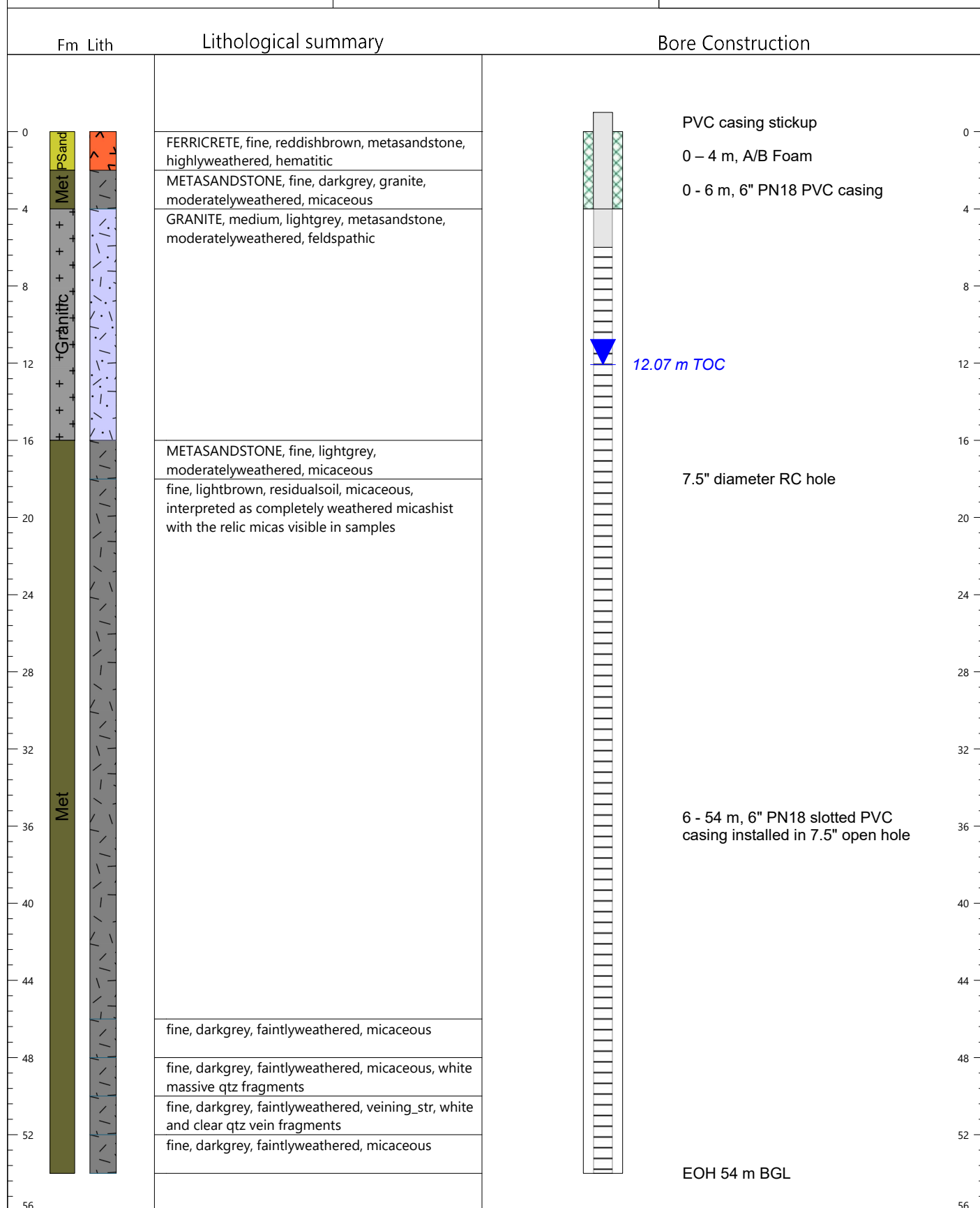
Additional notes:

WINU1453 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 399833.12 mE / 7684083.64 mN
Elevation: 265.26 m AHD (RL = TOC)

Construction start date: 07/12/2024
Construction end date: 07/12/2024
Inclination: -90°
Depth drilled: 54 m BGL

Volume Purged: 1671.0 L
EC: 212 µS/cm
pH: 7.29
Temp: 36.0 °C
Static Water Level: 12.07 m TOC



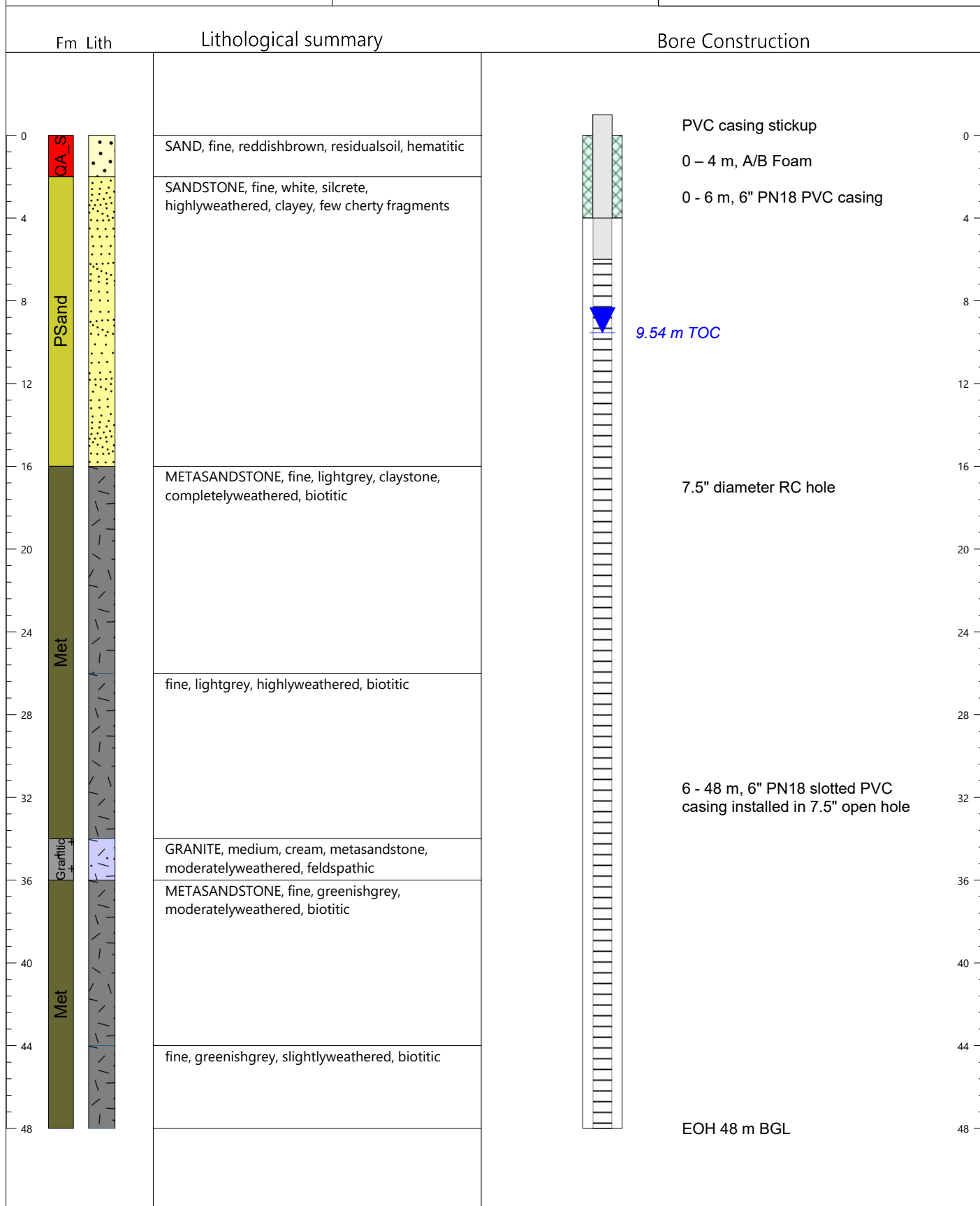
Additional notes:

WINU1454 - Stygofauna Bore Log

Project: Winu Stygofauna Investigation Program
Client: Rio Tinto
CRS: GDA94 MGA51
Coordinates: 399806.44 mE / 7683678.33 mN
Elevation: 264.31 m AHD (RL = TOC)

Construction start date: 07/12/2024
Construction end date: 07/12/2024
Inclination: -90°
Depth drilled: 48 m BGL

Volume Purged: 1652.0 L
EC: 744 µS/cm
pH: 7.34
Temp: 34.7 °C
Static Water Level: 9.54 m TOC



Additional notes: