Appendix H

918 Panel Watercourse Stability and Geomorphological Assessment (GHD 2026a)

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918 Panel Watercourse Stability and Geomorphological Assessment

Clarence Colliery

Clarence Colliery Pty Ltd

14 January 2026

→ The Power of Commitment

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1. Introduction

1.1 Project background

Clarence Colliery is an underground coal mine located in the Western Coalfield approximately 15 km east of Lithgow, NSW. Clarence Colliery is indirectly wholly owned by Centennial Coal Company Pty Limited (Centennial) through a joint venture structure. Clarence Colliery Pty Limited (Clarence) is the manager of the joint venture and Clarence Coal Pty Limited is the statutory operator of Clarence Colliery. The mine is operated by Clarence Coal Pty Limited (Clarence) on behalf of the owner. Clarence Colliery is currently operated under the conditions of the existing consolidated consent DA504-00 MOD 10, for the extraction of up to 3 million tonnes per annum of run of mine (ROM) coal from the mine.

Clarence propose to develop the 918 Panel in the north of the Clarence Colliery mine lease, and to the west of the previously partially extracted Panels 906, 908 and 910 and the 900 Panel first workings panel. The proposed 918 Panel (comprising sub-panels 918A, 918B1 and 918B2) includes both first and second workings and comprises secondary shortwall extraction on either side of a central spine pillar. Note that 918 Panel in this report refers collectively to the 918A, 918B1 and 918B2 sub-panels.

To avoid directly mining beneath the majority of swamps above the 918 Panel, the 918A sub-panel has been shortened at the southern and northern ends and the 918B sub-panel has been split into a 918B1 sub-panel and a 918B2 sub-panel (see Figure A1, Appendix A). The sub-panels are planned to be extracted in the following order and direction:

– Panel 918A, commencing at the southern end and mining towards the north.
– Panel 918B1, commencing at the northern end and mining towards the south.
– Panel 918B2, commencing at the northern end and mining towards the south.

1.2 Geomorphological assessment scope

Schedule 3, Section 2 g (iii) of development consent DA504-00 requires Clarence to develop and implement a Water Management Plan (WMP) as part of an Extraction Plan. GHD is preparing a separate WMP addressing specific water-related conditions. DA504-00, Schedule 3, Section 2 g (iii) includes the following requirements, noting that other requirements will be addressed separately by Clarence:

– Detailed baseline data on geomorphic conditions of watercourses and/or water bodies that could be affected by subsidence.
– Detailed surface water impact assessment criteria, including specific trigger levels for active remediation of geomorphic and erosional impacts (including supporting justification for the selected triggers).
– A plan to respond to any exceedances of the surface water assessment criteria.

GHD Pty Ltd (GHD) were engaged by Clarence to undertake a geomorphological baseline assessment of watercourses and swamps within the Paddys Creek and Bungleboori Creek catchments to meet DA504-00 requirements. An initial site assessment to establish baseline conditions was conducted in May 2023. A follow-up site assessment in November 2023 assessed areas outside this initial scope.

Subsidence modelling was provided by MSEC (August 2025[1]). The study area is defined by the predicted 20 mm subsidence contour or the 35 degree angle of draw, whichever is the larger, within the anticipated impact area of planned extraction of mining the 918 Panel, as shown on Figure A1 in Appendix A. The study area for this baseline assessment extends to the outer combined limit of the 20 mm subsidence contour and adjacent reaches of watercourses and swamps which could be affected by the subsidence.

[1] MSEC. 2025. Clarence Colliery – 918 Panel, Subsidence Predictions and Impact Assessment Report, Report for Clarence Colliery No. MSEC1493, August 2025.

There are several Temperate Highland Peat Swamps on Sandstone (THPSS) – Newnes Plateau (NP) Hanging Swamps, and THPSS – NP Hanging / Shrub Swamps in the study area. The primary swamps above the proposed 918 Panel are associated with the drainage lines of Bungleboori Creek (Pine and Nine Mile Swamps) and Paddys Creek (Paddys Creek Shrub and Hanging Swamps). The locations of these swamps are presented on figures in Appendix A. These swamps are sensitive to change and this assessment, therefore, focuses on establishing their contemporary condition.

1.3 Limitations

This report has been prepared by GHD for Clarence Colliery Pty Ltd and may only be used and relied on by Clarence Colliery Pty Ltd for the purpose agreed between GHD and Clarence Colliery Pty Ltd as set out in this section of the report.

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

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

The opinions, conclusions and any recommendations in this report are based on:

– Conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.
– Information obtained from visual observations undertaken at or adjacent to specific monitoring points. Site conditions at other parts of the site may be different from the site conditions found at the specific monitoring points. Investigations undertaken in respect of this report are constrained by the particular site conditions, such as accessibility and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.
– Assumptions made by GHD described in this report (refer Section 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect

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

This report is not intended to provide a fully comprehensive assessment of factors contributing to mine impacts, such as panel extraction, groundwater/surface water and flora impacts, and comprehensive studies of analogous areas have been undertaken by other consultants. This report is intended to outline GHDs understanding of potential panel extraction impacts as they may relate to likely geomorphological impacts to these watercourses and swamps from the proposed panel extraction.

1.4 Assumptions

GHD assumed that the information supplied by Clarence regarding the proposed panel extraction and subsidence impacts is complete, accurate and appropriate for the requested assessment.

2. Method of assessment

2.1 Assessment outline

The assessment of watercourse stability within the potential impact area for extraction of the 918 Panel uses the following methodology:

– Desktop assessment:
  - Review of existing information regarding conditions in the watercourses and swamps in the study area, including proposed mining, geology, soils, rainfall and bushfire, within the proposed extent of the 918 Panel and impact areas shown in Figure A1, Appendix A.
  - Review of relevant Centennial Coal monitoring data, including rainfall, groundwater and surface water data.
– Site assessment, with locations visited shown on Figure A2 and site visit photograph locations on Figure A3, Appendix A, and photographs and observations presented in Appendix B:
  - Geomorphological assessment of Paddys Creek and Bungleboori Creek watercourses, with establishment of suitable monitoring points. Coordinates of monitoring points were recorded using a hand-held GPS.
  - Condition of watercourse at each monitoring point was recorded, with views (where feasible) looking upstream, downstream, at the left and right banks and any other points of interest.
  - Location and extent of existing areas of erosion were recorded.
  - Location of surface water features including rock pools and dams were recorded using hand-held GPS.
– Review of available data and field observations to determine whether Paddys Creek and Bungleboori Creek, including associated swamp areas, would be susceptible to adverse impacts from the proposed works.
– This report provides a summary of the desktop and site visit assessment results.

2.2 Watercourse condition assessment method

Watercourses within the study area are typically ephemeral topographic depressions in the hillside. These watercourses typically have no defined bed or bank, with flows trickling through vegetation along the valley floor or within small, defined channels. Erosion within the watercourses is typically not defined by the steepness of the valley walls.

Watercourse condition was considered *ad hoc*, using appropriate geomorphological indicators of stability, depending on the channel and valley characteristics. Relevant observations and interpretation of baseline condition are included in the site description.

2.3 Swamp condition assessment method

The swamp condition was assessed using methods proposed by Fryirs et al. 2016[2]. THPSS swamps can be divided either by geomorphology and/or hydrology (e.g., Fryirs et al., 2016), or underlying rock and location (e.g., IESC, 2014[3]). Fryirs et al., 2016 discovered two main swamp types: intact swamps and channelised (valley) fill swamps. Channelised swamps generally had much larger, more elongate catchments than intact swamps (Fryirs et al., 2016). However, an assessment of intrinsic versus extrinsic variables indicated that there were no controlling factors explaining the variation in swamp type and condition, such as local history and stochastic events (extreme rainfall/runoff events; Fryirs et al., 2016). A summary of attributes which can be used to assess the condition of the two swamp types are presented in Figure 2.1 and Figure 2.2. Further information regarding condition identifiers and swamp behaviour / response is discussed in Section 3.4.

2.4 Landform definitions

Clarence has asked GHD to adopt definitions for landforms within the study area (and Newnes Plateau in general). These definitions were developed by MSEC (E. White, *pers. comm.,* 19/12/23) and are generally consistent with relatively recent definitions included in State Significant Development consents for slopes in underground coal mines. The definition of a pagoda has been amended to indicate the process of formation. The definitions are as follows.

Table 2.1 MSEC (2023) landform definitions adopted for GHDs geomorphological assessment

Landform	Definition (MSEC, 2023)
Gentle slopes	An area of land having a gradient of less than 1 in 6 (18% or 10°)
Moderate slopes	An area of land having a gradient of greater than 1 in 6 (18% or 10°) and less than 1 in 3 (33% or 18.3°)
Steep slopes	An area of land having a gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°)
Minor cliff	A continuous rock face, including overhangs, which has a minimum length of 20 metres, a height between 5 metres and 10 metres, and a minimum slope of 2 to 1 (> 63.4°)
Cliff	Continuous rock face, including overhangs, having a minimum length of 20 metres, a minimum height of 10 metres and a minimum slope of 2 to 1 (> 63.4°)
Pagoda	Smooth or platy conical sandstone formations formed by differential erosion of sedimentary rock found in the Blue Mountains and Newnes Regions of NSW
Gorge	A deep, narrow valley with cliffs on both sides

[2] Fryirs, K.A., Cowley, K.L., and Hose, G.C., 2016. Intrinsic and extrinsic controls on the geomorphic condition of upland swamps in Eastern NSW. Catena 137, p100–112.
[3] Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). 2014. Temperate Highland Peat Swamps on Sandstone: longwall mining engineering design – subsidence prediction, buffer distances and mine design options. Report commissioned by the Department of the Environment.

Condition rating	Good condition	Moderate condition	Poor condition
Number of swamps assessed (338 total)	165 (49%)	146 (43%)	27 (8%)
Channel attributes	Water evident on surface of the swamp. Multiple, discontinuous surface drainage lines. Little surface vegetation disturbance. There are no knickpoints in these systems.	Surface water only evident close to drainage lines on the swamp surface. Single, continuous drainage line developing. Significant surface vegetation disturbance around channel. Knickpoints exist in system.	Little surface water and first obvious signs of desiccation of swamp. Small, single channel evident throughout swamp valley fill. Vegetation on the surface of swamp is moderately to highly disturbed and/or cleared.
Channel planform	95–100% of the swamp contains an intact, continuous swamp surface. No channel entrenchment is occurring. The riparian vegetation is native, extremely dense and consists of hydrophilic species that dictate where surficial drainage lines occur. No desiccation is visible.	Less than 70% of the swamp contains an intact, continuous swamp surface. Drainage lines having developed into small, single channel in downstream sections of swamp. Hydrophilic vegetation is confined to lowest relief area of swamp and is severely disturbed in places. Signs of weed plumes. Highest relief margins of swamp becoming desiccated.	50% - 60% of the swamp contains an intact, continuous swamp surface. Single, well defined channel is evident and is expanding. Hydrophilic vegetation is rare. Riparian zones are generally exotic and scattered. Up to 40% of the swamp contains channelised fill system. These areas are desiccated.
Valley fill character	No incision of drainage lines is occurring. The material accumulating on the swamp surface is comprised largely of organic matter. Only minor sand sheets adjacent to hillslopes may occur. Peat formation is occurring. No sand sheets are visible.	Incision of drainage lines occurring, producing a single, dominant surficial drainage line. Sand sheets and flood outs visible in downstream sections. Little organic matter accumulating.	Major incision into sands. Little to no organic matter accumulating. Sand s heets and flood outs dominate swamp surface.
Types of anthropogenic disturbance observed	No stormwater outlets or sealed roads immediate to the swamp. Gravel roads approximate to swamps	Stormwater outlets entering swamp. Sealed roads approximate to swamp.	Stormwater outlets entering upstream area of swamp. Sealed roads approximate to swamp.
Photograph			

Figure 2.1 Summary of identifiers of geomorphic condition of intact swamps in the Blue Mountains

(Source: Table 4, Fryirs et al., 2016)

Condition rating	Good condition	Moderate condition	Poor condition
Number of swamps assessed (120 total)	32 (28%)	61 (50%)	27 (23%)
Channel attributes	Compound cross section within an incised trench or moderately incised channel. Vegetated benches may be evident. Stable banks with no undercutting or slumping visible. No active knickpoints evident. Occasional tussock vegetation on sand bars throughout channel. Appropriate width:depth ratio.	Symmetrical, incising channel. Banks are exposed and near vertical. Some undercutting may be evident. May contain active knickpoints within system. No aquatic vegetation within channel. Channel has a high width:depth ratio.	Symmetrical, incising channel. Banks and bed are exposed and eroding along entire reach. Active undercutting and slumping occurring. No aquatic vegetation and multiple knickpoints throughout system. Channel has a high width:depth ratio.
Channel planform	The channel is laterally stable with limited adjustment potential. Well defined low flow channels exist within incised macrochannel. Scattered to good condition riparian zone which may contain exotics and/or native flora.	Floodplain is disconnected from channel. Disturbed riparian zone, variable exotic and native vegetation. Signs of desiccation of swamp surface. Minor undercutting of banks may be occurring suggesting active channel expansion in places. Sand sheets may be evident on the channel bed.	Active lateral and vertical expansion of channel. Floodplain disconnected from channel. Little or no riparian zone. Swamp is desiccated, ground table is lowering and no hydrophilic vegetation is evident. Sand sheets may cover channel bed.
Bed character	Bed generally stable due to incision to bedrock. Channel is aggrading in places. Low flow channel redistributes sediment. Sands stored in geomorphic units such as benches, point bars and islands, producing hydraulic diversity on the channel bed. Aquatic vegetation stabilising instream geomorphic units and some organic matter may be accumulating on these surfaces. Reach is acting as sediment transfer or accumulation zone.	Channel bedload dominated by sand. Reach is still releasing some sediment through active knickpoint retreat into the swamp. Moderate bed stability. No organic matter accumulating. Acting as a sediment source zone.	Bedload dominated by sand. Reach has limited capacity to retain sediment. Reach is still releasing sediment from channel banks. Bed may be still incising or has reached bedrock. No organic matter accumulating. No aquatic vegetation.
Types of anthropogenic disturbance observed	Stormwater outlets entering site. Gravel roads approximate to site.	Multiple stormwater outlets entering site. Some sealed and some gravel roads may exist approximate to these sites.	Multiple stormwater outlets entering sites. Sealed roads approximate to all sites.
Photograph			

Figure 2.2 Summary of identifiers of geomorphic condition of channelised fill swamps in the Blue Mountains

(Source: Table 5, Fryirs et al., 2016)

3. Study area background

3.1 Watercourse and swamp overview

Bungleboori Creek rises within a twin-headed, elongate, narrow swamp (see Figure A1, Appendix B). The creek consists of a series of swamps (THPSS) connected by the creek channel. The southwestern-orientated upstream swamp is referred to as Pine Shrub Swamp (Clarence swamp ID, S_UID 184) and western-orientated upstream swamp referred to as Nine Mile Swamp (tributary swamp S_UID 260 and 262). The main swamp within the Bungleboori upper catchment is referred to as Lower Mine Mile Swamp (S_UID 582, 574, 581, 583, 576, 575, 580). Above the shrub swamp, several hanging swamps are located perched on the steep valley sides. These are referred to as Lower Nine Mile Hanging Swamps, S_UID 577 and 579, with an additional swamp in that system referred to as Paddys Creek Hanging Swamp, S_UID 584 (located upstream of Lower Nine Mile Shrub Swamp S_UID 580).

Bungleboori Creek is fed predominantly by shallow groundwater and also minor, rainfall-activated watercourses flowing down the valley sides. The creek transitions into a steep, narrow, bedrock valley downstream of monitoring point BC3. The anticipated panel extraction impact area is concentrated within the upper swamp reaches.

The study area includes a short reach of Paddys Creek, downstream of the large swamps and upstream of the confluence with Bungleboori Creek. Paddys Creek is bedrock-controlled, flowing within a narrow gorge. Similar to Bungleboori Creek, the upper reaches are characterised by a series of swamps fed predominantly by groundwater. Paddys Creek also transitions into a bedrock-controlled cliff-lined narrow valley with contorted meanders incised into bedrock.

Swamps within the area were heavily impacted by the Gospers Mountain fire in late 2019. This was followed by a period of higher-than-usual rainfall in 2021, 2022 and early 2023. Following the site visit in 2023, the Newnes plateau and study area experienced some very dry months during the spring of 2023 and 2024, followed by wetter than usual conditions, with high rainfall totals during summer / autumn 2024 and autumn / winter 2025 (see Sections 3.5 and 3.6).

3.2 Likely proposed extraction impacts

3.2.1 Predicted subsidence and impacts

As discussed in Section 1.1, Clarence have obtained predictions of surface subsidence in response to the proposed extraction from the 918 Panel. MSEC (2025) indicate that the proposed workings include secondary extraction on either side of a first workings central spine pillar. Areas of secondary extraction avoid Paddys and Bungleboori Creek. The full thickness of the Katoomba Seam will be extracted. The various subsidence model outputs are shown in Figure A1, Appendix A, with the study area designated as the outer limit of the 35 degree angle of draw (AoD) and the predicted limit of vertical subsidence delineated by the 20 mm subsidence contour. MSEC (2025) have adopted a conservative AoD of 35 degrees, rather than the standard 26.5 degrees based on historic subsidence from Panels 906 - 910. The 20 mm subsidence contour extends outside the AoD in the high relief, incised section of Paddys Creek (see Figure A1, Appendix A).

The depth of cover directly above the proposed 918 sub-panels varies between 227 m and 294 m (MSEC, 2025). Subsidence is anticipated to be due to pillar compression rather than sag subsidence. This mechanism will reduce the potential for irregular movement. However, irregular subsidence may also be associated with:

– Geological structure (e.g., joints / bedding planes, faults and dykes). MSEC (2025) note that, in some circumstances, it is not possible to predict non-conventional, anomalous, irregular ground movements. Subsidence modelling undertaken by MSEC (2025) incorporates conventional and non-conventional ground movement based on past occurrence. The potential for significant non-conventional movement is anticipated to be low, due to the low predicted total subsidence and adjacent historic ground response to mining.
– High relief topography, e.g., increased horizonal downslope movement.
– Local morphology, e.g., valley closure / upsidence in narrow, deeply incised valleys.

Previous extraction of adjacent Panels 906 to 910 resulted in maximum subsidence of 88 mm (Panel 910), 158 mm (Panels 910 and 908) and approx. 195 mm (906 – 910), with tilts of up to 0.6 mm / m. Maximum subsidence was achieved several months after extraction. Extraction of Panels 906, 908 and 910 was undertaken using partial pillar extraction compared to the planned secondary shortwall extraction for Panel 918.

Tensile stresses were measured along two transects. These crossed watercourses, but did not experience elevated compressive strains, indicating that valley closure or upsidence did not occur. Historic measurements of strain in partial and total extraction areas where the maximum measured vertical subsidence was below 100 mm were reviewed. Approximately 95% of the measured strains were below 0.3 mm / m, a value adopted for the predicted response to 918 Panel extraction.

The maximum predicted total vertical subsidence is 76 mm ± 20 mm. This is anticipated to occur directly above sub-panels 918A and 918B2 where two sub-panels were extracted adjacent to each other and the depth of cover is greatest (MSEC, August 2025).

Far field effects, outside the AoD and subsidence area, are predicted to be small and in the direction of the panels, based on historic information from analogous mining areas. Impacts are not expected to be significant (MSEC, 2025).

MSEC (2025) also provide anticipated impacts to landforms, summarised as follows:

– Watercourses: negligible impact from predicted modelled tilts and bedrock fracturing. Tilts are anticipated to be two orders of magnitude lower than the natural bedslope. Bedrock fractures are considered unlikely and limited to minor (< 3 mm) joint opening with no surface expression due to plastic surface soils. Lack of impact in areas of greater subsidence.
– Aquifers, groundwater and springs: impacts are expected to be confined to below the Mount York Claystone, approx. 110 m above the 918 Panel.
– Cliffs, minor cliffs, pagodas and steep slopes: negligible impacts due to not expected to experience measurable conventional and/or non-conventional subsidence, tilts, curvatures or strains. Rock fracturing and associated rock fall is considered unlikely since the predicted subsidence is significantly lower than other areas where no impacts have been observed. Therefore, impacts to cliffs, minor cliffs, pagodas and steep slopes are unlikely to impact downslope watercourses and swamps.
– Swamps: impacts from subsidence, mining-induced tilts, fracturing of underlying rock and associated impacts on groundwater are considered to be unlikely given the minor anticipated ground movement and lack of impact in areas with greater subsidence.

3.3 Newnes Plateau geology and soils

Clarence has an in-depth understanding of geological conditions on the Newnes Plateau. Therefore, GHD has not attempted to provide more than a high-level summary of conditions relevant to the watercourse assessment. The study area is underlain by Early Triassic Narrabeen Group Banks Wall Sandstone (MinView geological mapping, accessed September 2025). The area is also characterised by outcropping of Burralow Formation. McHugh (2013[4]) observed that outcropping of the Burralow Formation, with interbedded sedimentary sequences and claystone aquitards (with seven major aquitards referred to as YS1 to YS6), perform a vital function in the presence and persistence of shrub and hanging swamps on the Newnes Plateau.

Joint patterns within the sandstone have influenced the pattern of watercourse development, with Paddys Creek and Bungleboori Creek flowing through gorge reaches, where contorted, hairpin meanders have developed around northwest/southeast trending spurs, topped by pagoda formations.

Soils in the study area are typical of residual/weathered sandstones, comprising acidic quartz sands, clayey sands and sandy/clay loams in the following soil landscape assemblages (eSpade soils mapping and associated soil landscape fact sheets, accessed June and November 2023):

– Newnes Plateau[5] soil landscapes along the eastern section of the site, on broad ridgetops. These areas are prone to sheetwash and track erosion, and are particularly susceptible to erosion following vegetation clearance (e.g., logging or bushfire).
– Warragamba[6] soil landscapes on steep slopes and rocky gorges throughout the site, which are prone to rockfall and landslides.
– Mount Sinai[7] soil landscapes, associated with narrow ridges, rocky benches and pagoda formations, which can be prone to sheetwash, particularly following bushfire.
– Wollongambe[8] and Medlow Bath[9] soil landscapes. These soils are prone to erosion once ground cover is disturbed, with moderate to severe rilling and sheet erosion of tracks.
– Swamps are characterised by Deanes Creek[10] soil landscapes, dominated by organic-rich sandy and sandy clay loams overlying sandy clays and coarse sands. Loose quartz sand layers are common as surface layers or as layers within the organic-rich topsoil.

3.4 Swamp formation and typical conditions

3.4.1 Swamp formation

Temperate Highland Peat Swamps on Sandstone (THPSS), including Newnes Plateau Shrub Swamps (NPSS), are assemblages of flora and fauna that have developed over thousands of years (Goldney et al., 2010). Their formation is reliant on natural landforms which retard surface and subsurface flows, such that material accumulates upstream of that point, in time resulting in the accumulation of up to many metres of peat (IESC, 2014). However, some NPSS do not even have peat layers (Goldney et al., 2010). As peat accumulates, the capacity of the swamp to hold water increases.

Valley fill swamps were formed during Holocene-aged post-glacial sediment accumulation, when streams had reduced transport capacity (Cowley et al., 2018[11]). Higher rainfall and temperatures during this period allowed preservation of organic matter within the valley fill. Water is typically contained within the fill, and surface water is only seen following heavy rainfall.

[4] McHugh, E. 2013. The Geology of the Shrub Swamps within Angus Place / Springvale Collieries, Preliminary Report, July 2013. data.centennialcoal.com.au/domino/centennialcoal/cc205.nsf/0/10EE4D4E5744AD10CA257CB50082DA6B/$file/The Geology of Shrub Swamps.pdf Accessed March 2025.
[5] Newnes Plateau Soil Landscape Fact Sheet **8931np.pdf (nsw.gov.au)**
[6] Warragamba Soil Landscape Fact Sheet **8931wb.pdf (nsw.gov.au)**
[7] Mount Sinai Soil Landscape Fact Sheet **8931ms.pdf (nsw.gov.au)**
[8] Wollongambe Soil Landscape Fact Sheet **8931wo.pdf (nsw.gov.au)**
[9] Medlow Bath Soil Landscape Fact Sheet **8931mb.pdf (nsw.gov.au)**
[10] Deanes Creek Soil Landscape Fact Sheet **8931dc.pdf (nsw.gov.au)**
[11] Cowley, K.L., Fryirs, K.A. and Hose G.C. 2018.The hydrological function of upland swamps in eastern Australia: The role of geomorphic condition in regulating water storage and discharge. Geomorphology 310, p29–44.

Essential conditions for formation and survival of THPSS are (IESC, 2014):

– Impeded vertical drainage at the floor of the underlying rock.
– Waterlogged, anoxic conditions and low temperatures, which reduce vegetation decomposition rates.
– Organic matter accumulation much faster than the rate of decomposition, with acidic conditions an advantage.

Groundwater is retained in the Burralow Formation instead of infiltrating through to the underlying formations due to the presence of claystone beds (McHugh, 2013). McHugh (2013) provides the mapped extent and thickness of the Burralow Formation across the western Newnes Plateau. This specifically mentions and maps Pine Swamp and Nine Mile Swamp, with the influence of the Burralow Formation on Paddys Creek Shrub/Hanging Swamps and lower Nine Mine Swamp inferred along the mapped margins of the Burralow Formation.

McHugh (2013) states that:

– Semi-permeable units within Burralow Formation that are over 2 m thick are critical in hanging swamp formation.
– Retardation of groundwater due to Burralow Formation aquitards also contributes water to the shrub swamps.
– Banks Wall Sandstone has few semi-permeable units and is not a source of aquitard groundwater. Instead, infiltration of water from the Burralow Formation is retarded, enabling shrub swamp formation either partially or wholly on the Banks Wall Sandstone.

THPSS occurring wholly within the Banks Wall Sandstone are typically adjacent to subcrops of the lower Burralow Formation aquitard sequence, receiving groundwater seepage from these horizons (McHugh, 2013). This leads to lateral groundwater seepage and establishment of vegetation communities supported by the resultant springs. Figure 3.2 provides a conceptual sketch of the critical relationship between Burralow Formation aquitards and groundwater supply to Lower Nine Mile Shrub Swamp (S_UID591) and Paddys Creek Hanging Swamp (S_UID564), which supplies downstream reaches of Paddys Creek. Figure 3.3 provides a plan view of the relationship between Burralow Formation aquitard outcropping and swamp location. This plan indicates that aquitards YS5, YS5a and YS6 are critical for groundwater supply to the swamps within the study area. The swamps can be divided into the following:

– Swamps located within the Burralow Formation, supplied by aquitards YS3 and YS4: Pine Shrub Swamp, Pine Hanging Swamp, Nine Mile Swamp and upstream reaches of Paddys Creek Shrub and Hanging Swamps.
– Swamps located within the Burralow Formation, supplied by aquitards YS5, YS5a and YS6: upper reaches of Lower Nine Mile Swamp and Lower Nine Mile Hanging Swamps.
– Swamps located within the Banks Wall Sandstone, supplied by upslope springs from aquitards YS5, YS5a and YS6: downstream reaches of Lower Nine Mile Shrub Swamp and Paddys Creek Shrub and Hanging Swamps.

These geological and hydrogeological differences provide explanation as to the source of swamp moisture and anticipated response to climatic fluctuations, e.g., during drought periods, it would be anticipated that swamps located on the Burralow Formation, and supplied by multiple aquitards, would have a greater resilience to drying than those located on the more permeable Banks Wall Sandstone.

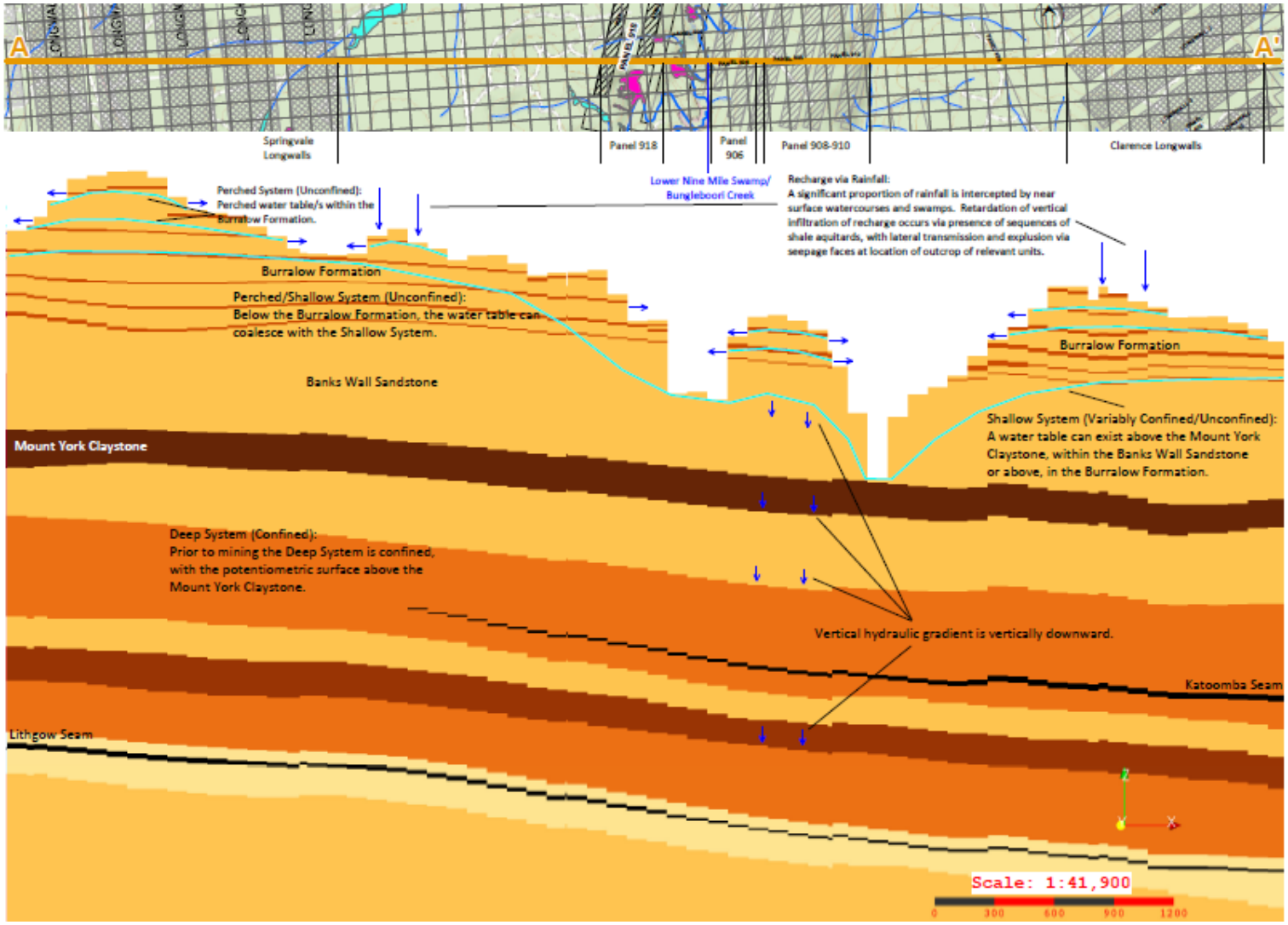


Figure 3.1 Conceptual hydrogeological section through Paddys Creek Hanging / Shrub Swamps and Lower Nine Mile Shrub Swamp and Bungleboori Creek, showing Burralow Formation aquitards (source JBSG 2025[12])

[12] JBS&G. 2025. Extraction Plan for 918 Panel: Groundwater Assessment, report prepared for Clarence Colliery Pty Ltd, November 2025.

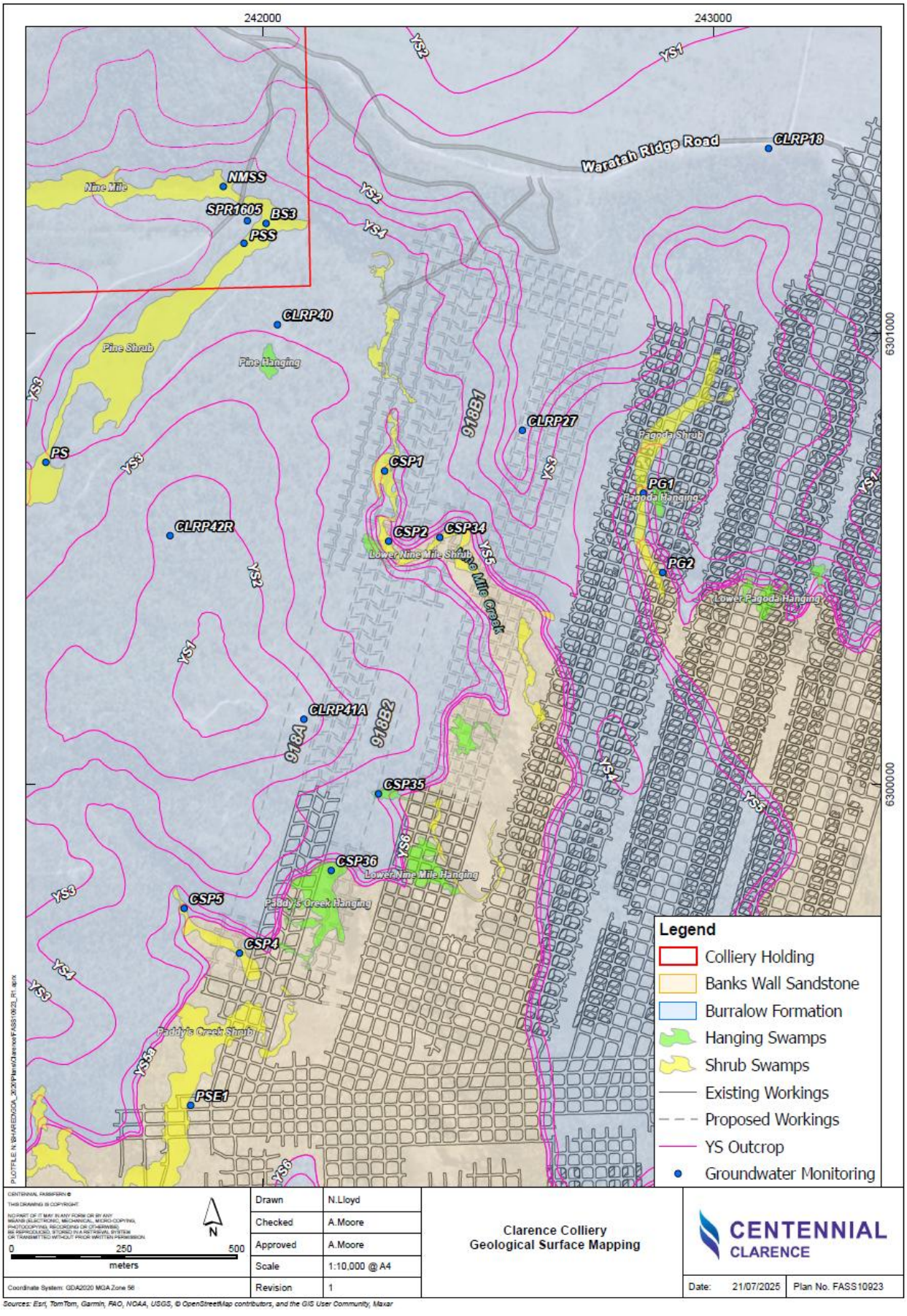


Figure 3.3 Clarence Colliery surface geology mapping, showing relationship between Burralow Formation aquitards and swamp location (supplied: Clarence Colliery, 16/09/25)

3.4.2 Swamp condition

NPSS are highly variable in terms of their key attributes (e.g., stratigraphy, drainage, vegetation cover, geomorphological evolution, topography and presence of incision). Their distinct characteristics makes each hydrologically, geomorphologically and ecologically unique (Goldney et al., 2010). Goldney et al. (2010) indicate that temporal and spatial distribution of water is the most important intra-swamp variability factor.

Fryirs et al. (2016) and Cowley et al. (2018) noted that there is a fundamental difference between the hydrologic function of intact and channelised swamps in the Blue Mountains. They found that water table variability is almost three times higher in channelised swamps compared with intact swamps (see Figure 3.4). Mean water levels did not vary appreciably between dry and wet periods in either type of swamp.

Poor condition intact swamps can transition to channelised fill-type swamps and continue to deteriorate in condition (Fryirs et al., 2016). This change in regime can also cause changes to vegetation communities, with a reduction in swamp vegetation assemblages and invasion of woody vegetation (Fryirs et al., 2016).

THPSS swamps are complex entities that are dynamic, changing and responsive to driving variables. In their natural state, they have a high degree of system resilience and stability: they are capable of withstanding significant environmental change, such as fire and extreme drought (Goldney et al., 2010[13]). Following disturbance, self-repair strategies are initiated. However, if a series of such disturbances (e.g., prolonged drought and fire combined) can cause ecological thresholds to be crossed, this can lead to collapse of the self-maintaining swamp system. Recovery may be possible from these major events but could take prolonged periods of time.

Fryirs et al. (2016) note that incision induced by a change in hydrologic function can destabilise swamp functioning. Once a system begins to incise, geomorphic condition is significantly impacted and the deterioration can trigger a negative feedback loop, i.e., a shift to a new geomorphic and hydrologic regime. Intact swamps tend to mitigate flood responses (with little/no effect on water tables when rainfalls are below 30 mm per event), whereas channelised swamps tend to exacerbate downstream effects of flooding. Intact swamps can also provide water to the downstream system during prolonged dry periods. Thus, channelised fills have been modified from long-term water storage into a water transfer zone (similar to a conventional creek).

Plants within the swamps have different tolerances to wetting and drying, and typically form well-defined zones from the lowest elevation central drainage line to the swamp edge, which may extend out to the break of valley slope. Very wet swamps tend to have a well-developed fringe of Coral Fern, whereas drier swamps do not (Goldney et al., 2010). This means that good condition swamps can look very different in terms of their vegetation assemblages.

Goldney et al. (2010) provide guidelines to potential vegetation impacts following LWM panel extraction:

– A decline in diversity and abundance of plant species which typically are associated with waterlogging and swamp land plant communities.
– An increase in diversity and abundance of plant species which typically occur in forests or woodlands in locations initially supporting species characteristic of swamp communities.
– An increase in diversity and abundance of exotic species or native species favoured by disturbance.
– Unusual variation in species diversity.
– Decline in condition of swamp plant species known to be sensitive to changes in water availability. These species include Coral Fern (*Gleichenia dicarpa*) and *Sphagnum cristatum*.

These environmental changes should be considered when assessing swamps for mining-related impacts. However, GHD notes that historic partial extraction mining practices within the Clarence mining lease have had no recorded adverse impacts on swamps, groundwater and associated vegetation.

[13] Goldney, D., Mactaggart, B. and Merrick, N. 2010. Determining whether or not a significant impact has occurred on Temperate Highland Peat Swamps on Sandstone within the Angus Place Mine lease on the Newnes Plateau, report prepared for Department of the Environment, Water, Heritage and the Arts (DEWHA), Cenwest Environmental Services, January 2010.

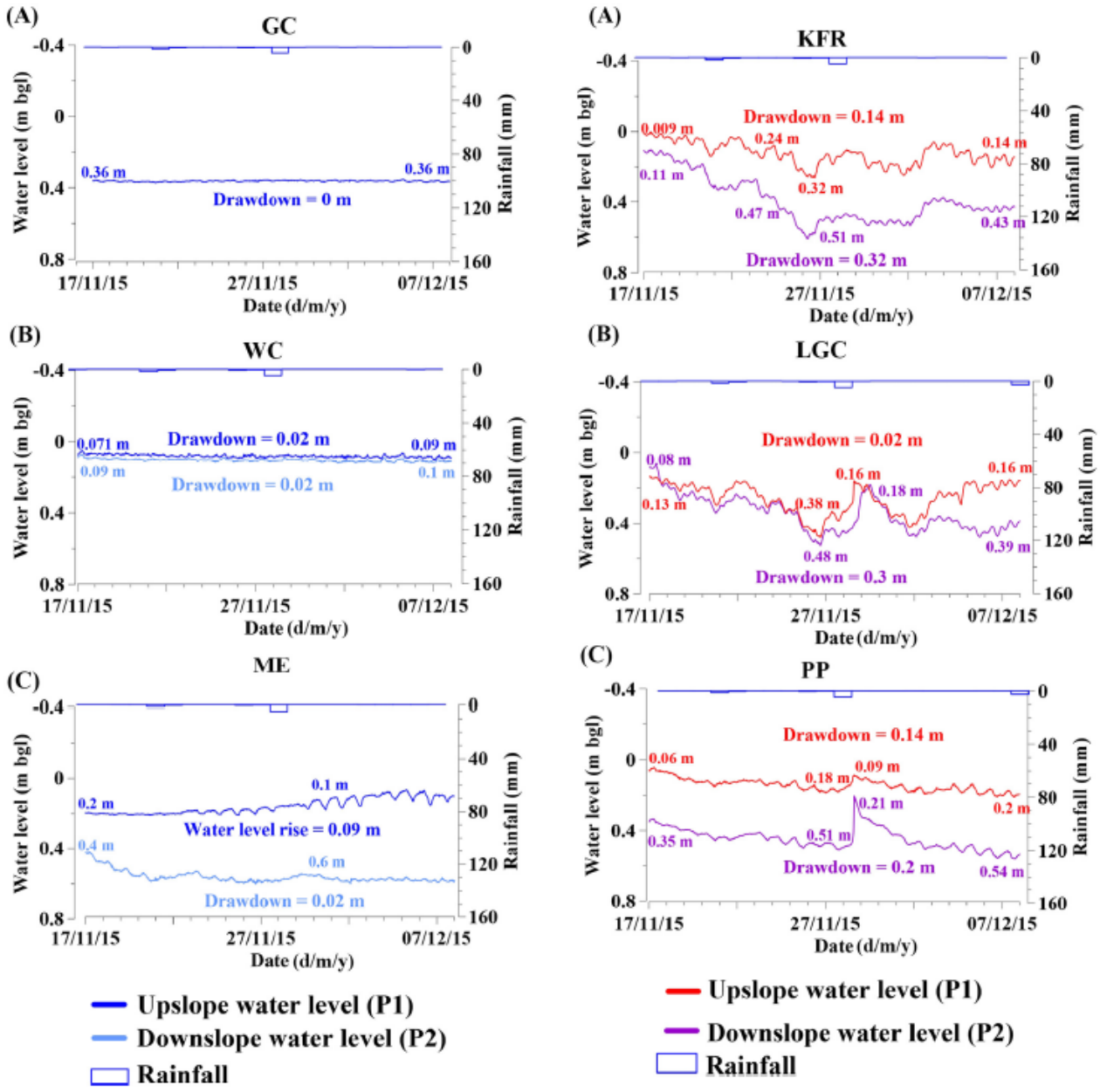


Figure 3.4 ***Comparison between groundwater and rainfall / runoff in intact and channelised fill swamps in the Blue Mountains (taken from Figures 11 and 12, Fryirs*** et al.***, 2016)***

3.5 Rainfall

Clarence supplied daily total rainfall data from the Clarence Colliery weather station (CLAWS001), located at the pit top, for the period May 2012 and September 2025. Historical rainfall data for Mount Boyce, the closest rain gauge in operation, were also evaluated (see Table 3.1). There were notably high rainfall annual totals during 2007 and 2020-2022, and low rainfall totals during 2018 – 2019.

– These data show the dry drought years between mid-2015 and late 2018, with dry periods extending into 2020 interspersed with intense rainfall. From November 2021 to late-2022, record rainfalls have been recorded.

– Maximum recorded daily total rainfall over the period of record at the Clarence weather station was 99.4 mm on 9/02/2020, with other high daily totals on 22/03/2021 (77.6 mm), 4/07/22 (69.8 mm), 20/12/2023 (95 mm) and 6/04/2024 (97.4 mm). These intense storms were regional, as indicated by the high rainfall totals also recorded at Mount Boyce. Daily rainfall of 149 mm was recorded at Mount Boyce on 06/04/24.

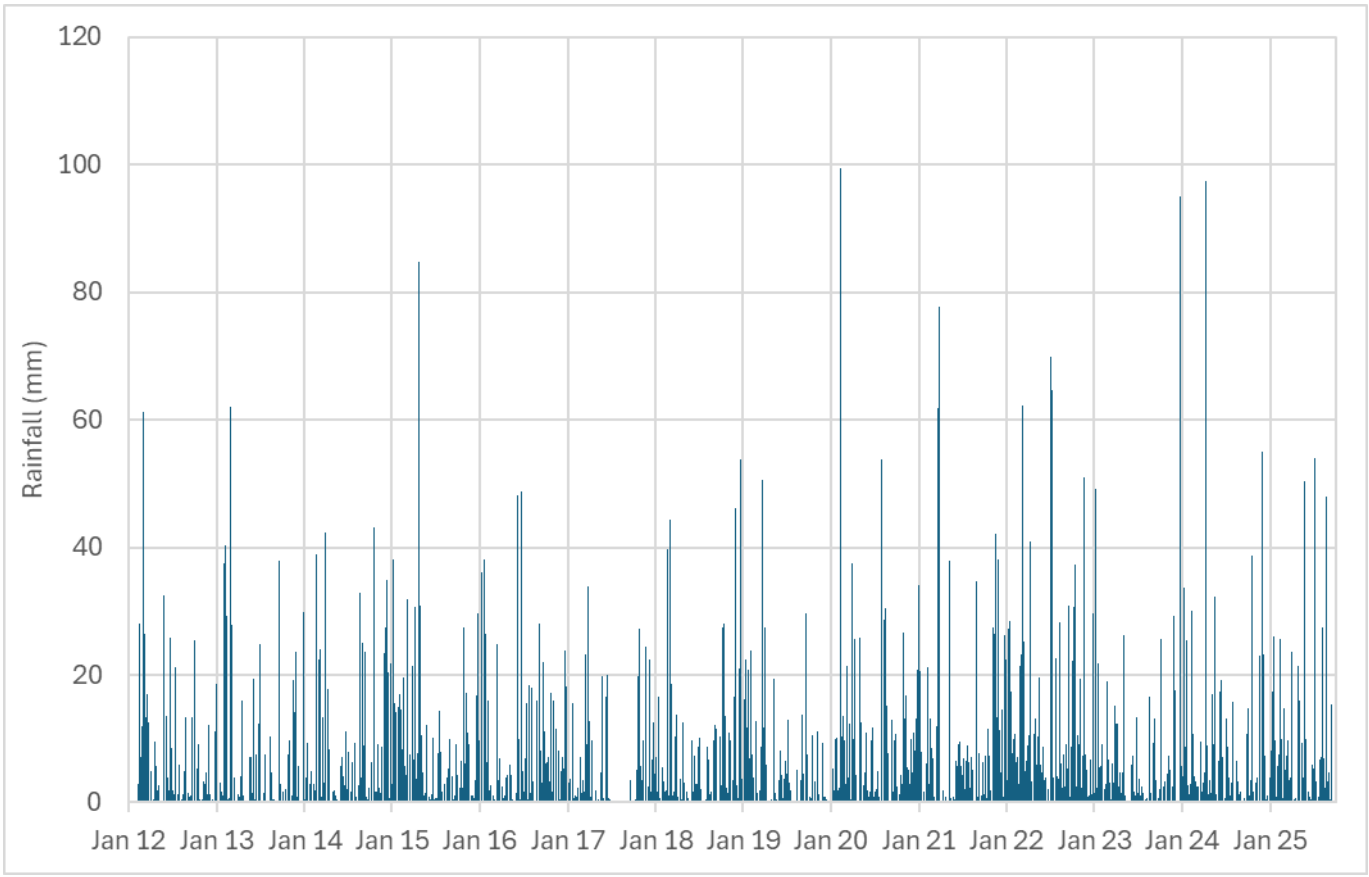


Figure 3.5 Daily rainfall total, Clarence weather station, May 2012 – September 2025

Table 3.1 Daily rainfall totals greater than 80 mm at Mount Boyce (Source: Bureau of Meteorology historic weather data)

Date	Daily rainfall total (mm)	Date	Daily rainfall total (mm)
04/01/1996	128	29/11/2018	105.0
31/08/1996	95	09/02/2020	157.8
12/02/1997	84	10/02/2020	136.6
08/08/1998	121	19/03/2021	87.8
30/06/2005	90.6	21/03/2021	110.8
09/06/2007	89.2	22/03/2021	88.0
29/01/2013	92.2	03/03/2022	88.4
24/02/2013	166.8	03/07/2022	118.6
21/04/2015	105.2	04/07/2022	91.0
05/06/2016	107.6	06/04/2024	149.0
15/03/2017	89.2	23/05/2025	99.8

3.6 Creek discharge

Clarence currently estimates creek discharge using instantaneous velocity measurements (using a Model CMC20A flow meter) and calculations of creek cross-sectional area. These data were only available within the study area for one location within Paddys Creek and one within Bungleboori Creek, and only for selected dates between 2022 and June 2025. Records were limited due to low flow and no access due to poor track condition. These data were insufficient to establish flow variability and response to rainfall events. Daily total discharges ranged from 388 KL/day (27/02/23) to 15,977 KL/day (7/10/22) at Bungleboori U/S monitoring location, and 1,054 (17/05/22) to 6,209 KL/day (21/10/22) at PSE1 monitoring location. One measurement was obtained for PSE2 monitoring location, 7,201 KL/day (28/11/22). Low flows were recorded at Bungleboori U/S and PSE1 during the period of record.

3.7 Groundwater

Groundwater monitoring records were provided by Clarence for the following piezometers, shown on Figure A4, Appendix A:

– Paddys Creek Shrub Swamp (S_UID 565) and tributary hanging swamp piezometers (discussed in Section 3.7.1 below):
  - PSE1 – within the downstream section of the main swamp (see Figure 3.6)
  - PSE2 – within the upstream section of the southern branch (see Figure 3.6)
  - CSP4 – within the downstream section of the northern branch of the swamp (see Figure 3.7)
  - CSP5 – within the upstream section of the northern branch of the swamp (see Figure 3.7)
  - CSP35 – within the upstream section of S_UID584 hanging swamp (see Figure 3.8)
  - CSP36 – within the upstream section of S_UID564 hanging swamp (see Figure 3.8)
– Lower Nine Mile Swamp (S_UID 581) piezometers (within the Bungleboori Creek system; discussed in Section 3.7.2 below):
  - CSP1 – within the upstream section of the swamp (see Figure 3.9)
  - CSP2 – within a narrow downstream section of the swamp, below Lower Nine Mile Hanging Swamp S_UID 583, (see Figure 3.9)
  - CSP34 – approx. 165 m downstream of CSP2, between proposed Panels 918B1 and 918B2 (See Figure 3.9).

Piezometers CSP34 – CSP36 had four months' data at the time of writing (September 2025). Groundwater information has been compared to rainfall CRD (Cumulative Rainfall Deviation, a measure of long-term rainfall patterns) for the Newnes Prison Farm rainfall gauge (data provided by Clarence).

3.7.1 Paddys Creek Swamp groundwater

– Data from the main Paddys Creek Swamp (S_UID 564; PSE1 and PSE2, (see Figure 3.6) shows that groundwater levels show a clear response to rainfall, particularly in the downstream piezometer, PSE1, where flows are channelised, and runoff from the steep surrounding valleys enters the system. However, the groundwater fluctuations show a dampened response, particularly as water tables near ground-level.
– Overland flows were recorded in piezometer PSE2 in March 2021, and between February 2022 and February 2023. This latter period was in response to a sharp increase in rainfall CRD.
– There are insufficient data to fully assess the response of the north branch of Paddys Creek Hanging Swamp (S_UID 564; CSP4 and CSP5, see Figure 3.7), noting that PSE2 within the main swamp shows a subdued response through the same period of record (i.e., August 2022 onwards). However, it appears that groundwater levels are largely independent of rainfall, indicting an intact swamp.
– Piezometers were installed in June 2025 within Paddys Creek Hanging Swamp S_UID584: CSP35 piezometer and Paddys Creek Hanging Swamp S_UID564: CSP36 piezometer. There are insufficient data to establish long-term trends (see Figure 3.8). However, preliminary data indicates a groundwater-fed swamp with little response to individual rainfall events.

The available data, therefore, indicates that the main section of Paddys Creek Swamp shows the typical groundwater response of a channelised fill swamp. Groundwater levels are highly variable, with a strong reaction to individual rainfall events, as well as trends in long-term rainfall pattern. The north branch of Paddys Creek Swamp (CSP4 and CSP5) and the hanging swamps S_UID584 and S_UID564 (CSP35 and CSP36) appear more typical of intact swamp responses, with less groundwater variability. However, there is insufficient information to provide a definitive assessment.

3.7.2 Lower Nine Mile Swamp groundwater

- The data only extends from June 2022 (CSP1 and CSP2) and June 2025 (CSP34), which is insufficient to establish a trend.
- The upstream piezometer, CSP1 (see Figure 3.9), shows overland flow (i.e. piezometer levels above ground) for nearly the entire period of record. Piezometer levels at this location do not appear to fluctuate with CRD indicating a groundwater-driven system.
- Further downstream, piezometer CSP2 (see Figure 3.9) shows that groundwater levels fluctuated around ground-level, with some surface flows. There appears to be some response to rainfall at this location, although water level fluctuations were minor.
- The newly installed downstream piezometer, CSP34, (see Figure 3.9) has insufficient data to establish long-term trends, but appears to show a strong responsiveness to rain events.

The available piezometer data for Lower Nine Mile Swamp S_UID 581, within Bungleboori Creek, indicates an intact, groundwater-driven swamp, with some responsiveness to rainfall events. This pattern is indicative of the upslope outcropping of Burralow Formation aquitards YS5, YS5a and YS6 within a narrow, steep valley. However, as with the north branch of Paddys Creek Swamp, there is insufficient data to establish long-term trends or patterns.

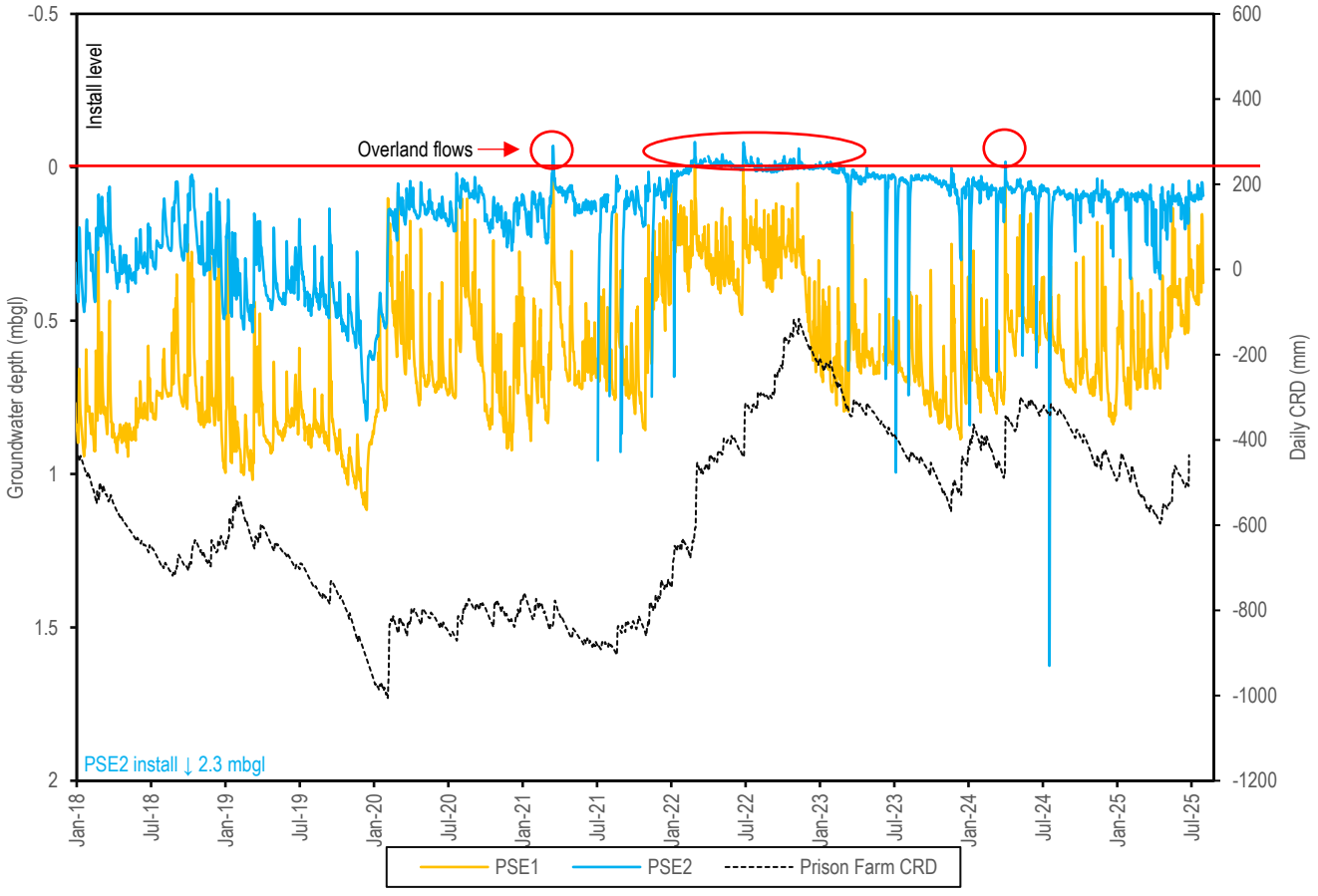


Figure 3.6 Clarence Colliery groundwater data for Paddys Creek Swamp (S_UID 565) piezometers PSE1 and PSE2, 2017 – 2025

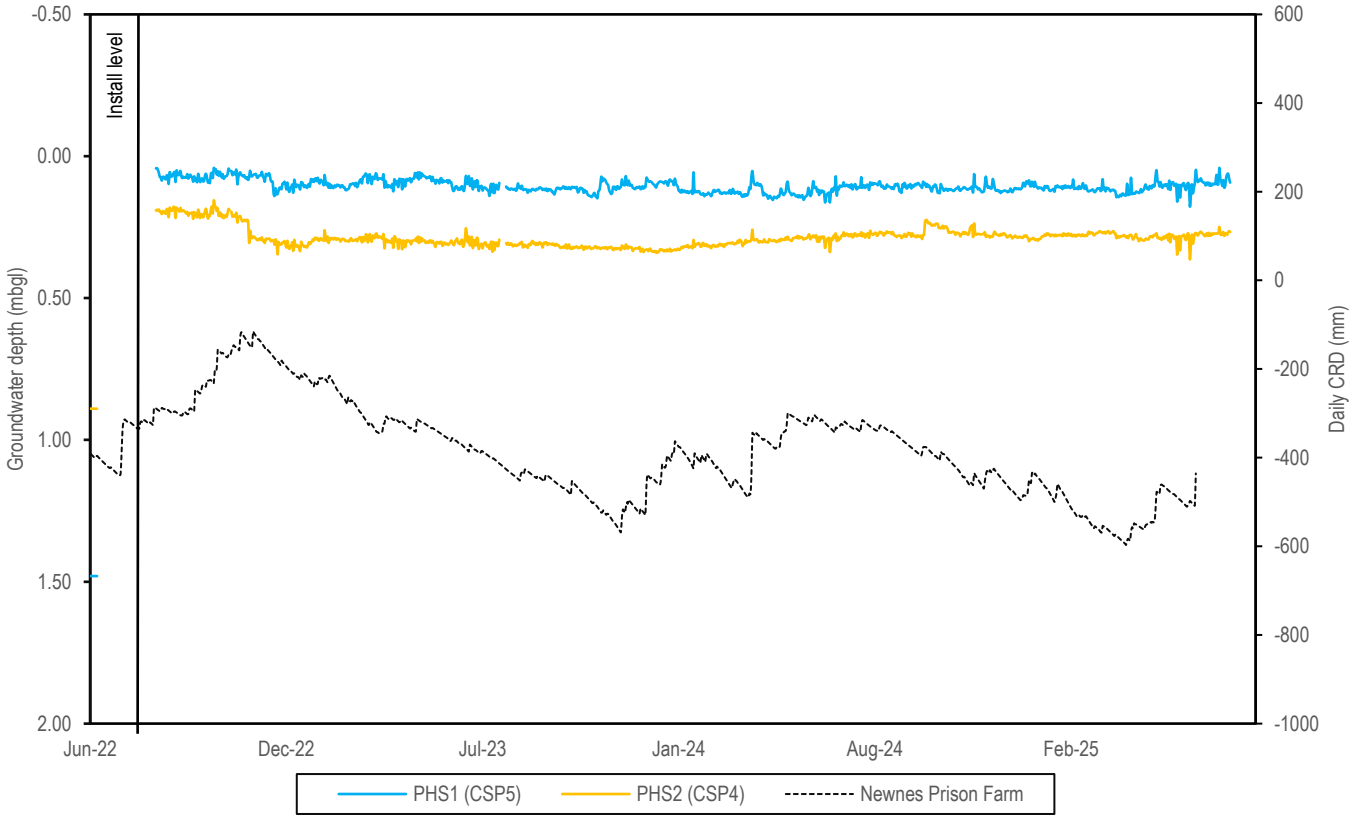


Figure 3.7 ***Clarence Colliery groundwater data for Paddys Creek Swamp S_UID 565 (north branch): CSP5 upstream piezometer and CSP4 downstream piezometer, 2022 – 2025***

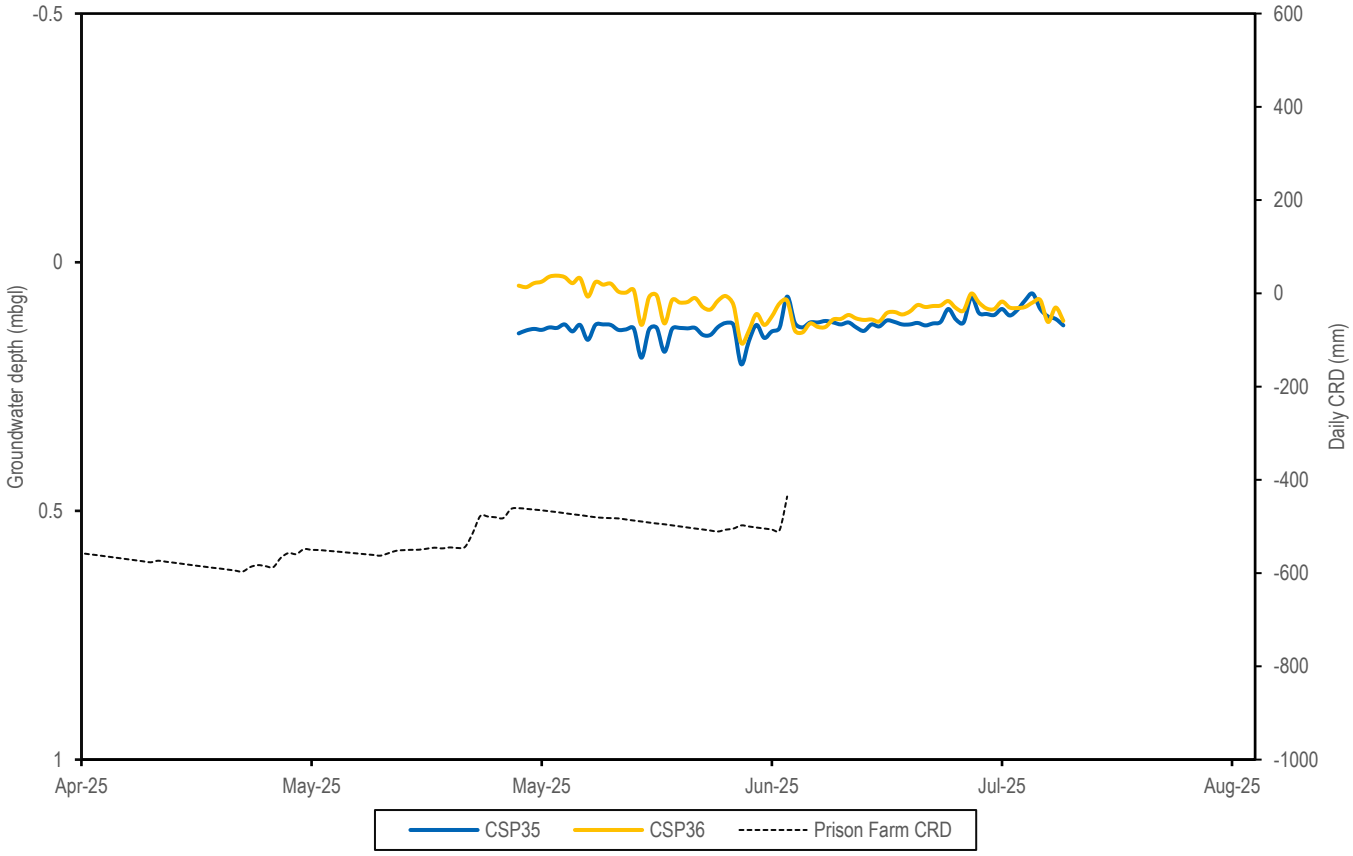


Figure 3.8 ***Clarence Colliery groundwater data for Paddys Creek Hanging Swamp S_UID584: CSP35 piezometer and Paddys Creek Hanging Swamp S_UID564: CSP36 piezometer, June – Sept 2025***

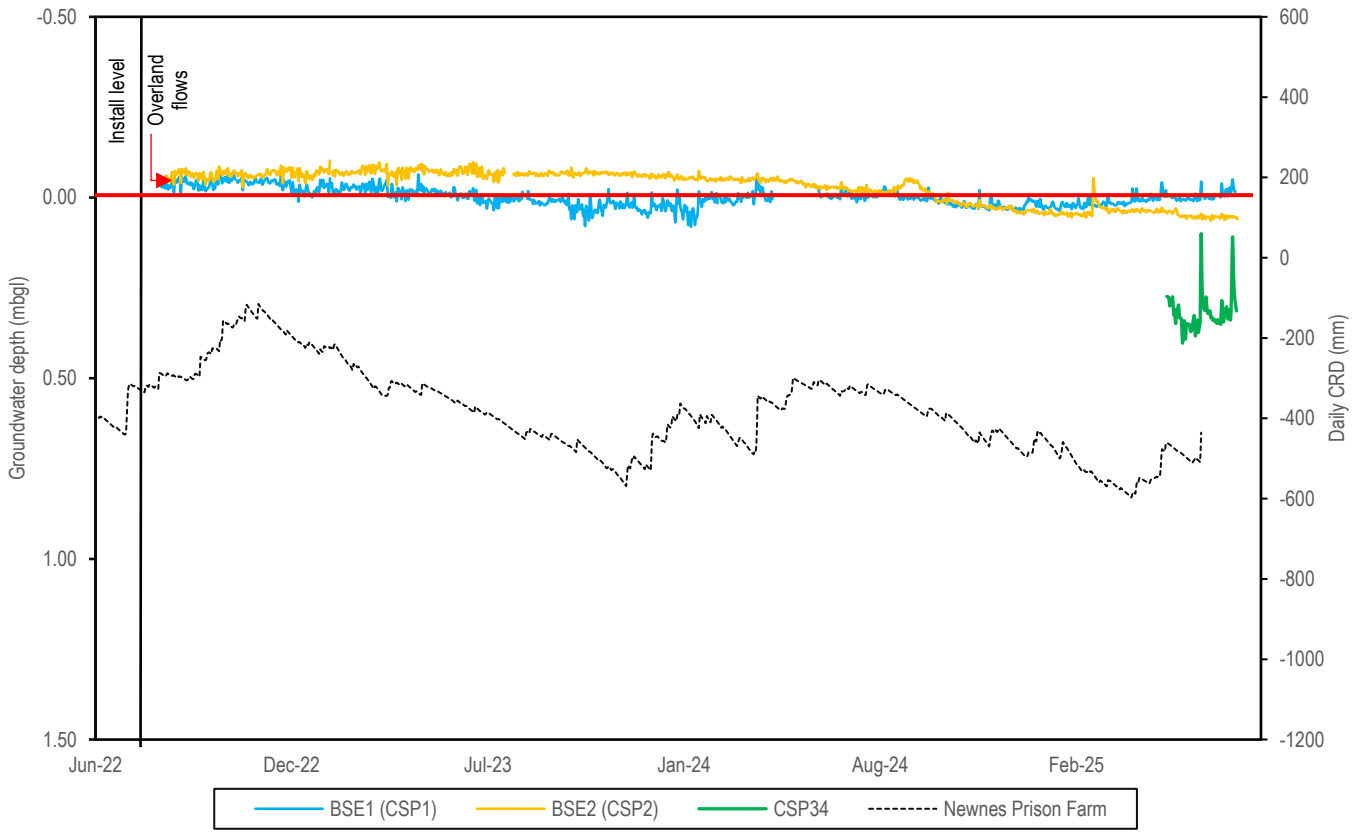


Figure 3.9 ***Clarence Colliery groundwater data for Lower Nine Mile Swamp S_UID 581: CSP1 upstream piezometer, CSP2 downstream piezometer, 2022 – 2025; CSP34 recently installed piezometer June – Sept 2025***

3.8 Historical landform change assessment

In order to assess historical landform change within the study area, available historical aerial imagery dating back to 1969 was assessed. Historical imagery between 1969 and 1998 was available from Historical Imagery (nsw.gov.au), with later dates from Google Earth. The assessment is provided in Table 3.2.

Table 3.2 Historical aerial imagery assessment of landform change, 1969 – 2023

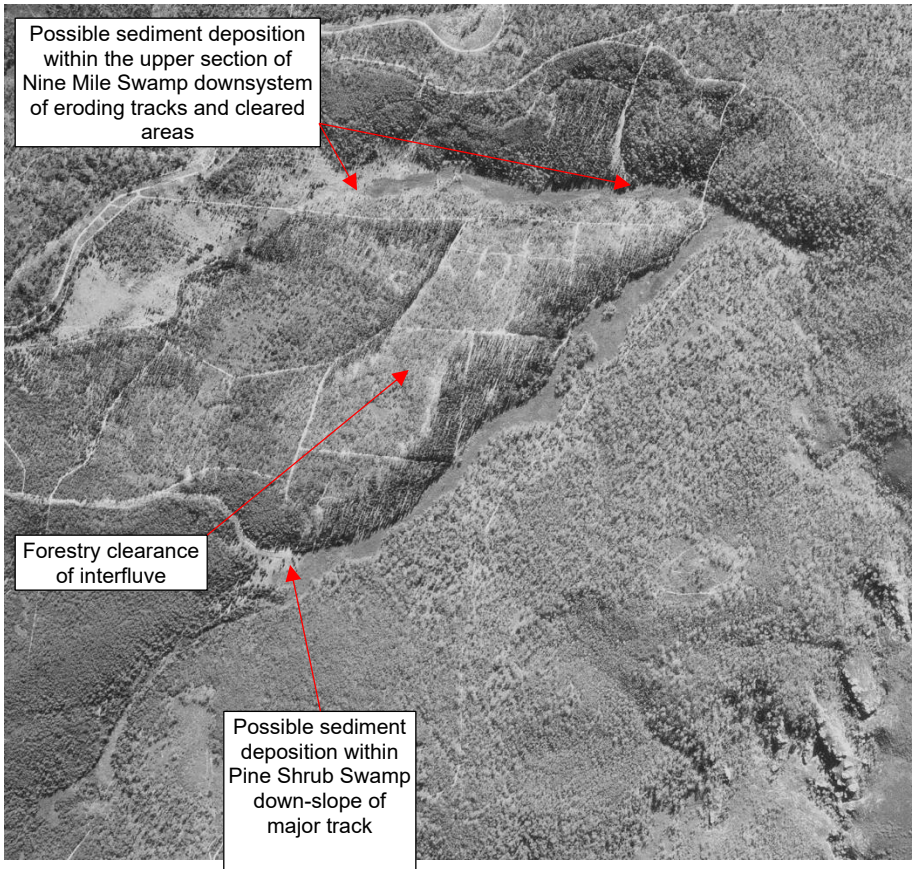
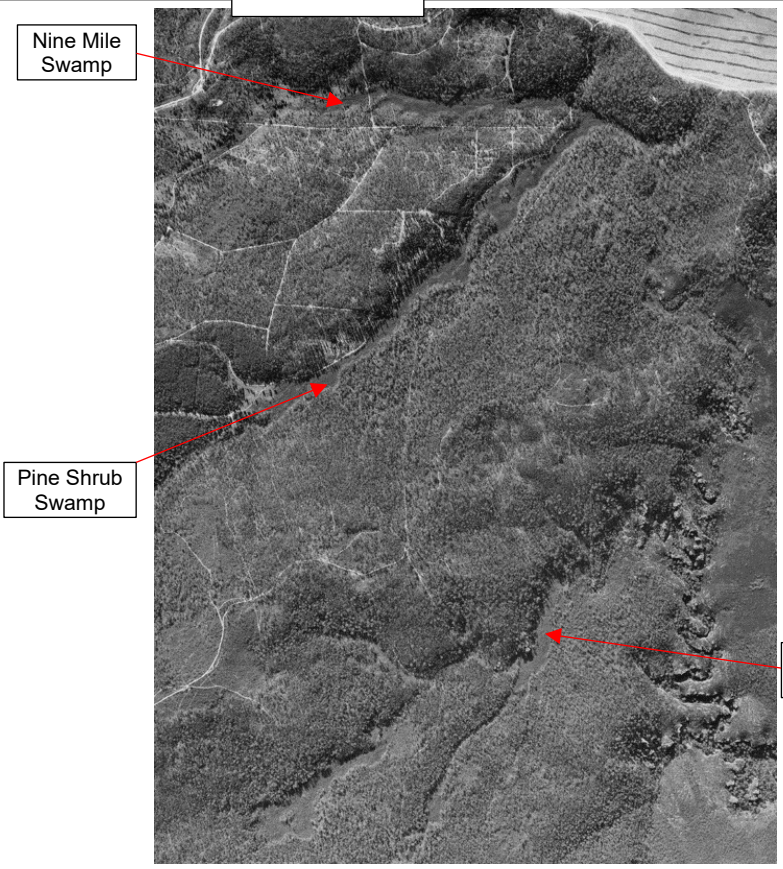
Image and observations	Notes and source
	**May 1969** Interfluves between the upper section of Nine Mile Swamp and Pine Shrub Swamp, and plateau / ridgetops show considerable impact from forestry and tracks, which has led to erosion and down-slope deposition in places. Other than identified areas of possible sediment deposition and track erosion, the swamps appear to be intact and in good condition. Sections of both swamps show defined watercourses where the swamp narrows. Paddys Creek swamps (not shown) are lightly impacted by tracks, and appear intact and in good condition. Source: Wallerawang: film 1618, run R4W, frame 5213, 1:38,000
	**May 1975** Major forestry clearance is occurring to the north. Continued development of tracks and forestry areas is occurring. Channels within the upper section of Nine Mile and Pine Shrub Swamps are better defined. Paddys Creek Swamp and tributaries appear intact, with little obvious adverse impact. Source: Wallerawang: film 2315, run R3W, frame 179, 1:40,000

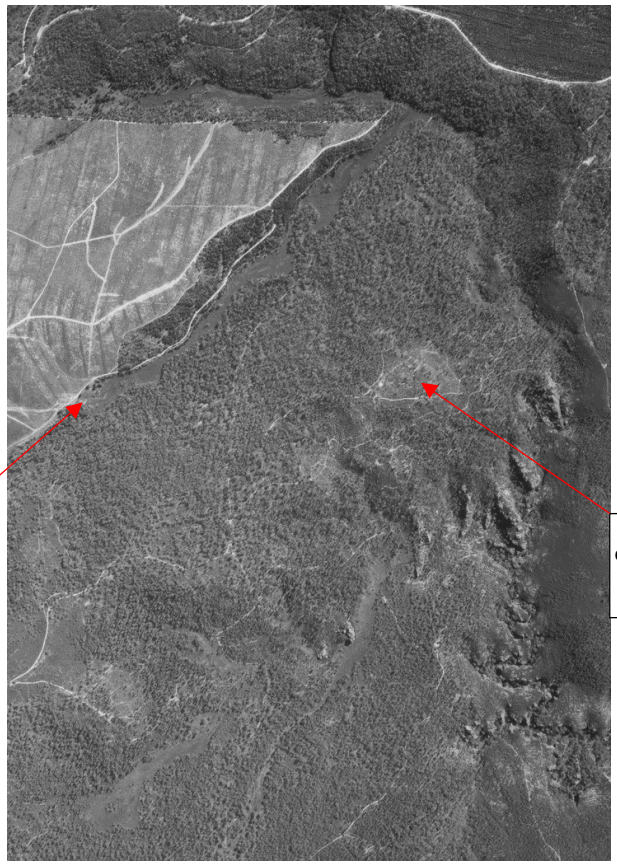
Image and observations	Notes and source
	**March 1984** Large swathes have been cleared for forestry on the interfluve between Nine Mile and Pine Shrub Swamps. Many tracks dissect the plateau areas, particularly in and adjacent to Pine Hanging Swamp, and crossing the head of Paddys Creek Swamp and at the Nine Mile / Pine Swamp confluence. Sediment appears to have migrated from a track into the upper section of Pine Swamp. Source: Wallerawang, Film 3377, run R11, Frame 56, 1:25,000
	**September 1991** Area appears dry, with sparse woodland and thinning swamp vegetation in places (drought commenced in this year). Sediment inputs to head of Pine Swamp and margins of the upper sections of Nine Mile Swamp from cleared forestry areas / tracks. Appear to be many fallen trees within and adjacent to the Paddys Creek and Lower Nine Mile Hanging Swamps, in the area shown. Source: Wallerawang, Film 4041, run R11, Frame 122, 1:25,000

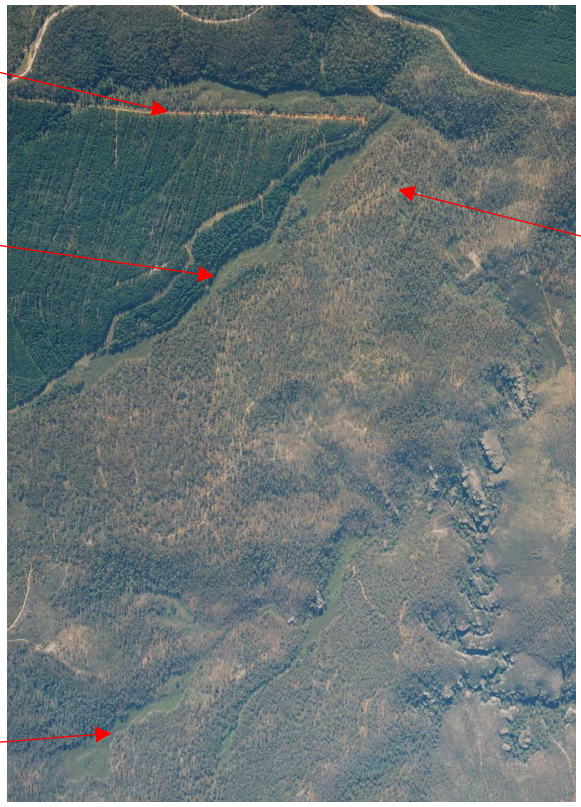
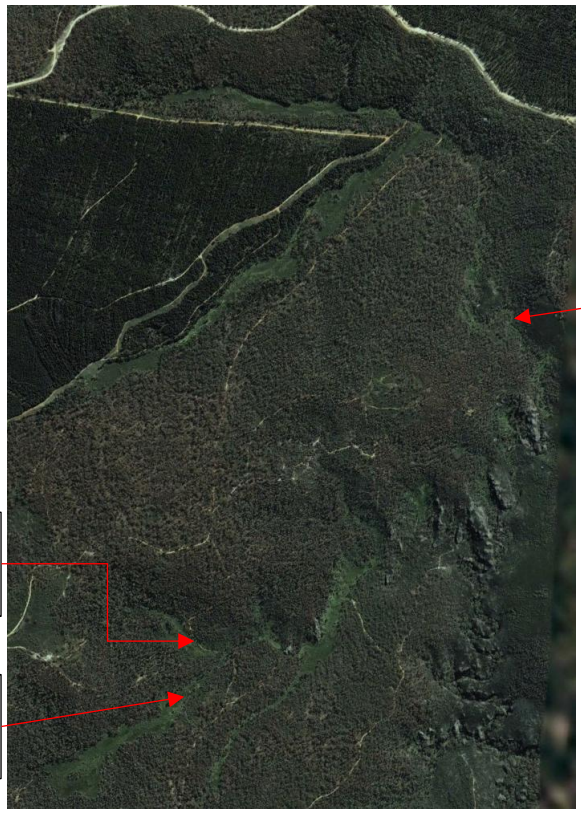
Image and observations	Notes and source
	**June 1998** Vegetation coverage and density has improved since 1991. Swamp condition appears to have improved. Distinct channels can be observed within upper Paddys Creek swamp and sections of Pine Shrub Swamp. Pine Hanging Swamp is clearly visible for the first time. Tracks show iron oxidisation (red staining) and erosion. Source: Wallerawang, Film 4437, run R11, Frame 214, 1:25,000
	**March 2002** Swamps appear to be in good condition, with recovery of previous erosion. Swamps appear intact, other than the upper section of Paddys Creek Shrub Swamp and the narrow gorge sections of Lower Nine Mile Swamp. Source: Google Earth 2023

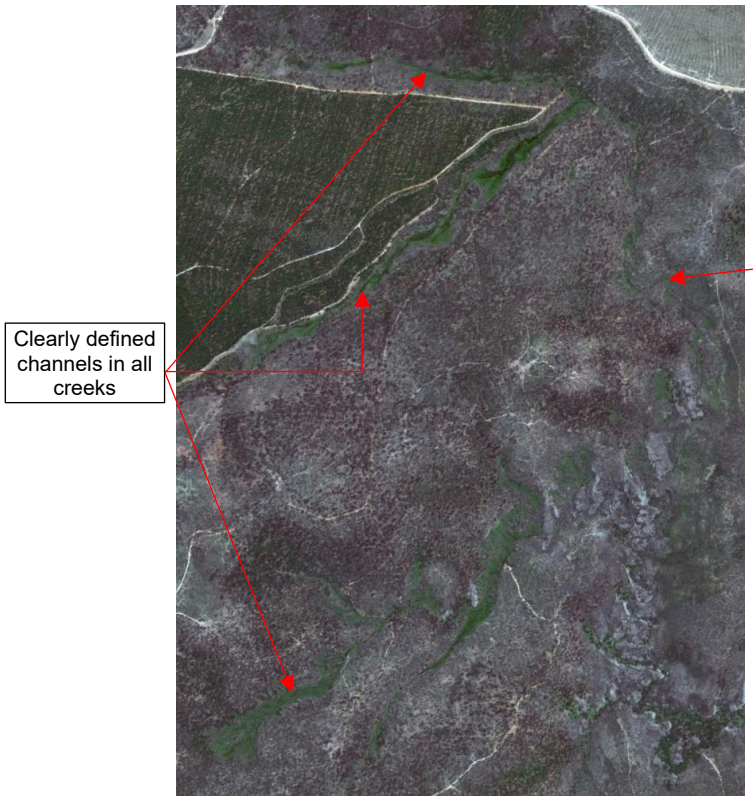
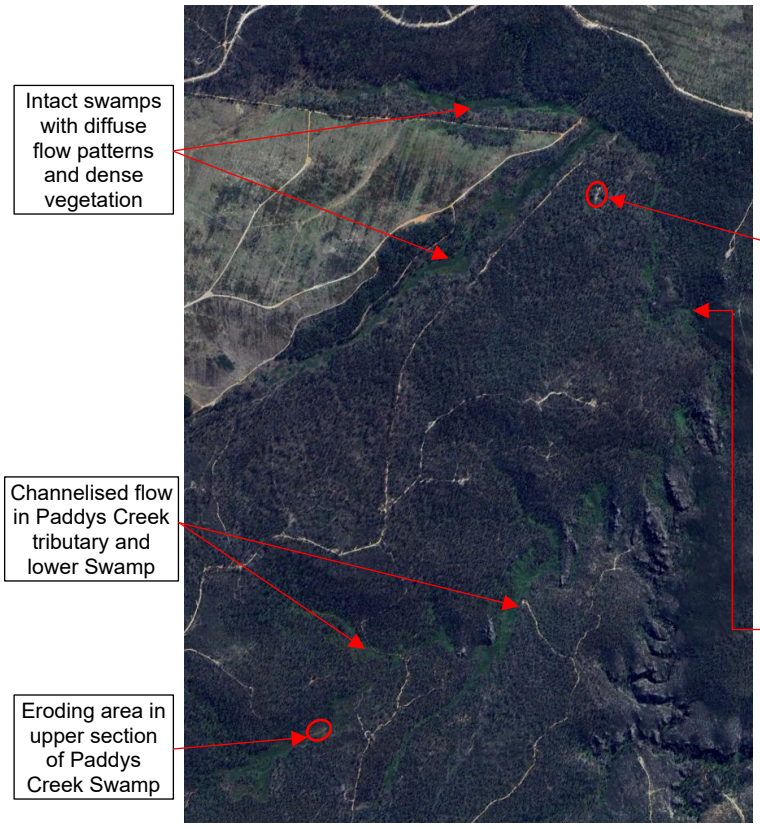
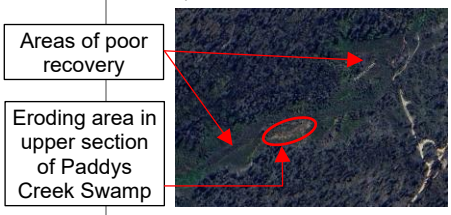
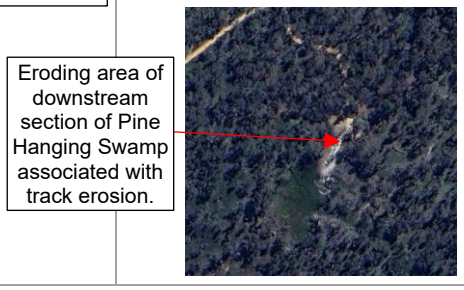
Image and observations	Notes and source
	**November 2014** Riparian and interfluve areas appear denuded of vegetatation, and it is assumed that this area was affected by the 2013 fires. The swamps, therefore, stand out clearly, indicating their resilience due to their ability to retain water. Flow within the swamps is flowing within well-defined single / multiple channels and broader swales. Morphology appears to indicate temporary transition to channelised fill-type swamp. Channels were still visible in 2016, but swamps appear to have reverted to intact-type by 2019. Source: Google Earth 2023
 Source: Google Earth 2023	**September 2023** Swamps show rapid recovery after 2019 / 2020 fire. Pine and Nine Mile Swamps appear intact, with evidence of dispersed flow and good vegetation cover. Upper Paddys Creek Swamp shows some damage, with areas showing slower recovery and a broad area of erosion / sediment deposition (indicated and shown below).  Track erosion appears to have headcut into the lower section of Pine Hanging Swamp (shown below). 

Image and observations	Notes and source
	The Paddys Creek tributary Swamp and the lower swamp have channelised flow.

The assessment of historical change indicates that the swamps show significant variability in morphology, extent, and vegetation condition / coverage. The swamps have been subject to anthropogenic impacts since at least the late 1960s. However, adverse impacts appear negligible, with only localised, minor impacts due to inputs of sediment from eroding tracks.

The morphology and response to external drivers indicates that the larger swamps are on the cusp of intact / channelised fill swamp morphology. Therefore, major extrinsic influences, e.g., fires or drought, can tip the systems from intact swamps to channelised fill, with recovery following a period of benign conditions. The recent sequence of drought, major bushfire and prolonged / intense rainfall has resulted in destabilisation of the upper section of Paddys Creek Shrub Swamp. However, the majority of swamps have seen good recovery in response to the wetter-than-average conditions.

The smaller swamps within the lower Paddys Creek and Bungleboori Creek gorges have been insulated from the adverse anthropogenic impacts in the area. These swamps have responded to natural climatic and groundwater fluctuations, and appear to be in good condition. The hanging swamps and broader areas of the larger swamps appear intact, with a clearly defined channel running through the narrow, elongate sections of Lower Nine Mile Swamp.

4. Site visit findings

Several very steep hanging swamps are located above the steep, narrow, bedrock valleys, some of which were not accessible to assess during the site visit, including Paddys Creek Hanging Swamps, S_UID 564 and S_UID 584, tributary swamps above the main Paddys Creek Shrub Swamp, S_UID 565 and Lower Nine Mile Swamps, S_UID 579. These were not safely accessible due to track condition, lack of easily accessible vantage points and difficult terrain. Pine Hanging Swamp, S_UID 578, was not included in the site visit, as the mapping layer used for identification in the field did not include this swamp. Although outside the anticipated AoD / 20 mm subsidence contour, accessible reaches of Pine Shrub Swamp, S-UID184, and Nine Mile Swamp, S_UID262, were assessed to provide an overview of swamp and watercourse condition upstream of the target reaches. These were assessed as identified anthropogenic non-mine-related changes within these reaches could impact the downstream target reaches.

Site visit locations are shown in Appendix A, Figure A2, and photograph locations in Appendix A, Figure A3. A summary of the site observations and photographs is presented in Appendix B.

4.1 Bungleboori Creek, including Pine and Nine Mile Swamps

During the site visit, all swamps were waterlogged and/or running.

The hillside above the left (west) margin of Pine Shrub Swamp showed evidence of severe fire damage from the recent 2019/2020 Gospers Mountain Fire. Many of the larger trees were burned and had not recovered. However, the swamp itself and far (eastern) hillside had recovered well, with dense, full-assemblage vegetation. Fringing Coral Fern was observed. During the site visit, the ground was waterlogged, but no flows were observed.

It was not possible to verify the erosion observed on aerial photographs within the lower section of Pine Hanging Swamp. However, track erosion was observed in the area, and the imagery clearly shows erosion.

Downstream of the confluence between Pine Shrub Swamp and upper section of Nine Mile Swamp, a narrow creek runs through drier ground. The channel within this area was still flowing, but no surface water was present. It is possible that this area had been geomorphologically impacted by the two large tracks crossing upstream of BC1, although there is no visible evidence of such impact much beyond the track area. The headwaters and interfluve between the twin swamps have been impacted by forestry clearance and tracks.

Sections of the twin-headed swamp, comprising Pine Swamp and the upper section of Nine Mile Swamp, would be classified variously as:

– Pine Shrub Swamp above the confluence is a good-condition intact swamp, despite recent fire damage, which is still visible on the hillside above the left (west) margin.
– At the confluence of the two swamps and downstream, the swamp transitions to a good condition channelised-fill swamp where a defined channel has formed, e.g., the northern upstream branch. The track crossings were observed to have a localised impact.
– Below the eastern track crossing, upstream and adjacent to BC1, there is a defined channel connecting Nine Mile Swamp (S_UID 184) with Lower Nine Mile Swamp (S_UID 582). This reach is not classified as a swamp, and was observed to be in good geomorphological condition, with no observed erosion, flow variability and good in-channel and riparian vegetation cover. Iron floc deposits were observed within this channel, indicating groundwater fluctuation and mobilisation / oxidisation of iron above the water table.

Lower Nine Mile Swamp, S_UID 582 / 574 between BC1 and BC2 appears to be a good condition channelised-fill swamp. Impacts from the eroding fire trail appear localised. Lower Nine Mile Swamp, S_UID 581 running between locations BC2 and BC3 also appears to be a good condition channelised-fill swamp. These swamps (or elongate swamp) had a well-defined flowing channel, which appeared stable. Dense riparian and abundant in-channel vegetation was observed.

Hanging swamps within and adjacent to the proposed mining area are located within the bedrock-controlled, deeply incised contorted meanders of the Bungleboori Creek. These were obscured by pagodas during the May site visit. During the November 2023 site visit, observations were made of the very steep Lower Nine Mile Hanging Swamp, S_UID 577. This was a good-condition intact swamp perched above a deeply incised hairpin meander. A large pool was present in the bedrock creek below the swamp. Hanging swamps S_UID 599 and 584 could not be assessed on site, but aerial photographs indicate that these swamps are in similar good condition with no visible defined channel (i.e., good condition intact swamps).

4.2 Paddys Creek and swamps

At PC1_1 (site 4), minor slumping of the erodible sandy right bank was observed, shown in photo 7119 in Appendix B. Other than this, the watercourses were observed to be in good condition, with geomorphological diversity (i.e., pools and steeper sections; narrow and wider sections), dense riparian and sometimes in-channel vegetation and stable bed and banks. The major swamp upstream of PC1, and at location PC1_2, is classified as a good condition channelised-fill swamp (in accordance with Fryirs et al*.,* 2016), although it is noted that upstream, there is no defined channel, indicating sections of intact swamp. The steep hanging swamp above PC2, S_UID 564, is classified as a good-condition intact swamp, as no defined channel could be observed.

Both creeks transition into steep, narrow, deeply incised, bedrock valleys. These are characterised by incised, contorted meanders which have left pagoda formations many tens of metres tall within the meander cores. Watercourses through these narrow valleys are bedrock-controlled. A deep pool was observed at PC3 / site 8, below sediment deposits from a gully eroded into the valley walls above.

4.3 Summary

The swamps observed appeared to be in good condition, with complete recovery of vegetation, including index species, such as Coral Fern. In general, the larger swamps in the study area were intact, with dispersed flow and sections of channelised flow. The downstream swamp-fed creeks were flowing swiftly and swamp surfaces were waterlogged with visible surface water. Geomorphological indicators of swamp extent (waterlogging, surface flow, peat extent and vegetation) indicated swamp expansion during the recent wet years. It is anticipated that swamp extents are likely to fluctuate according to climatic and groundwater conditions. During prolonged drought periods, therefore, the swamp extents may be reduced.

Away from the swamp areas, surface runoff was typically confined to poorly-defined topographic depressions. Better-defined channels were observed:

– Where flows had been concentrated along tracks or downstream of tracks, often associated with erosion due to trafficking.
– Where flows were concentrated along swamp margins, typically between colluvium and swamp soils.
– Within channelised fill-type swamps e.g., the narrow, elongate Nine Mile Swamp assemblage within the narrow, incised valley of Bungleboori Creek and lower Paddys Creek Shrub Swamp.
– Within gorges and narrow valleys where creek channels are bedrock controlled. These are typically fed by flow discharging from upstream swamps.

Some pools within the bedrock-controlled watercourses were associated with the lower sections of swamps and sediment input from gullies. This is contrary to what might be expected. It is likely that the additional discharge from the upstream swamps / gullies outweighs the sediment deposition, resulting in net scour / channel enlargement.

5. Swamp and watercourse susceptibility assessment

GHD have been provided with subsidence modelling information, which indicates maximum vertical subsidence of 76 mm (MSEC, 2025) (see Figure A1, Appendix A). This is in contrast to conventional LWM, where subsidence can reach well over 1 m. These predictions would indicate that surface impacts should be low. In addition, assessments of subsidence / upsidence, tilt and strain indicate predicted values well below guideline thresholds for adverse impacts. However, given the presence of swamps within the study area and high relief above the proposed mining area, robust assessment and monitoring is vital.

GHDs experience of THPSS on the Newnes Plateau has indicated that impacts to swamps from LWM are as follows:

– Mine water discharge causing vegetation die-off, changes to swamp chemistry and peat desiccation, which would not be relevant in this instance.
– Bedrock cracking on the valley floor due to unexpected geological anomalies.
– Higher than anticipated tilt and strain, often due to high relief at the surface.
– Differential strain and surface subsidence, particularly over pillars and barriers.
– Disruption of shallow groundwater due to any of the above reasons, i.e., near-surface and stored within the peat/swamp soils (possibly relevant).

However, as observed in Section 3.4.2, there have been no recorded adverse impacts from historic partial extraction mining techniques within the Clarence mining lease, where subsidence is an order of magnitude less than within LWM-impacted areas.

GHD's site observations indicate that the watercourses within the study area are largely either bedrock-controlled or stable channels flowing within good-condition swamps. The bedrock-controlled channels flow within steep-sided gorges and appear to be predominantly fed by groundwater from the upstream swamps and Burralow Formation aquitard springs. Watercourses and swamps were flowing despite a lack of recent rain prior to the 2023 site visit, indicating a predominance of groundwater-fed systems. Therefore, any disruption to this groundwater due to rock cracking could have a significant impact on the affected swamp. In addition, the hanging swamps perched above the narrow bedrock valleys are located on very steep slopes. Disturbance of these areas could see rapid erosion and possible collapse of the system due to the high relief.

Impacts to swamps have also occurred due to fire and anthropogenic impacts such as track construction and degeneration/erosion. GHD observed contrasting recovery between the severely burned woodland on hillslopes and the good recovery of swamps along valley floors and in hillside depressions. This shows the positive influence that swamp systems have on natural recovery following such extreme events. This also illustrates the requirement for swamps to surpass a threshold before adverse impacts occur. The swamps in the study area were subject to prolonged drought, intense bushfire and prolonged, intense rainfall / runoff events, but have largely rebounded rapidly and successfully. However, extrinsic disturbance of these systems can cause a change in the balance of the contributing components whereby vegetation can be lost and erosive thresholds surpassed, e.g., due to lower water tables.

GHD considers that areas most sensitive to changes in the driving variables, particularly groundwater supply, would be:

– The swamps within the upstream reaches of Bungleboori Creek have been subject to the most anthropogenic impacts of all those in the study area. These swamps have shown transition from intact to channelised fill morphology due to external stresses in the past, although they maintained an intact morphology during the recent drought / bushfire / high rainfall sequence. Therefore, they may be more sensitive to additional non-mine-related impacts as a result. It is possible that downstream swamps may also be affected. Monitoring is recommended to determine the likely cause of any future changes within reaches in the study area downstream.

- The track leading to Pine Hanging Swamp has caused erosion of the lower section of the swamp. This is a minor swamp, which appears to be becoming destabilised due to the recent sequence of climatic events combined with the presence of the track. The deteriorating condition of this swamp provides an indication of the rapidity of change under adverse conditions. However, the track does not now appear to be accessible and the swamp is outside the study area.
- The five very steep hanging swamps perched above the narrow bedrock valleys of Bungleboori and Paddys Creek (Paddys Creek Hanging Swamps, S_UID 564 and S_UID 584, and Lower Nine Mile Swamps, S_UID 583, 579 and 577), would be sensitive to changes in groundwater and ground movement. These swamps are located in a high relief area along the edge of the study area, where subsidence is predicted to be between 50 mm and negligible. These areas were difficult to access, and consideration could be given to monitoring these swamps using high-resolution aerial imagery.
- The downstream section of the major swamp feeding Paddys Creek, Paddys Creek Shrub Swamp, S_UID 565. Loss of this groundwater is likely to cause downstream bedrock reaches of Paddys Creek to become dry.
- The high relief, narrow bedrock valleys and pagodas of the downstream reaches of Paddys Creek. These areas could be subject to higher-than-anticipated valley closure and upsidence due to the high relief. The bedrock-controlled creek flowing through the base of the gorge would be sensitive to any cracking or buckling of the rock where the magnitude of subsidence is high enough to cause these types of surface movement. However, predicted impacts are anticipated to be negligible (MSEC, August 2025).

Lessons learned from mining-impacted swamps indicates that impacts are more likely to occur over pillars and barriers. However, these case studies are from areas subject to longwall mining, rather than the partial extraction technique proposed by Clarence for the study area. GHD understand that subsidence within the study area is anticipated to cause negligible impacts to groundwater and rock structure, with impacts confined to below the Mount York Claystone layer. Modelling indicates that valley closure and upsidence are not anticipated to cause adverse impacts. Therefore, GHDs assessment indicates that, although there are some sensitive landforms and watercourses within the study area, geomorphological impacts are anticipated to be negligible. Adverse impacts are more likely to occur due to track erosion and fluctuation of natural conditions (e.g., drought, intense rainfall and bushfire).

6. Recommendations

GHDs recommendations as an outcome of the watercourse baseline condition assessment are discussed in the following sections.

6.1 Management and mitigation

Given the anticipated negligible adverse mining-related geomorphological impacts to the swamps and watercourses of the study area, no management or mitigation measures are recommended, other than the track remediation discussed in Section 6.3. Given the difficulty in remediating impacted THPSS, Clarence's demonstrated approach of minimising mining-related impacts to groundwater and surface features through adjustment of mining techniques from longwall to secondary partial extraction is pragmatic.

6.2 Monitoring

Monitoring recommendations are as follows:

– Although mining-related impacts are anticipated to be negligible, monitoring of the swamps should be conducted on a regular basis to validate the assessment findings. As a minimum, annual inspections of accessible areas should be conducted. Further inspections could be considered following destabilising events, such as bushfire or intense/prolonged rainfall events. As well as the locations provided in Table 6.1, a general assessment of swamp condition should be conducted, to avoid inadvertently missing obscured impacted areas. GHD considers it more likely that adverse change would occur from non-mining impacts, and this monitoring would enable the likely cause of such changes to be determined.

– Clarence may wish to consider obtaining repeat high-resolution aerial photography of swamps within the study area. This would enable ongoing aerial photograph monitoring of swamp condition. This is especially important for swamps which are difficult to access. Lidar capture in conjunction with the aerial photography would also be advantageous, as this could be used to monitor vegetation height, and may also pick up small areas of erosion that may be obscured by vegetation from ground level.

– It is understood that the rock outcropping and pagoda formations above the proposed mining area will be assessed. Clarence should ensure that these assessments are robust and fit-for-purpose, to ensure that any geological anomalies and formations sensitive to disturbance are identified, particularly if non-conventional or unexpected change occurs which could impact down-system watercourses and swamps.

Table 6.1 Recommended monitoring locations (see table note)

Site ID	Easting*	Northing	Location and notes
BC1	242129	6301239	Downstream of anthropogenically impacted Nine Mile and Pine Shrub Swamps (S_UID 262 / 184).
BC2	242303	6300793	Upstream section of Nine Mile Shrub Swamp S_UID 583.
BC3	242449	6300491	Downstream section of Nine Mile Shrub Swamp S_UID 583.
BC4	242610	6300492	View over Nine Mile Hanging Swamp S_UID 577.
PC1_1	241852	6299325	Downstream section of Paddys Creek Shrub Swamp, S_UID 565. Outside the study area, but easily accessible.
PC1_2	242001	6299453	Downstream section of Paddys Creek Shrub Swamp, S_UID 565. Outside the study area, but easily accessible and downstream of a difficult access tributary branch of Paddy's Creek Shrub Swamp.
PC2	242149	6299676	View of Paddys Creek Hanging Swamp, S_UID 564.
PC3	242328	6299640	Within bedrock gorge of Paddys Creek.

* Coordinates are provided in GDA_2020 Zone 56.

Table note: Although specific monitoring locations are provided, GHD recommends that future monitoring includes a broader view of swamp and watercourse conditions, and includes aerial photograph assessment.

6.3 Access track remediation

Access tracks to the majority of locations have become eroded and gullied in sections due to high rainfall during 2022. Track deterioration can also be responsible for localised detrimental impacts to swamps and watercourses (see image 7142 and erosion in the lower section of Pine Hanging Swamp, S_UID 578). Some popular tracks had been rehabilitated between the May and November 2023 visits, but some areas were still difficult or impossible to access due to the track condition. It is recommended that track rehabilitation is continued, with regular ongoing maintenance, before these tracks become impassable. This would make monitoring of the anticipated area of impact more difficult and costly. Adverse impacts could also be exacerbated, particularly within the lower section of Pine Hanging Swamp.

7. Conclusion

7.1 Baseline geomorphological assessment

GHD conducted a baseline geomorphological condition assessment of watercourses and swamps above the proposed 918 Panel. The findings of the assessment are as follows:

– An assessment of historical change using aerial imagery indicated anthropogenic impacts over the majority of the site, associated with forestry vegetation clearance and track erosion. However, impacts within swamps and watercourses were minor and confined to localised erosion and sedimentation, with rapid recovery once the activity ceased. Swamps that were subject to anthropogenic impacts include upper Nine Mile Swamp and Pine Swamp, adjacent to forestry and major tracks. Hanging swamps and bedrock-controlled watercourses within the narrow Bungleboori and Paddys Creek gorges were insulated from these impacts.
– Swamp condition was assessed using a condition assessment developed by Fryirs et al. (2016). The narrow, elongate swamps running through bedrock gorges have good condition channelised fill morphology, with a well-defined, stable creek channel, with sections of intact swamp, where flow trickles through the vegetation. Larger swamps in the study area appear to be on the threshold of intact/channelised fill morphology. Major extrinsic change (e.g., bushfire) can cause a transition from an intact morphology with dispersed flow, to a channelised fill morphology with well-defined channels through the swamp. In addition, the larger swamps can show variability of morphology, with sections of intact swamp and sections of channelised fill. Groundwater data from upper and lower Paddys Creek Swamp (piezometers PSE1 and PSE2) indicates fluctuating water tables and rapid response to rainfall events, typical of channelised fill swamps. Hanging swamps perched above Bungleboori and Paddys Creek gorges were assessed to be good condition intact swamps.
– Drought, bushfire and prolonged rainfall, occurring separately or together, have caused variable impacts on the landscape elements of the study area. The swamp systems typically rebound more rapidly than the surrounding woodland areas, due to the presence of groundwater. Following the recent sequence of drought, major bushfire and then prolonged/intense rainfall, the majority of swamps have now completely recovered. In contrast, adjacent woodland still shows major fire damage, with partial recovery of mid and understorey vegetation. There are swamp areas which show impacts from the recent events. Upper Paddys Creek Swamp has fire-damaged areas with associated erosion. A track leading to the Pine Hanging Swamp has resulted in erosion of the lower swamp.
– Minor to moderate erosion along access tracks was observed. However, impacts were localised, with minor associated erosion and sedimentation within the observed swamp and watercourses. Some track remediation had occurred between the May and November 2023 site visits.

In summary, all swamps and watercourses were in good condition. The exceptions are the upper section of Paddys Creek Shrub Swamp (S_UID 565) and Pine Hanging Swamp (S_UID 578), outside the study area, which have been impacted by bushfire / rainfall and track erosion respectively.

7.2 Impacts, triggers and remediation recommendations

A review of adverse subsurface mining impacts reveals that the majority of reports concentrate on LWM impacts. The proposed 918 secondary partial extraction technique is anticipated to have significantly lower tilts, strains and subsidence than standard longwall mining and guideline thresholds for adverse impacts. Therefore, negligible impacts to groundwater and rock structure are anticipated, with impacts confined to below the Mount York Claystone layer. There have been no records of mining-related impacts in areas undermined by Clarence's partial extraction mining operations since 1998.

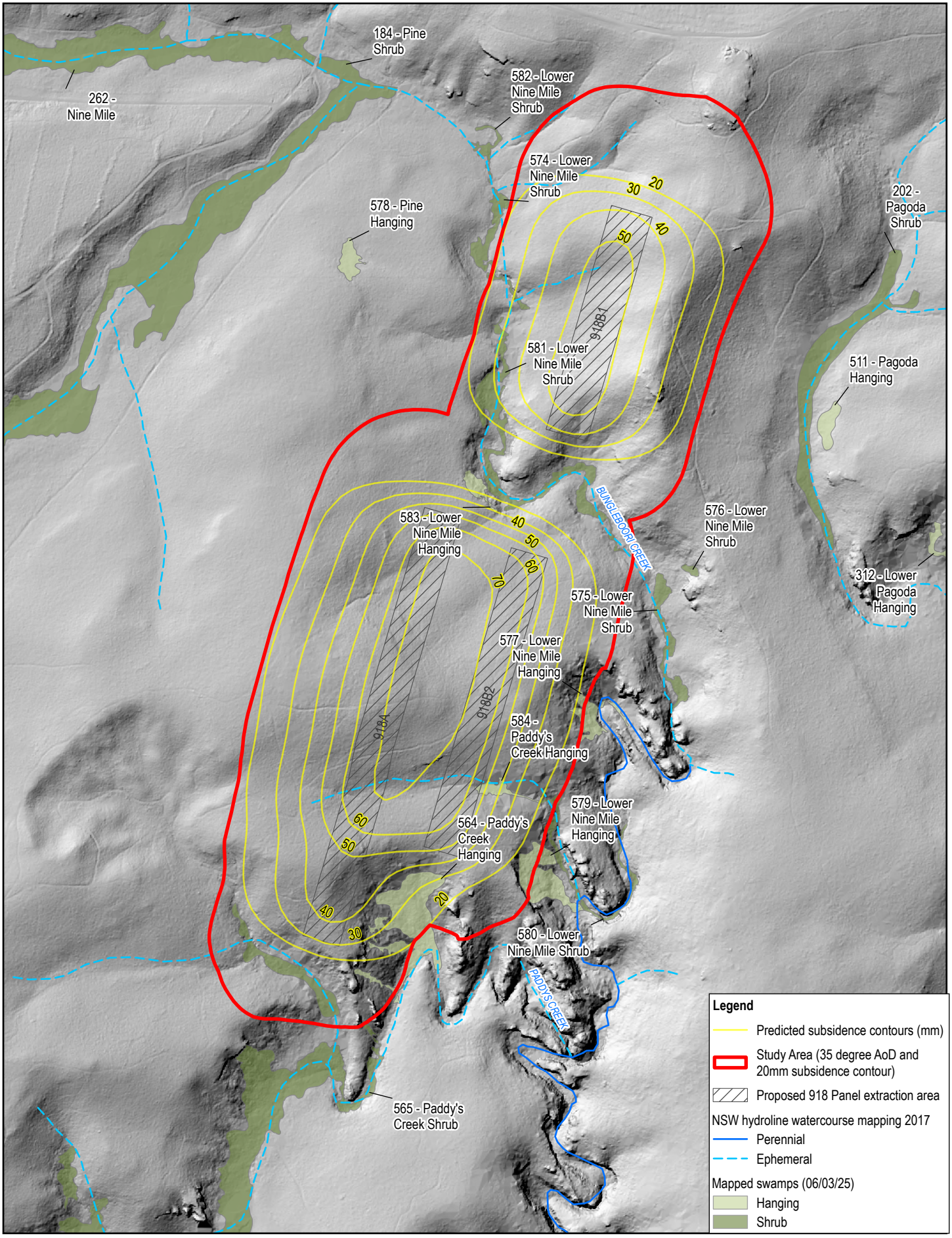
GHDs baseline geomorphological condition assessment has identified that, although the swamps in the study area are sensitive to external change, the predicted ground impacts are not anticipated to adversely impact these features. Therefore, no associated management or mitigation measures are recommended.

GHD recommends the consideration should be given to conducting regular swamp monitoring, with aerial photograph / lidar assessment in difficult access areas. Track repair should also be considered to ensure continued (and improved) access to remote areas, as well as limiting adverse localised impacts from track erosion.

Appendices

Appendix A

Location maps and figures



Paper Size ISO A4

0 100 200 300 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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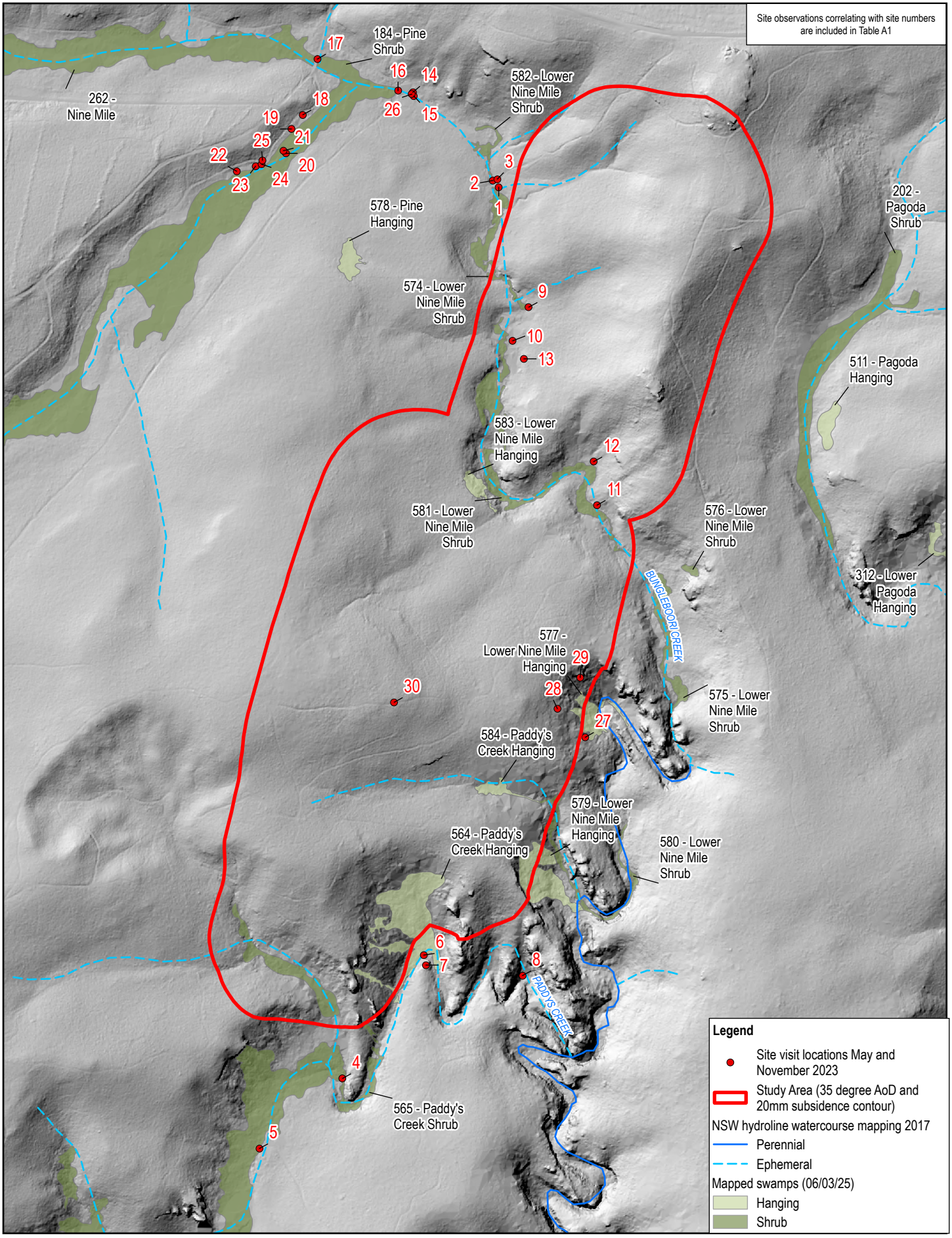
Location map and predicted subsidence contours

Project No. **12575473**
Revision No. **Rev 0**
Date **24/11/25**

FIGURE A1

C:\Users\lellis\Documents\Clarence\Clarence\Clarence_Working\Clarence_Working.aprx - Fig_A1_Location_Subsidence
Print date: 24 Nov 2025 - 10:09

Data source: . Clarence Colliery: Subsidence mapping, Swamp mapping, AoD / Study area. Hillshade created from 2011 ELVIS lidar data. Created by: lellis



Paper Size ISO A4

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Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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Project No. **12575473**
Revision No. **Rev 0**
Date **17/09/25**

Site visit locations

FIGURE A2

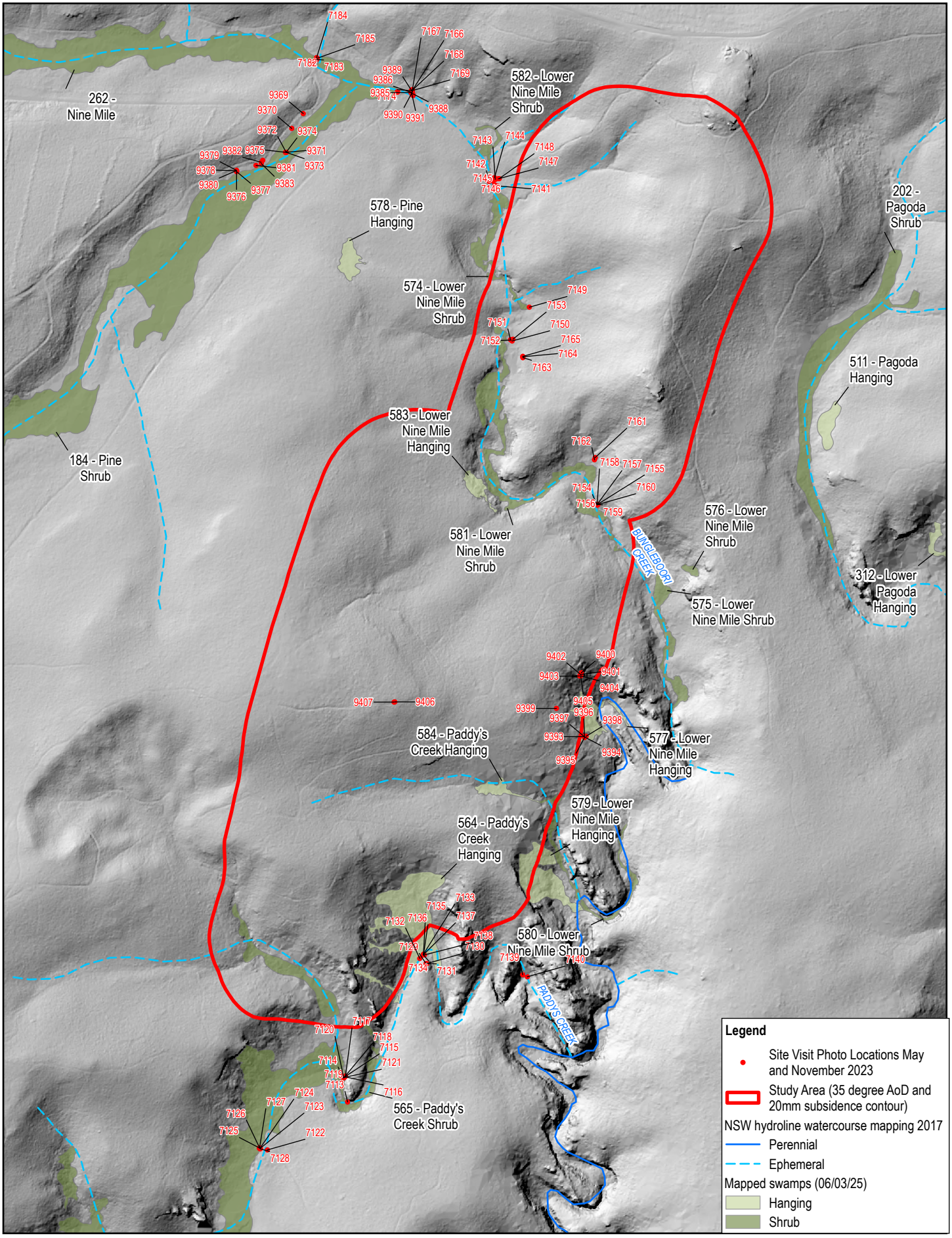
C:\Users\lellis\Documents\Clarence\Clarence\Clarence_Working\Clarence_Working.aprx - Fig_A2_SiteVisitLocations
Print date: 17 Sep 2025 - 15:47

Data source: . Clarence Colliery: Subsidence mapping, Swamp mapping, AoD / Study area. Hillshade created from 2011 ELVIS lidar data. Created by: lellis

Table A.1 Site visit observations

Site ID	Date of observation	Site observations	Easting*	Northing
1	24/05/2023	Flattened vegetation above left back of creek indicating overbank flows	242285	6301069
2	24/05/2023	At track crossing. Eroding. Some deep (1 m) pools. Vegetation in channel. Much wider where track crosses. Dense vegetation upstream and downstream. Swift flow pooling on track.	242275	6301081
3	24/05/2023	Eroding track	242283	6301084
4	24/05/2023	PC1_1. D/s end of swamp, near large tree, upstream of pagoda. Minor erosion on right bank, sandy material. Swift flow. Coral fern. Good condition.	242002	6299454
5	24/05/2023	PC1_2. Next to car parking area. Flow 1.5 m wide, pools & riffles with in-channel vegetation. Swamp intact. Pagodas u/s & d/s	241851	6299327
6	24/05/2023	Base of steep intact hanging swamp. Swift flow in creek. Rock steps and pools. Approx 1-1.5 m wide.	242149	6299678
7	24/05/2023	PC2. Rock viewpoint over swamp & valley.	242153	6299659
8	24/05/2023	PC3. Rock steps. Sediment deposited from gully above	242328	6299640
9	24/05/2023	Flood debris approx. 2 m above creek channel	242339	6300852
10	24/05/2023	BC2. Small, defined creek incised approx. 0.5 m into swamp. Ground waterlogged in places. Well vegetated. Rock outcropping on right valley wall and small rock outcrop upstream.	242310	6300791
11	24/05/2023	BC3. Swiftly flowing, rock outcropping in bed and banks. Creek running along valley side / swamp boundary. Channel shallow, 1.5-2 m wide. Dense swamp vegetation.	242463	6300493
12	24/05/2023	View over creek and swamp from track	242457	6300572
13	24/05/2023	View across creek from rock outcrop.	242331	6300758
14	24/05/2023	BC1. Channel along margins of swamp. Reeds and grasses since first monitoring. 0.5 m wide & deep. In channel vegetation. No apparent impact from track upstream.	242129	6301241
15	24/05/2023	BC1. View across swamp. Shrubs. Moist ground but no obvious waterlogging & surface water. Dry swamp.	242131	6301234
16	24/05/2023	Ford across creek. Remediation work, angular cobbles and erosion matting. Widens at track. Swift flow.	242103	6301244
17	24/05/2023	Track crossing. Angular cobbles & erosion matting. Channel less well defined.	241956	6301301
18	15/11/2023	Eucalypts in swamp	241930	6301200
19	15/11/2023	Clear vegetation contours, coral fern & leptospermum	241910	6301175
20	15/11/2023	Swamp waterlogged but not flowing. Dense vegetation, some shrubs. Some drier islands with eucalyptus & woody shrubs	241899	6301131
21	15/11/2023	Waterlogged ground	241895	6301135

Site ID	Date of observation	Site observations	Easting*	Northing
22	15/11/2023	View across upstream section of swamp. Good condition. Was severely burned from tree damage	241810	6301098
23	15/11/2023	Trees above left swamp edge severely fire damaged	241845	6301107
24	15/11/2023	Marker PS08 veg transect? No flowing water, no visible erosion from hillside into swamp. Swamp good condition.	241855	6301111
25	15/11/2023	Minor erosion along edge of former track, in sandy soil	241857	6301118
26	15/11/2023	Repeat BC1. Low flow, vegetation increased density. Iron floc.	242128	6301238
27	15/11/2023	Edge of very steep hanging swamp. Coral fern & sandy peat soils. Dense vegetation. Above gorge / pagoda and hairpin meander	242442	6300072
28	15/11/2023	Coral fern above mapped swamp	242392	6300124
29	15/11/2023	BC4. Monitoring point from rock outcrop. Rock pool at base of swamp. Good view of hairpin meander and good condition very steep hanging swamp	242433	6300180
30	15/11/2023	Erosion and deposition in erosion fencing around cleared car park area	242096	6300136



Paper Size ISO A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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918 Panel Watercourse Stability and Geomorphological Assessment

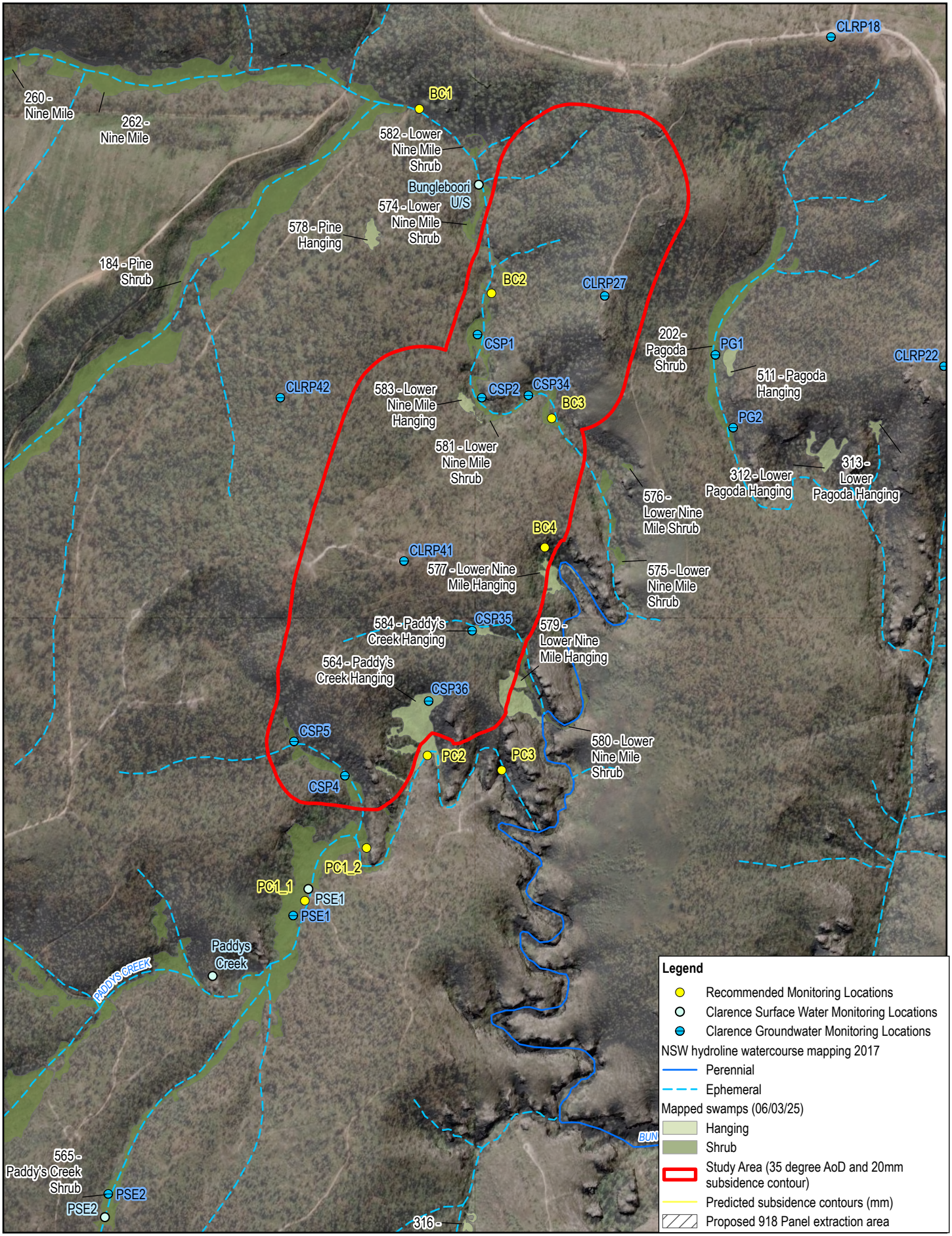
Photograph locations

Project No.	**12575473**
Revision No.	**Rev 0**
Date	**17/09/25**

FIGURE A3

C:\Users\lellis\Documents\Clarence\Clarence\Clarence_Working\Clarence_Working.aprx - Fig_A3_PhotoLocations
Print date: 17 Sep 2025 - 16:11

Data source: . Clarence Colliery: Subsidence mapping, Swamp mapping, AoD / Study area. Hillshade created from 2011 ELVIS lidar data. Created by: lellis



Paper Size ISO A4

0 100 200 300 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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918 Panel Watercourse Stability and Geomorphological Assessment

Project No. **12575473**
Revision No. **Rev 0**
Date **24/11/25**

Monitoring locations

FIGURE A4

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Print date: 24 Nov 2025 - 10:05

Data source: World Imagery: Vantor. Clarence Colliery: AoD / Study area, Clarence monitoring locations and swamp mapping. Hillshade created from 2011 ELVIS lidar data. Created by: lellis

Appendix B

Site visit observations and photographs

B-1 Bungleboori Creek stability assessment

NOTE: Paddys Creek Hanging Swamps, S_UID 564 and S_UID 584, tributary swamps above the main Paddys Creek Shrub Swamp, S_UID 565 and Lower Nine Mile Swamps, S_UID 579, were not assessed on site due to track condition, lack of easily accessible vantage points and difficult terrain.

B-1-1 Pine Shrub Swamp, S_UID 184

Monitoring Point / Orientation	Location	Swamp characteristics	Other notes
PS1	PS1 is located along a disused track above the left margins of the swamp: photographs from other locations of general swamp condition plus recommended monitoring point at site 22	– Swamp has no defined channel, with waterlogged sandy peat material within the swamp. – Vegetation is dense and continuous, with apparent full assemblage of swamp species. Swamp shows good recovery since 2020 fires, in contrast to severely burned trees on hillslopes to the north of the swamp.	– No apparent erosion of track and hillside, i.e., no sand deposits or sediment-covered vegetation along the swamp margins.

Upstream	Downstream	Upstream / West	View towards Right Bank
View upstream across Pine Shrub Swamp, S_UID 184, from site 22.	View downstream across Pine Shrub Swamp, S_UID 184, from site 22.	View of severely burned forest on hillside above well-recovered swamp S_UID 184, from site 22.	View across swamp S_UID 184from left to right margins, showing dense, good condition vegetation, from site 22
November 2023			
 9376	 9377	 9378	 9379
 9377			

Towards right bank, at star picket	Looking northwest	Track erosion	Fire-damaged hillside
November 2023			
View southeast across Pine Shrub Swamp, S_UID 184, showing dense vegetation at site 24	View northwest at severely burned hillside above left margin of swamp S_UID 184 at site 24	Minor erosion in edge of former track, above left margin of swamp S_UID 184 at point 25	Severely burned forest / hillside above left margin of swamp S_UID 184 at site 23
 9382	 9383	 9384	 9381

Upstream	Downstream	Left swamp margin	Right swamp margin
View upstream across Pine Shrub Swamp, S_UID 184	View downstream across Pine Shrub Swamp, S_UID 184	Dense, good condition swamp vegetation contrasting with severely fire-damaged hillside above. Close-up of waterlogged, muddy ground.	Dense swamp vegetation with slightly fire-damaged forest above swamp S_UID 184.
 9371	 9372	 9373	 9374
		 9375	

Monitoring Point / Orientation	Location	Channel characteristics	Other notes
BC1 at sites 14 / 26	BC1 is located below the downstream end of a good condition, narrow, elongate channelised fill Pine Swamp, S_UID 184, and about 40 m downstream of the access track ford.	– Channel runs along left margin of swamp (noting it is no longer mapped as a swamp). – Approx. 0.5 m wide and deep. – No visible adverse erosion or deposition, other than iron floc coating sediment and vegetation where inundated. Channel appears stable and in good condition.	– Dense reeds and grasses, which had grown between May and November 2023. – No apparent impact from upstream track.

Upstream	Downstream	Left Bank	Right Bank
View upstream of dense riparian corridor and narrow, incised channel	View downstream of dense riparian corridor and narrow, incised channel. Rock outcrops above the left bank downstream.	View of riparian corridor above left bank and close-up of left bank and channel, showing dense vegetation	View of swamp adjacent to right bank, showing shrub vegetation indicative of drier swamp conditions.
May 2023 – site 14			
 7166	 7168	 7172	 7174
 7167	 7170	 7173	
November 2023 – site 26			
 9387	 9390	 9388	 9391

Upstream	Downstream	Left Bank	Right Bank
	 9386		

Condition adjacent to BC1,			
Upstream valley floor	Downstream	Across (left to right, looking southwest)	
 7177	 7176	 7175	

Track approx. 40 m upstream of BC1, at site 16			
View upstream of densely vegetated Pine Swamp, S_UID 184, and water pooled on track. Track has been repared with angular cobbles.	View downstream of pooled water entering much smaller natural channel. Note in-channel vegetation.	View of left bank, where repaired track enters watercourse.	View of right bank, showing broad pooled water and repairs to track with angular cobbles and jute erosion matting.
 7178	 7181	 7179	 7180
Main track approx. 220m upstream of BC1			

B-1-2 Nine Mile Swamp, S_UID 262 / Pine Swamp, S_UID 184 transition

View upstream of densely vegetated Nine Mile Swamp, S_UID and channel, with water pooled on track at site 17. Track has been repared with angular cobbles.	View downstream of pooled water entering much smaller natural channel in Pine Swamp S_UID 184. Note in-channel vegetation.	View of left bank, where repaired track enters watercourse.	View of right bank, showing broad pooled water and repairs to track with angular cobbles and jute erosion matting.
 7182	 7183	 7184	 7185

B-1-3 Lower Nine Mile Shrub Swamps, S_UID 582 and S_UID 574

Track approx. 350m upstream of BC2, sites 1, 2 and 3 between Lower Nine Mile Shrub Swamp, S_UID 582 and S_UID 574			
View upstream at iron-stained channel, which widens at track crossing at site 3. Dense riparian vegetation.	View downstream showing narrowing of channel below track, with small, pools (up to 1m deep). Densely vegetated riparian corridor and some vegetation in channel.	Comaprison of 2022 and 2023 condition of left bank of creek and track. Track has eroded since 2022, with gullies and sheetwash eroding to bedrock in places.	View of vegetated creek right bank and gullied track above left bank.
 7143	 7145	 2022 condition	 7147
Swamp appears more extensive than mapped, with a narrow swamp connecting mapped swamps upstream and downstream of track.	 7146	 7142	 7148

B-1-4 Upper section of Lower Nine Mile Shrub Swamp, S_UID 581

Monitoring Point / Orientation	Location	Channel characteristics	Other notes
BC2, at site 10	BC2 is located approx. 300 m upstream from an eroding fire trail at the upstream end of Lower Nine Mile Shrub Swamp, S_UID 581.	– Small, well-defined channel approx. 1 m wide, incised approx. 0.5 m into Lower Nine Mile Shrub Swamp, S_UID 581. – Channel meanders acutely.	– Ground waterlogged in places. – Rock outcropping on right valley wall. Passed rock outcrops adjacent to creek upstream. – Flood debris had accumulated on trees approx. 2 m above creek level at time of site visit.

Upstream	Downstream	Left Bank	Right Bank
View upstream of narrow, incised channel winding through densely vegetated swamp S_UID 581 margins.	View downstream at narrow channel with wider pool at acute meander. Channel winds through densely vegetated swamp S_UID 581margins.	View of large tree and shrub swamp S_UID 581 margins above left bank.	View over swamp S_UID 581 and right bank of channel.
 7150	 7151	 7152	 7153

B-1-5 Lower section of Lower Nine Mile Shrub Swamp, S_UID 581

Monitoring Point / Orientation	Location	Channel characteristics	Other notes
BC3, site 11	BC3 was accessed from the firetrail and BC2, walking over the ridgeline and dropping into the valley via a gully. Located near the downstream end of Lower Nine Mile Shrub Swamp, S_UID 581, at site 11.	Small, well-defined channel approx. 1 m wide, incised approx. 0.5 m into swamp.	Ground waterlogged in places. Rock outcropping on right valley wall. Passed rock outcrops adjacent to creek upstream.

Upstream	Downstream	Left Bank	Right Bank
View upstream showing swiftly flowing, well-defined creek with bedrock outcropping in creek bed. Dense swamp vegetation within riparian corridor.	View downstream showing rock outrcopping within bed of creek. Rock outcrops visible approx 50 m downstream.	View of hillside above left bank.	View of right bank and swamp beyond right bank.
 7154	 7155	 7157	 7158
 7160	 7156		 7158

B-1-6 Lower Nine Mile Hanging Swamp, S_UID 577

Monitoring Point / Orientation	Location	Channel characteristics	Other notes
NMH_1, at site 29	NMH_1 was accessed by following a faint ridge from a subsidence monitoring point at the end of a track. There is a good vantage point from a rock outcrop to the north of swamp S_UID 577.	– Contorted hairpin meanders around rock cores, with the creek morphology strongly structurally controlled. Meander core shows exploitation of a joint, with a sharp, straight-edged rock remnant. – Creek bed is rock, with a deep pool below the hanging swamp and rock steps creating riffles.	Hanging swamp S_UID 577 is very steep and in good condition with intact, dense vegetation.

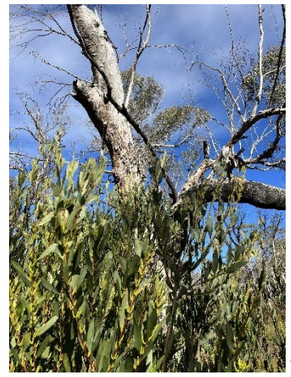
Wide view south over swamp S_UID 577, at site 29		Swamp S_UID 577	View north over rock outcropping along meander embayment
Swamp S_UID 577 is perched above hairpin meander around rock core.	Close-up of previous photograph, showing deep pool and rock steps in creek bed, with hanging swamp S_UID 577 perched above the downstream limb of the hairpin. Sharp, straight-edged rock remnant indicates joint exploitation.	Intact, densely vegetated swamp S_UID 577 with rock outcrop above.	Rock outcropping and pagoda formations along the meander embayment upslope of hairpin.
 9402	 9401	 9403	 9404

Southern margin of swamp S_UID 577 at site 27	Pagoda formations from site 29	Carpark at site 30, access point for swamp S_UID 577	
Coral fern and dense hanging swamp vegetation within swamp S_UID 577 at site 27.		Access point at carpark, site 30, for swamp S_UID 577, showing recent erosion.	Downslope erosion control within car park at site 30, showing recent deposition of eroded material.
 9407	 9393	 9407	 9406

B-2 Paddys Creek stability assessment

B-2-1 Paddys Creek Shrub Swamp, S_UID 565

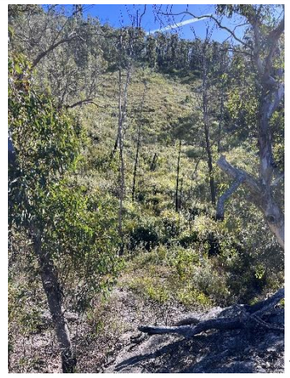
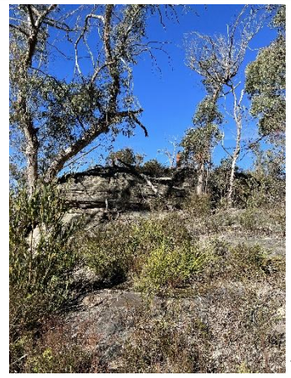
Monitoring Point / Orientation	Location	Channel characteristics	Other notes
PC1_1, site 4 **PC1_2, site 5**	PC1 location 1 is located at the base of the valley where safe to access, at the downstream end of Paddys Creek Shrub Swamp, S_UID 565 and upstream end of rock outcropping above the left bank, at site 4. Park at end of track and walk across dry hanging swamp to access main creek. Location PC1_2 is located adjacent to the trail end parking area, at site 5, upstream of PC1_1.	– The channel is bedrock-controlled with small, stepped waterfalls. Flow runs along the base of a rock outcrop. Banks were sandy, with minor slumping of the right bank. – Riparian corridor densely vegetated.	

PC1_1 – adjacent to upstream end of rock outcropping and downstream end of Paddys Creek Shrub Swamp, S_UID 565 at site 4			
View upstream at narrow channel at site 4. Bedrock outcropping in channel bed, with stepped waterfalls.	View downstream at natural wider pool within channel where water draining rock outcrop enters main channel. Pagoda visible in background.	View of rock outcropping above vegetated left bank, where water draining outcrop enters to form a wider pool in the main channel.	Slumping of sandy soil along right bank of creek. Large tree marks location of monitoring point.
 7114	 7116	 7117	 7119
 7121	 7115		 7120

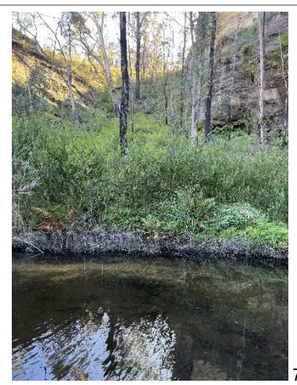
PC1_2 – adjacent to car park at site 5.			
View upstream at channel approx. 1.5m wide. Characterised by pools and riffles with in-channel vegetation. Rock outcrops visible in background.	View downstream at densely vegetated channel and riparian corridor, with good condition swamp (S_UID 565).	View across densely vegetated left bank and swamp (S_UID 565).	View of area above right bank to car parking area at trail end.
 7123	 7125	 7127	
 7124	 7126		

B-2-2 Paddys Creek Hanging Swamp S_UID 564

Monitoring Point / Orientation	Location	Channel characteristics	Other notes
PC2, sites 6 and 7	PC2 location is from a prominent rock outcrop overlooking Paddys Creek Hanging Swamp S_UID 564, at sites 6 and 7. The channel can be accessed safely to the left of the outcrop.	The channel is bedrock-controlled with rock steps and deeper pools. Channel is approx. 1 m - 1.5 m wide Riparian corridor densely vegetated.	

Upstream	Downstream	Left bank and Paddys Creek Hanging Swamp, S_UID 564	Right bank
View upstream at swiftly flowing, bedrock-controlled creek, approx. 1 m-1.5 m wide. Densely vegetated banks and riparian corridor.	View downstream at rock step and deeper pool. Densely vegetated banks and riparian corridor.	Top: view across good condition, well-vegetated, steep hanging swamp (S_UID 564) from rock outcrop above creek. Bottom: view of left bank and hanging swamp (S_UID 564) from creek level.	View of rock outcrop vantage point above right bank of creek.
 7133	 7135	 7129	 7138
 7134	 7136	 7137	

Monitoring Point / Orientation	Location	Channel characteristics	Other notes
PC3, at site 8	PC3 is located within a narrow bedrock valley and would provide an indication of any upstream impacts.	– The channel is bedrock-controlled with cascading rock steps and deeper pools. Channel is approx. 1 m-1.5 m wide, with the pool approx. 5 m-6 m wide. – Riparian corridor densely vegetated.	Reach is within a narrow gorge with fringing vegetation.

Upstream	Left Bank
View upstream at rock steps and scour holes in creek upstream of pool	View into gully above wide pool at meander apex, with sediment from gully forming a vegetated delta in break in valley side, and accumulating in pool.
 7139	 7140

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