APPENDIX D

SURFACE WATER IMPACT ASSESSMENT

Centennial Northern Coal Services – Cooranbong Entry Site Stockpile Extension Modification

Surface Water Impact Assessment

FINAL

September 2024

alluvium

Alluvium recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to and talking at the meeting places as one nation.

This report has been prepared by Alluvium Consulting Australia Pty Ltd for James Bailey & Associates (JBA) under the contract titled 'Centennial Coal Cooranbong Entry Site Modification'.

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Acronyms

AEP	Annual Exceedance Probability
ARR	Australian Rainfall and Runoff
CES	Cooranbong Entry Site
CHP	Coal Handling Plant
Centennial	Centennial Northern Coal Services Pty Limited
CL	Continuing loss
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	Department of Planning and Environment (now DPHI)
DPHI	Department of Planning, Housing and Industry
DPIE	Department of Planning, Industry and Environment (now DPHI)
EPL	Environment Protection Licence
FFA	Flood Frequency Analysis
IL	Initial loss
LDP	Licenced Discharge Point
ML	Megalitre
NCS	Northern Coal Services Project
NCSS	Newstan Colliery Surface Site
NSW	New South Wales
RC	Riparian Corridor
ROM	Run-of-Mine
VRZ	Vegetated riparian zone
WMA	Water Management Act 2000
WMP	Water Management Plan
2D	Two-dimensional

1 Introduction

1.1 Purpose of this report

The purpose of this report is to document a surface water impact assessment for a proposed Modification to Northern Coal Services (NCS) Project SSD-5145 (refer to Figure 1). Centennial Northern Coal Services Pty Limited (Centennial) proposes to apply for a Modification of SSD-5145 under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (the Modification) for:

- Development of the existing coal stockpile at Cooranbong Entry Site (CES) to increase capacity from 100,000 tonnes to approximately 400,000 tonnes; and
- Construction of infrastructure associated with the modified stockpile footprint. This will include access tracks, lighting towers, water sprays, fencing and water management infrastructure.

This assessment aims to evaluate the potential impacts on surface water resulting from the Modification and compliance with relevant regulatory frameworks and overarching water management strategies.

1.2 Scope of this assessment

This surface water impact assessment focuses on evaluating various key elements of surface water management and potential environmental impacts of the Modification (refer to Figure 2). The scope of the assessment includes assessment of surface water behaviour, mitigation measures, and reporting. Key components of the impact assessment include:

- A site water balance analysis to analyse current hydrological conditions and predict the effects of the Modification;
- Review of existing water quality monitoring programs and strategies for CES to address concerns such as sedimentation, contamination, and changes in hydrological patterns; and
- Hydraulic assessment using TUFLOW hydraulic modelling consistent with Australian Rainfall and Runoff (ARR) 2019 standards, to provide a thorough evaluation of flood risks, assess the concept layout and determine impacts on local watercourses.

Recommendations will focus on reviewing existing monitoring and mitigation measures, evaluating diversion performance and identifying any further mitigation measures required for the Modification, to address potential impacts on surface water.

1.3 Site overview

Location and description

NCS operations are located on the western side of Lake Macquarie, approximately 25 kilometres (km) south-west of Newcastle and 140 km north of Sydney. NCS comprises surface coal handling and processing facilities at the Newstan Colliery surface site and the CES, as well as private haul roads connecting Newstan Colliery, Awaba Colliery, CES and Eraring Power Station. The NCS facilities are integral to the handling, processing and transport of coal from Newstan Colliery (via conveyor) and Mandalong Mine (via an underground conveyor to CES then NCS private haul roads).

CES was originally developed as part of the Cooranbong Colliery in 1981. It comprises a Coal Handling Plant (CHP), coal stockpiles, coal conveyors, mine entries for access to Mandalong Mine, workshop and administration buildings, car parking, water management structures and other associated infrastructure.

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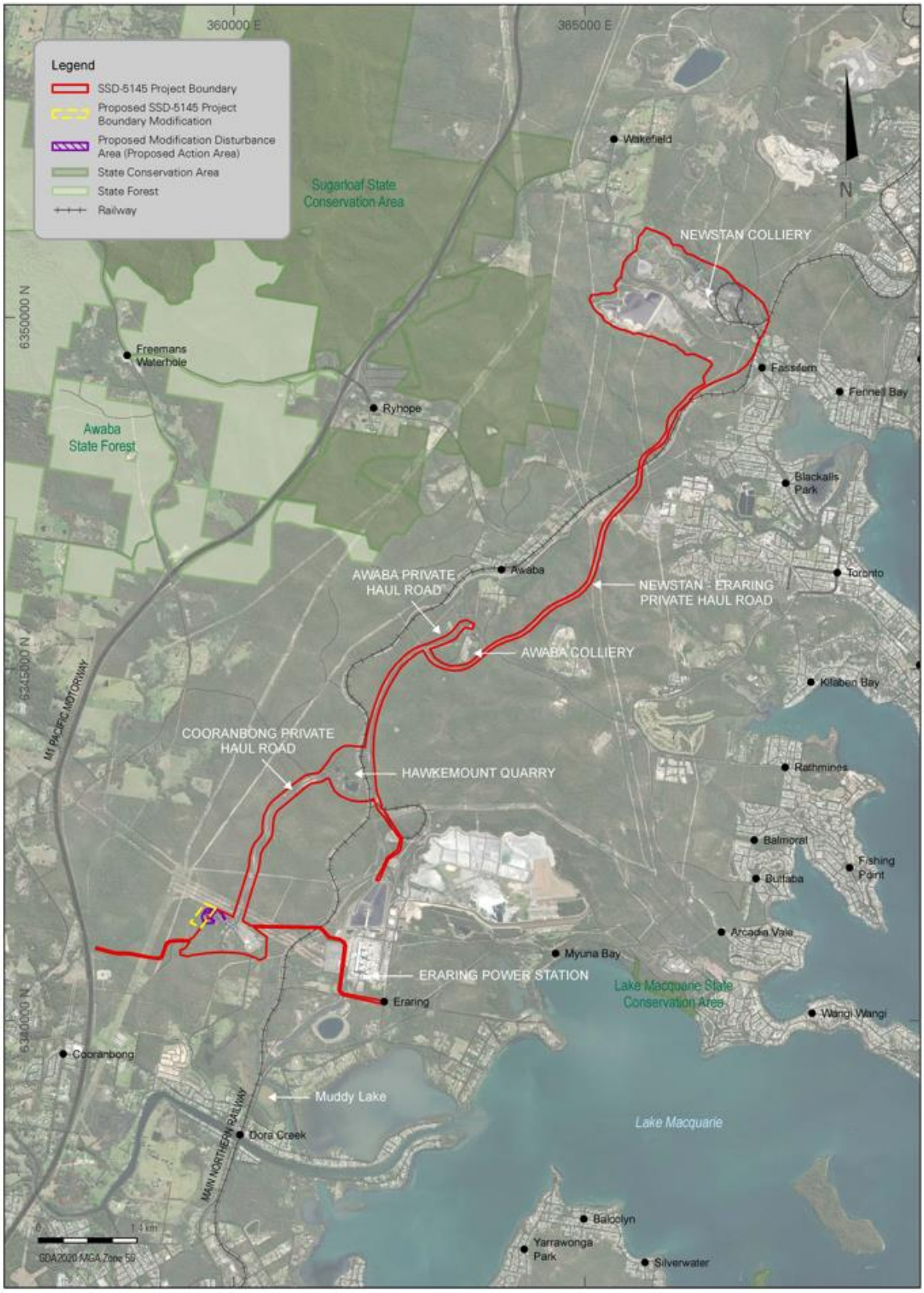

Figure 1. *Site location*

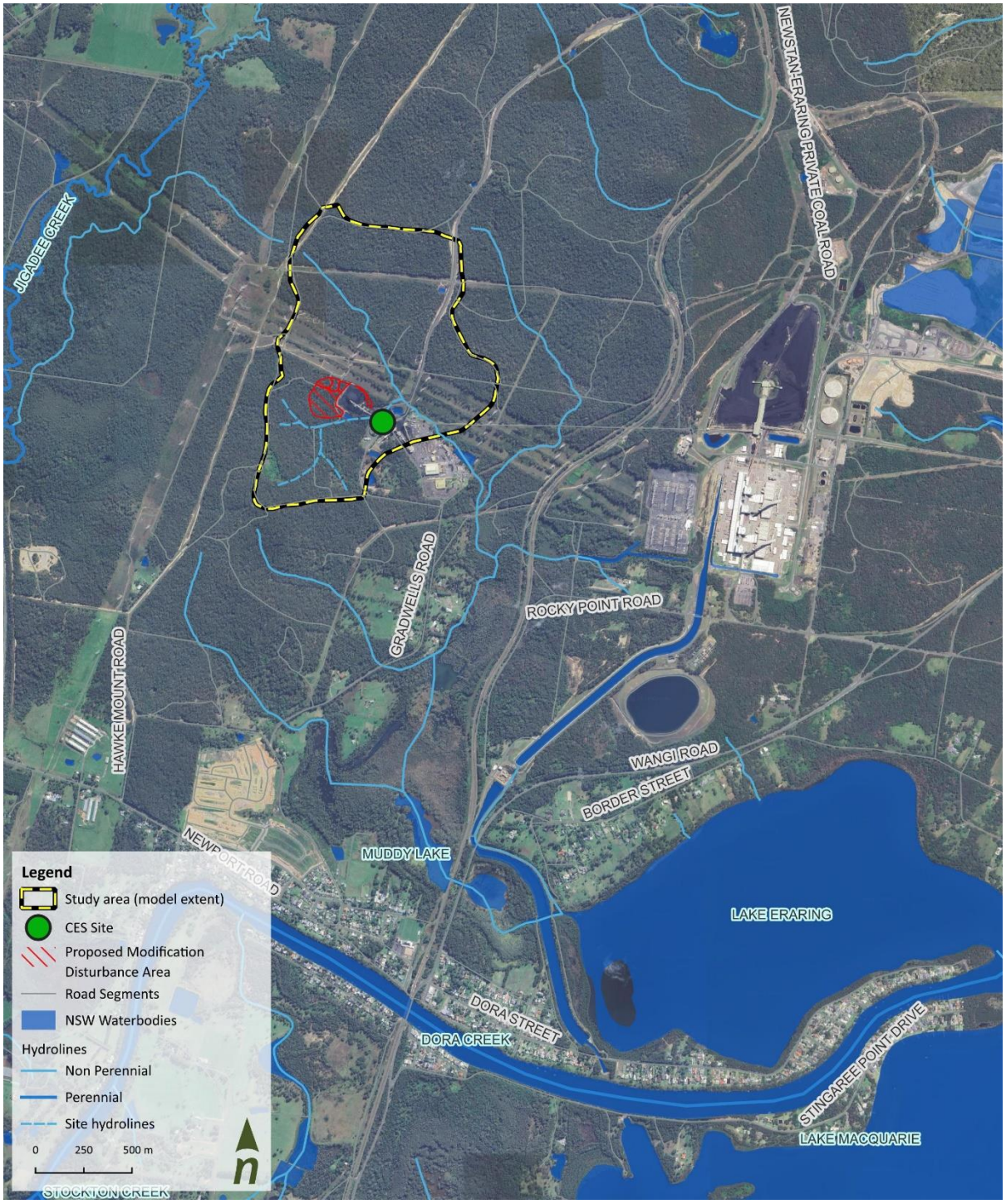

Figure 2. *Locality Plan and Modification Study Area*

Site specific considerations

The CES includes a coal handling plant (CHP), coal stockpiles, coal conveyors, mine entries for access to Mandalong Mine, an administration building, a car park, water management structures, and other associated infrastructure. CES is approved to operate 24/7 until the end of 2045 under SSD-5145.

The CES is authorised to receive, handle, and process a maximum of six million tonnes of Run-of-Mine (ROM) coal annually from the Mandalong Mine. The ROM coal, extracted from Mandalong Mine's underground operations, is transported to the surface at the CES via conveyor.

This ROM coal undergoes processing at the CES CHP before it is either conveyed overland to the Eraring Power Station or transported via the Cooranbong Private Haul Road to the Newstan Colliery Surface Site (NCSS) for additional processing and distribution to domestic and export markets.

The CHP at the CES is equipped with aerial conveyor systems, a rotary breaker and sizer, a crushing plant, coal bins, and coal stockpiles. These stockpiles include a 3,000-tonne and a 100,000-tonne ROM coal stockpile, along with a 1,500-tonne emergency coal stockpile. The facility also features an automatic truck loading system.

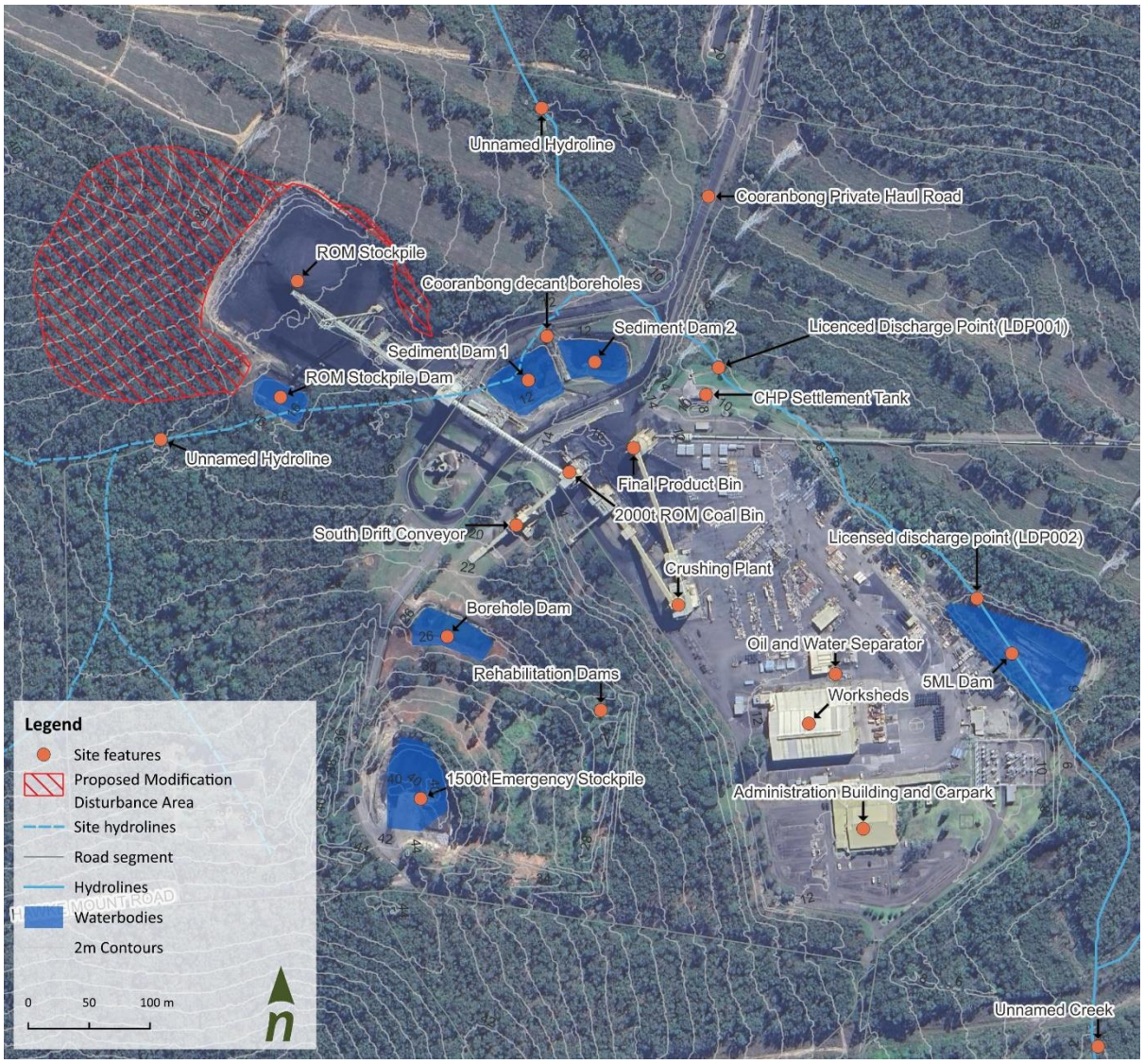

Figure 3. *CES Features (Information sourced from NCS WMP 2019)*

2 Legislative and regulatory context

2.1 Water Management Act 2000 (WM Act)

Activities conducted on waterfront land are governed by the *Water Management Act 2000* (WM Act). The objective of the WM Act is to provide for the sustainable and integrated management of the water sources of the State. The NSW Government, which administers the WM Act, is tasked with evaluating the potential impact of any proposed controlled activity on waterfront land, with the goal of ensuring that such activities result in minimal harm (DPE 2022a).

Waterfront land encompasses the bed and bank of any river, lake, or estuary, as well as all land within a 40-metre radius from the highest bank of these water bodies. Consequently, before initiating a controlled activity, it is mandatory to obtain regulatory approval.

The unnamed watercourse that intersects the existing, approved CES (refer to Figure 3) is classified as a third order stream. As such, a 30-metre vegetated riparian zone (VRZ) on each side of the watercourse, measured from the highest bank, is mandated (DPE 2022b).

Within the riparian corridors of third order streams, the following activities may be permissible:

- Offsetting riparian corridors (RC) for non-RC uses;
- Construction of cycleways and paths;
- Establishment of detention basins (restricted to 50% of the outer VRZ); and
- Installation of culvert and bridge crossings.

These details are based on specific guidelines and fact sheets provided by the Department of Planning and Environment (now the Department of Climate Change, Energy, the Environment and Water (DCCEEW)). It is always recommended to refer to the original documents for comprehensive information.

2.2 Development consent

Centennial received development consent for SSD-5145 on 29 September 2015. Two modifications to SSD-5145 were later approved on 25th January 2018 (MOD 1) and 25 November 2022 (MOD 3). The Northern Coal Services Water Management Plan (WMP) (Centennial 2019), completed in October 2019, offers a comprehensive overview of the conditions pertaining to both the original development consent and the subsequent modifications in relation to water management at CES.

2.3 Environment Protection Licence (EPL)

The Mandalong Mine site operates under EPL 365, ensuring that water discharge is regulated and monitored. CES has two licensed discharge points (LDP) under Mandalong Mine EPL 365 (LDP001 and LDP002 shown on Figure 10), which release water into an unnamed tributary of Muddy Lake. LDP001 receives mine water from the Borehole Dam or surface water from Sediment Dams 1 and 2, while LDP002 receives water from the 5 ML Dam (Centennial 2019).

2.4 Water Access Licences

Centennial Mandalong holds a water access licence (WAL 39767) which permits the extraction of up to 1,825 ML/year from the Cooranbong bore, into the Borehole Dam at the CES (refer to Figure 3). Annual groundwater take is reported in the Mandalong Mine water balance review (Centennial 2019).

The Modification will not require any changes to Centennial water licensing arrangements.

2.5 Harvestable rights

Landholders can capture and store a portion of rainfall runoff in harvestable rights dams without needing a water access licence or approval. CES is located in a 'coastal drainage catchments harvestable rights area', as of

September 2023, the harvestable rights limit for coastal-draining catchments are 10% of rainfall runoff (DPIE, 2024). Maximum harvestable right dam capacity is the maximum combined volume of water a landholder can capture and store.

The guidelines for determining the Harvestable Rights indicate however that the following dams are exempt from the calculation of the Harvestable Rights and do not require a water use approval and licencing under the WM Act:

- For the control or prevention of soil erosion;
- Flood detention;
- Capture, containment and recirculation of drainage and/or effluent to prevent contamination of a water source; and
- Specific environmental management purposes approved in writing.

As the existing CES sediment dams fall into one of these categories, Harvestable Rights have not been considered in this assessment.

3 Existing Environment

3.1 Climate

The climate in the Modification study area (refer to Figure 2) can generally be described as temperate, experiencing warm to hot summers and mild winters. Summer temperatures range from around 23 to 30 degrees Celsius, while winter temperatures vary between 17 to 22 degrees. The area receives moderate rainfall throughout the year, with a wetter season typically occurring in February to April. The annual average rainfall is 1125mm. A summary of climate data collected at the Cooranbong weather station between 2008 and 2024 is included in Table 1 and Figure 4. The total annual evaporation is estimated to be between 1400 to 1600 mm (refer to Figure 5).

Centennial have also recorded daily rainfall data at the CES since 2010.

Table 1. *Climate Data Summary: Cooranbong (Lake Macquarie AWS) Weather Station (less than 5km from CES)*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Mean Total Monthly Rainfall (mm)	109.6	138.4	**157.4**	105.6	56.6	94.8	71.7	48.7	57.4	89.8	103.6	88.2	1125.3
Highest monthly mean temperature (°C)	**31.2**	30.0	28.7	26.3	23.6	19.5	20.4	22.0	25.4	27.1	28.2	29.6	-
Lowest monthly mean temperature (°C)	26.8	26.1	25.0	23.1	19.8	17.7	**17.4**	18.3	20.6	22.4	23.0	23.5	-

*Weather station number: 61412. Data recorded between 2008 and 2024, data exported from Bureau of Meteorology website on 4/07/2024.

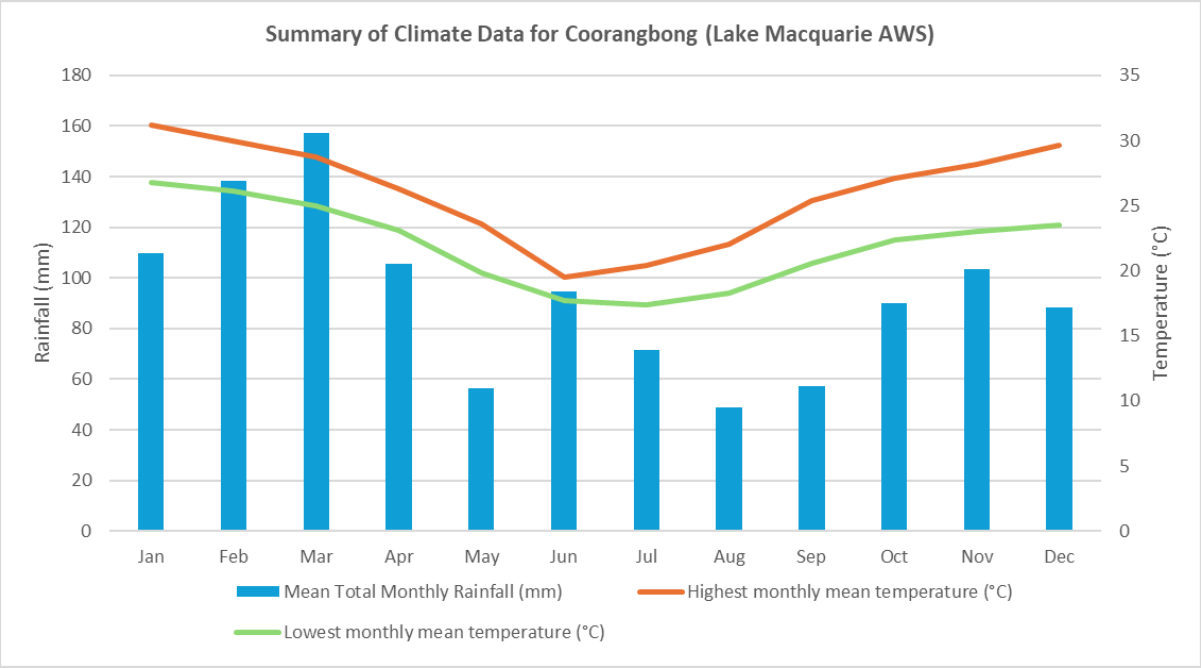

Figure 4. *Climate Data Summary*

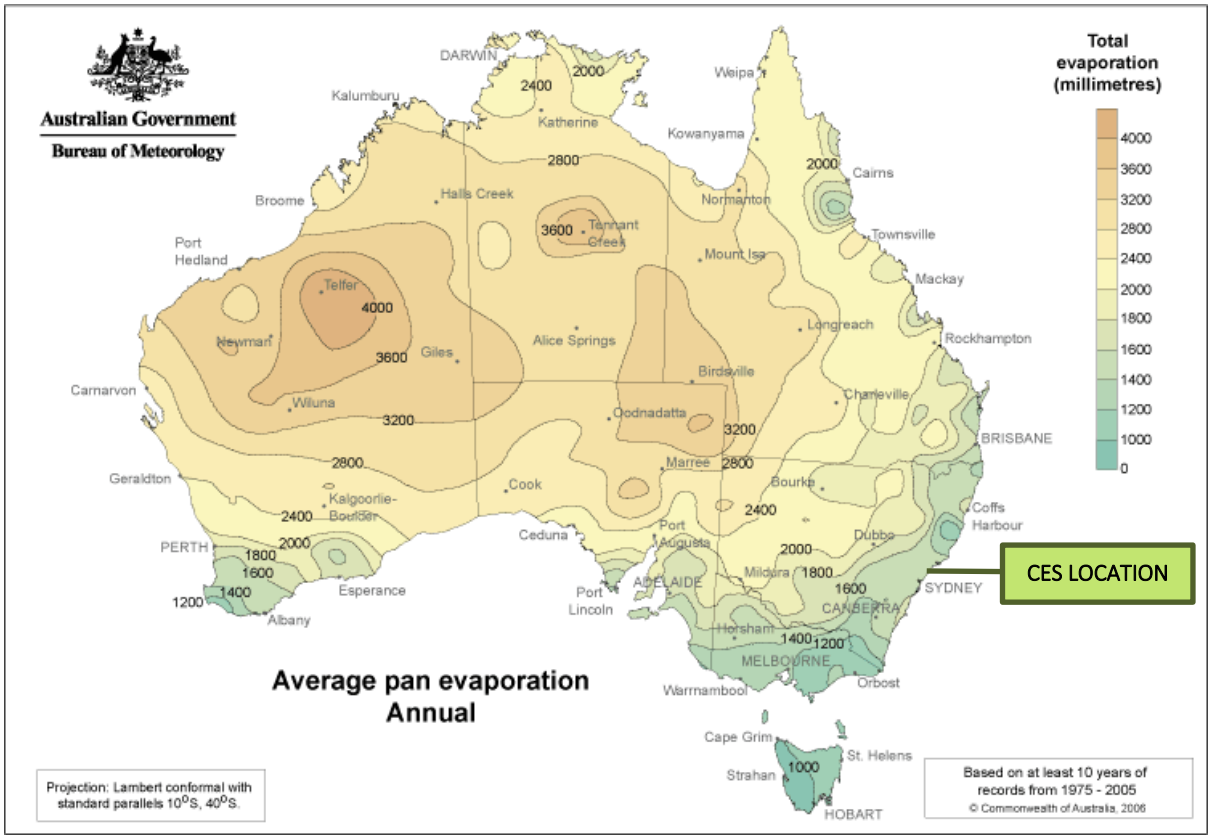

Figure 5. *Average annual pan evaporation (Bureau of Meteorology, 2024)*

3.2 Topography

The elevation of the study area ranges between 58m Australian Height Datum (AHD) at the southwestern corner of the model extent and 6m AHD at the unnamed watercourse discharging surface water from the southeastern of the model extent. The topography of the study area is characterised by ridgelines and creek valleys, with two main creek arms extending from the western side of the model extent, as shown in Figure 6.

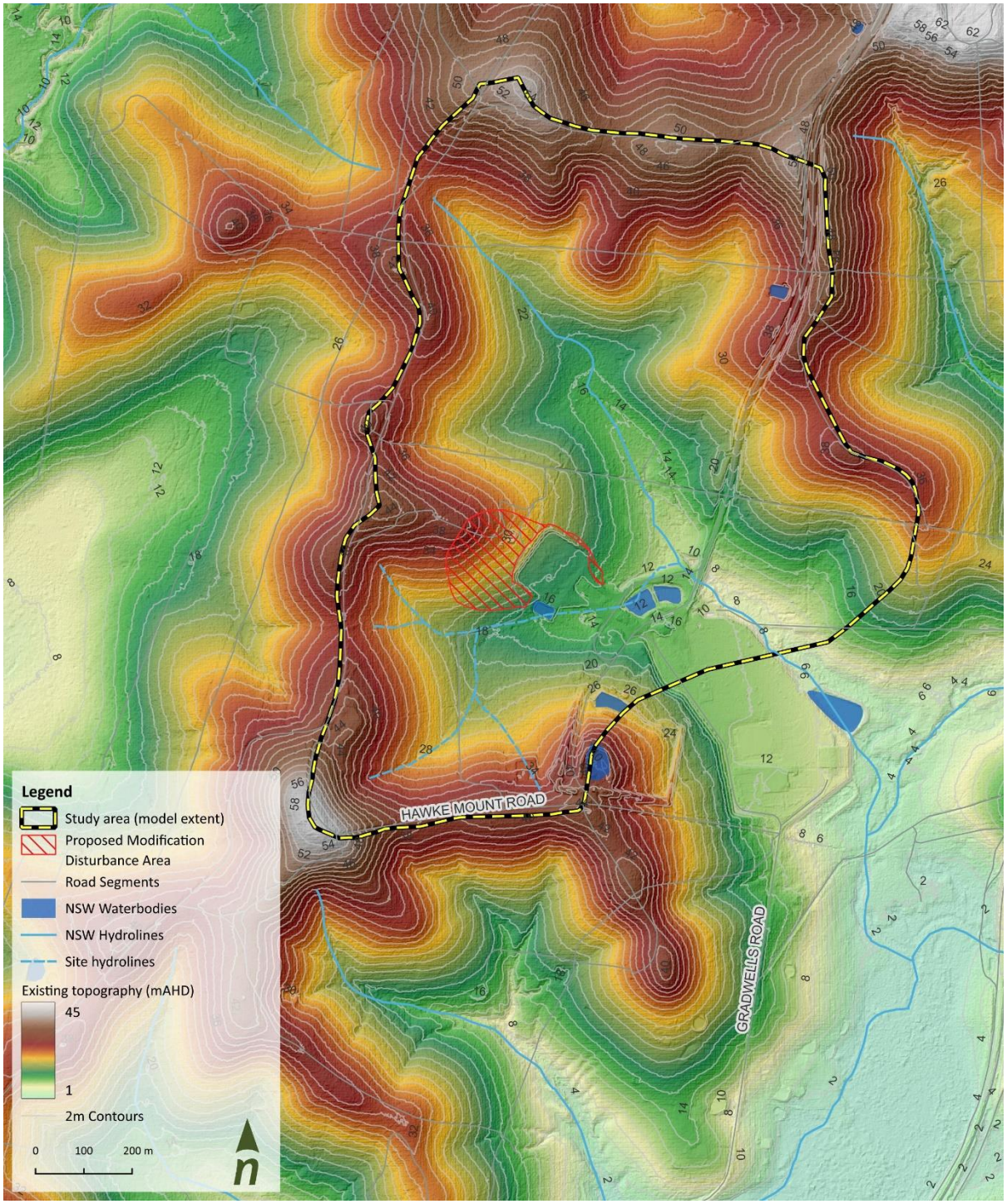

Figure 6. *Topography overview*

3.3 Catchment description

Regional setting

The study area for the Modification is located within the broader Macquarie Tuggerah Lakes catchment area on the Central Coast of New South Wales (refer to Figure 7). This area is directly south of the Hunter Basin. The wider catchment area encompasses more than 1600 square kilometres. The Macquarie-Tuggerah Lakes catchment is formed by three primary river systems; Dora Creek, Wyong River and Ourimbah Creek (Bioregional Assessment Programme 2019). The study area is located adjacent to the Dora Creek catchment, which flows into Lake Macquarie at the Dora Creek township.

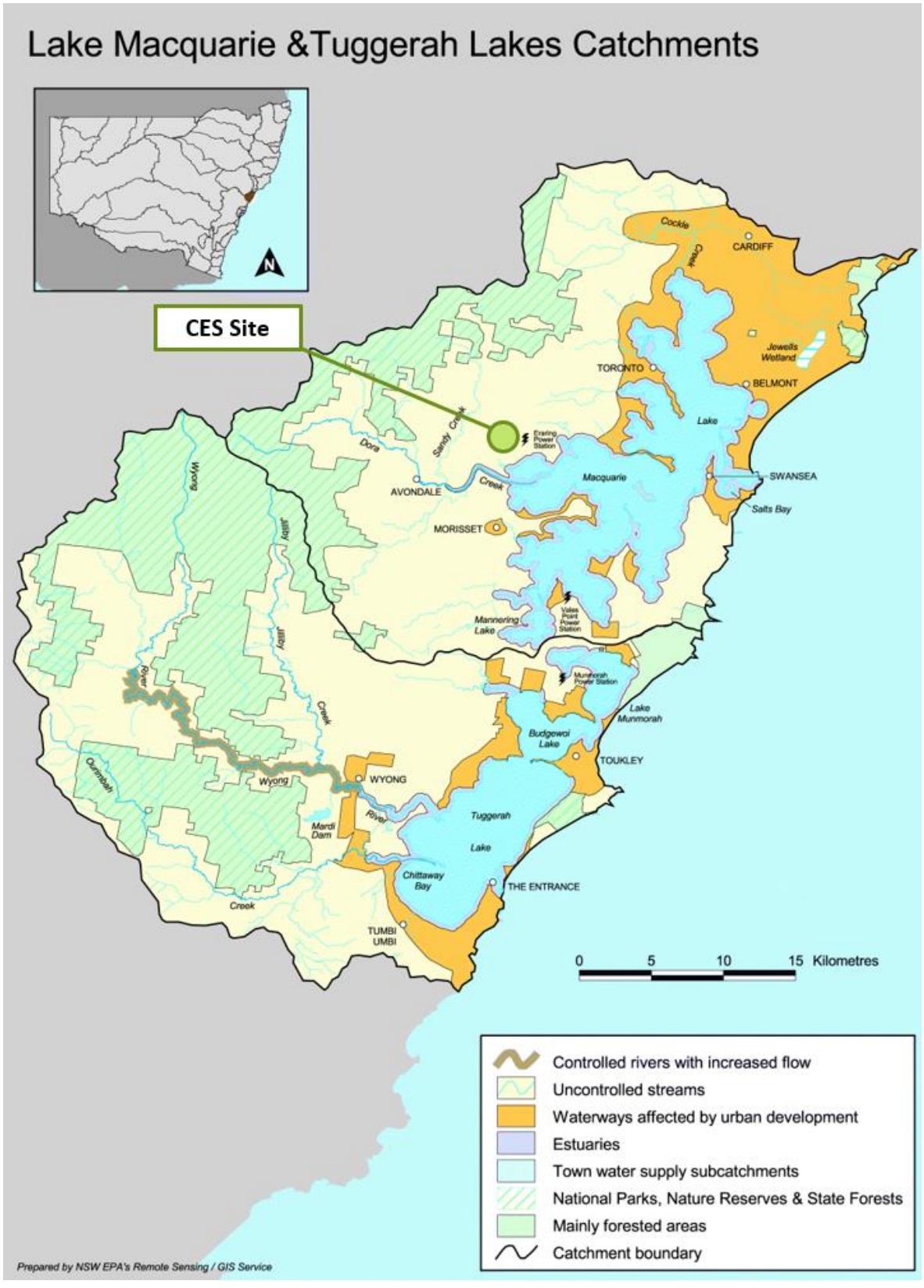

Figure 7. *Macquarie-Tuggerah Lakes Catchments (NSW Government 2006)*

Local setting

As shown in Figure 8, the study area, defined by the hydraulic model extent, is traversed by two smaller watercourses which discharge to an unnamed creek. The CES stockpile site is located within the catchment of

this unnamed creek that discharges to Muddy Lake. Muddy Lake, in turn, drains into Lake Eraring, which maintains a connection to Lake Macquarie (refer to Figure 2 and Figure 8).

The unnamed creek is classified as a third-order stream, flanked by a 30-meter vegetated riparian zone on both sides. This classification is based on the stream order guidance provided by the NSW Government (refer to Section 2.1).

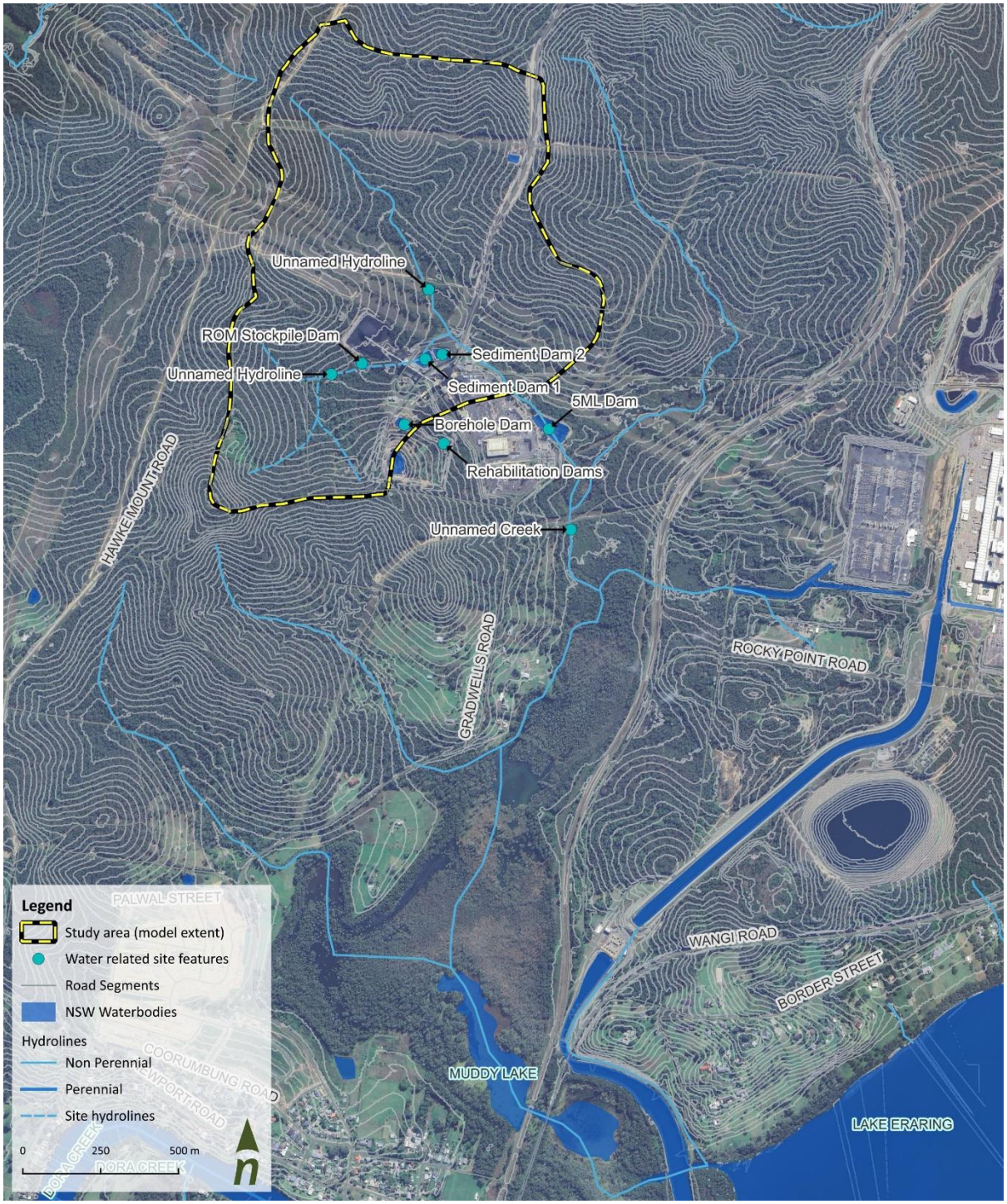

Figure 8. *Local catchment features*

3.4 Landuse

The broader Lake Macquarie catchment is highly urbanised, with key industrial and agricultural business areas. Towards the western boundary, the catchment transitions into bushland, forest and national park (DPIE 2023). According to NSW landuse data (2017), the landuse of the CES is categorised as mining, while the surrounding landuse includes; grazing native vegetation, utilities, transport and communication, residual native cover, roads, residential and farm infrastructure (as shown in Figure 3).

3.5 Surface water quality

In addition to the existing water quality monitoring program at the CES (outlined in Section 4.2) implemented as part of the WMP (Centennial 2019), Lake Macquarie is also sampled on a monthly basis (includes thirteen sample sites) as part of a joint program with Lake Macquarie City Council and Central Coast Council, supported by the NSW Government. This is part of the broader NSW Monitoring Reporting and Evaluation Program. Outputs of the monitoring program allow NSW Government to track the condition of estuaries over time by comparing observed data to a range of guideline values specific to NSW estuaries. This monitoring work is now continued through the Marine Estate Management Strategy, which aims to protect and enhance waterways and estuaries in NSW.

Lake Macquarie Council also monitors recreational water quality from thirteen lake sites on a weekly basis between November and April. As of March 2024, all sites had received a four-star rating, indicating enterococci levels below 41 colony forming units per 100 millilitres, deemed to be in 'good' condition and safe for bathing.

Downstream of Muddy Lake, Lake Eraring's water quality is closely monitored by Eraring Power Station operators (including at the associated Eraring Ash Dam), who regularly monitor water quality conditions and continually invest in reducing the risk of stormwater contamination (Origin Energy 2024).

3.6 Geology

The CES operates in the Newcastle Coalfield, located in the northeastern Sydney Basin, which is an area rich with coal, shale, and sandstone layers from the Permo-Carboniferous period. The geological base of this region is composed of Triassic claystone, sandstone, and conglomerate, supplemented by recent alluvial sediments along the river courses. The Triassic rocks are underlain by Permian Newcastle Coal Measures, which exhibit a gentle south-westward dip of approximately 1 to 2 degrees.

3.7 Soils

The soil profile within the CES area, is characterised by a variety of soil landscapes. The primary soil types are erosional and colluvial soils, which are potentially susceptible by disturbance activities associated with operations of the CES and the surrounding mining activities. In addition, sodic soils have been mapped within the NCSS and NCS Haul Road areas. Current assessments have not flagged any concerns regarding these sodic soils (refer to WMP (Centennial 2019). However, if any specific management measures are required, they will be implemented as part of the WMP.

4 Overview of Water Management System

4.1 Current system

The main objectives of the CES water management system are to:

- Separate clean and dirty water;
- Manage water quality impacts; and
- Handle transfers between CES and the Cooranbong Underground Storage (part of Mandalong Mine).

The different functions of the water management system at the CES are summarised in Table 2 and the sources are outlined in Table 3. A schematic of the overall water management system at the CES which was included as part of the WMP (Centennial 2019) is provided in Figure 9.

Table 2. *CES Water Management System components*

Category	Element
Types of water	Clean and dirty surface water
	Potable water
	Wastewater
	Mine water
Sources of water	Potable water (connection to Hunter Water Corporation reticulated potable supply)
	Rainfall
	Runoff
	Mine water transferred from Cooranbong Underground Storage
Primary water demands	Underground transfers to Cooranbong Underground Storage
	Surface dust suppression
	Machinery washdown
	Fire-fighting storage
	Staff amenities

Table 3. *CES runoff sources*

Runoff type	Typical runoff sources for CES
Clean water	Areas with no coal storage, transportation, handling, processing or any disturbance
	Diverted around dirty water
	Diverted around coal-contact catchments
	Natural catchments
	Sealed roads
	Sealed carparks
Dirty water	Disturbed areas
	Areas likely to contain suspended solids, oils, grease and hydrocarbons
	Workshop and fuel storage areas
	Coal-contact water – from coal storage, transportation, handling and processing areas

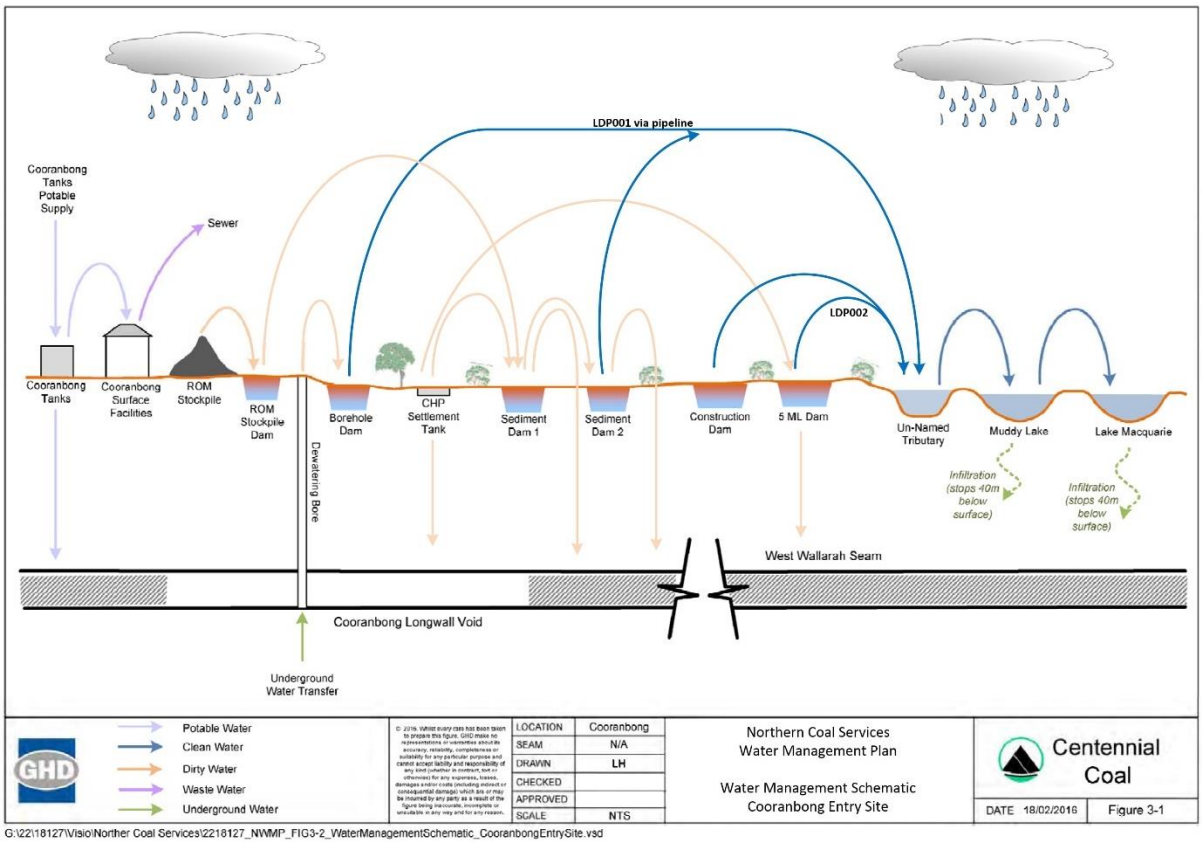

Figure 9. *Water Management Schematic (Centennial 2019, Page 36)*

The WMP (Centennial 2019) provides a comprehensive overview and data for the current water management system at the CES.

4.2 Existing water quality monitoring program

As described in the Water Management Plan (Centennial 2019) CES surface water quality is currently monitored at eight locations (refer to

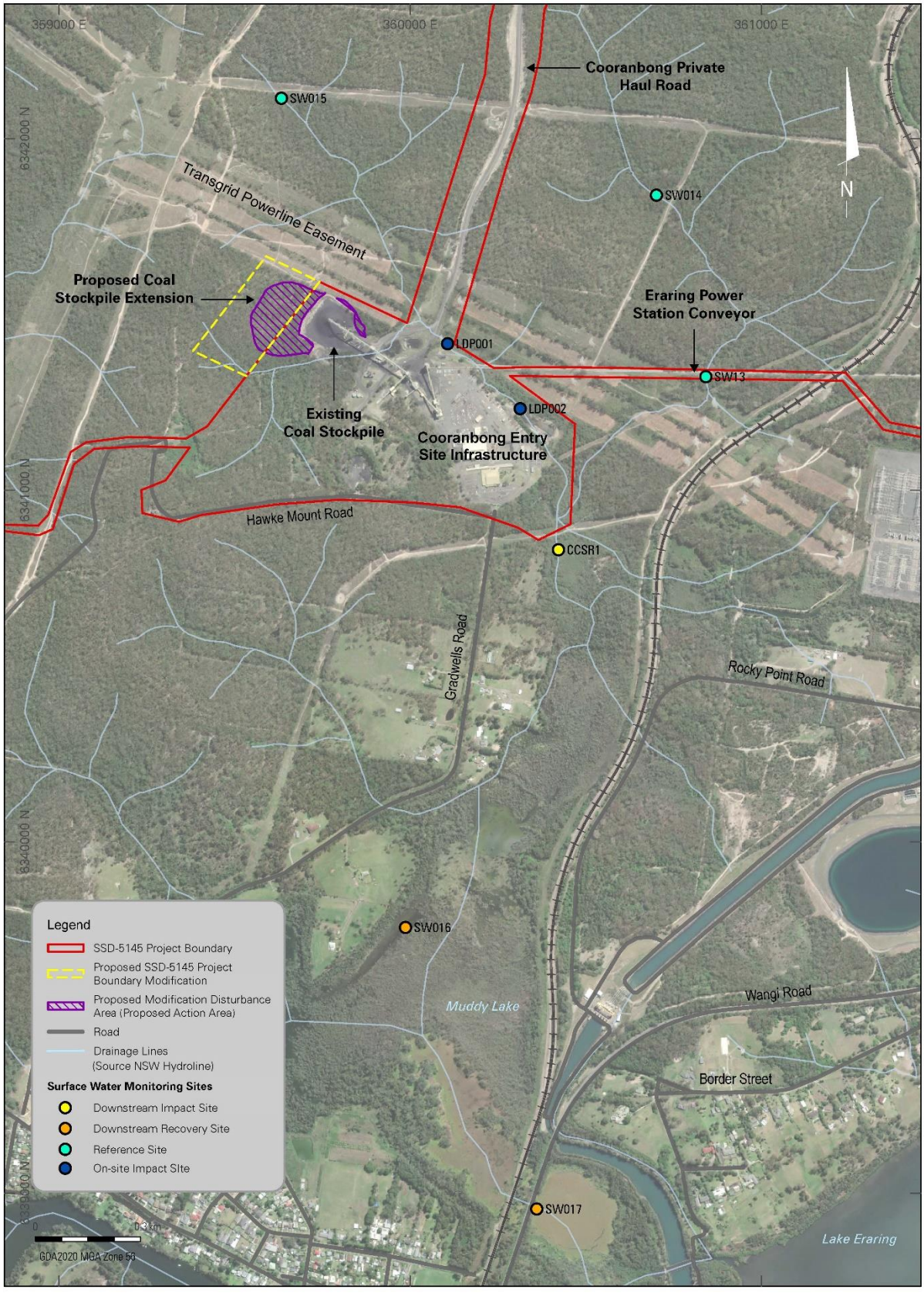

Figure 10). Monthly sampling is conducted at these locations to determine the levels of several different parameters including:

- Physiochemical: electrical conductivity, pH, oil and grease, total suspended solids and turbidity;
- Nutrients: total nitrogen including ammonia;
- Major ions: calcium, chloride, magnesium, potassium, sodium and total alkalinity; and
- Metals (dissolved and totals): aluminium, arsenic, boron, cobalt, cadmium, chromium, iron, lead, manganese, nickel and zinc.

For more detail about this monitoring program, refer to the Water Management Plan (Centennial 2019).

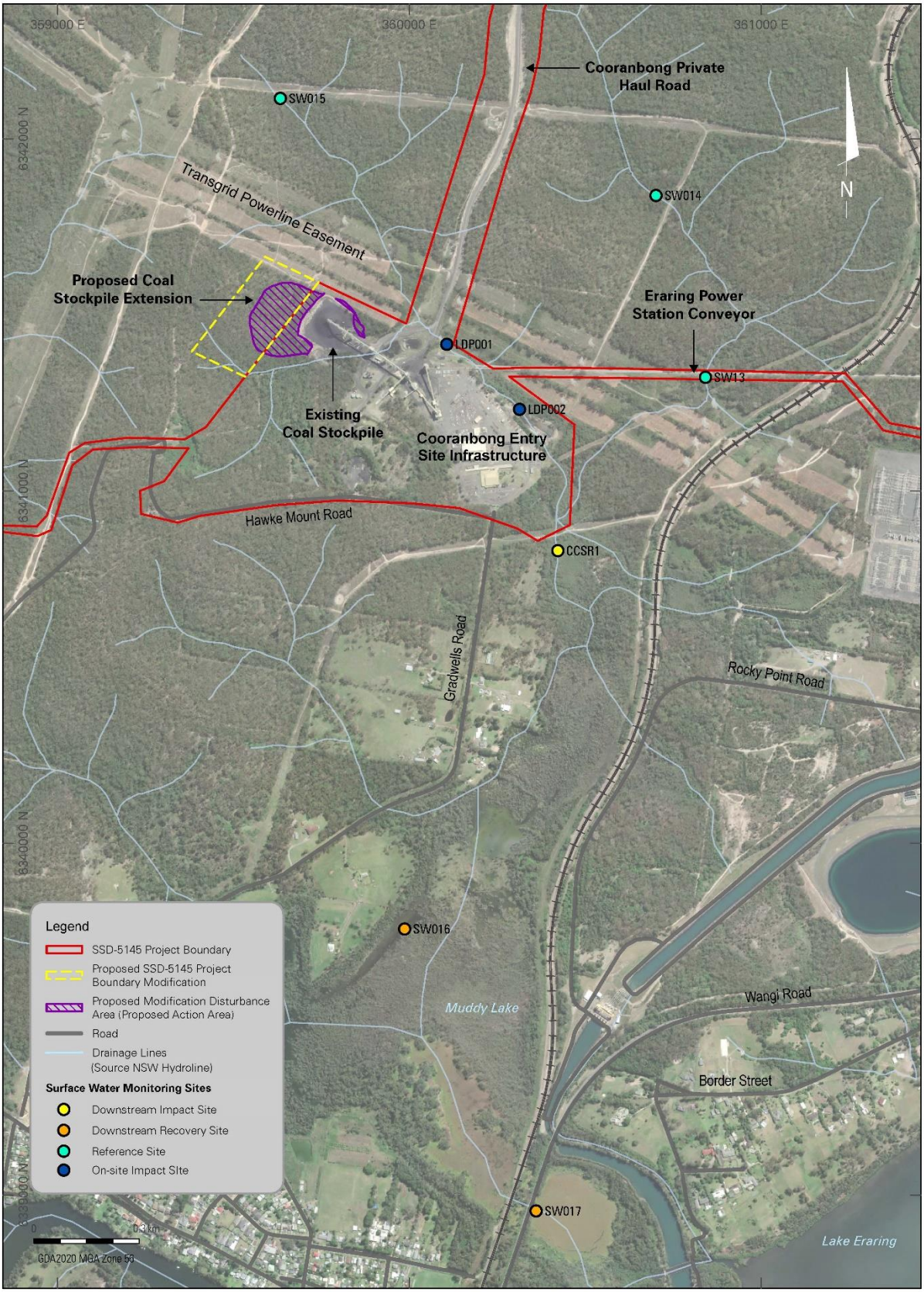

Figure 10. *CES surface water monitoring locations*

5 The Modification – proposed clean water diversion

The Modification is sought to expand the existing CES coal stockpile capacity from 100,000 tonnes to 400,000 tonnes, increasing the total stockpile footprint by approximately three hectares. The modified stockpile will be developed adjacent to existing approved infrastructure at the CES.

As per the existing CES water management system, clean water from the catchments upslope of the Modified stockpile would be diverted (with a diversion channel and bund) around the disturbed areas, to be discharged to the unnamed hydrolines (Centennial 2019) (refer to Figure 11).

Additional dirty water capture requirements associated with the extension of the stockpile would still be directed to the ROM Stockpile Dam as per the existing WMP (Centennial 2019). The ROM Stockpile Dam, which includes a connected drive-in coarse sediment sump, has been designed to capture coarse sediment and coal from the stockpile area. Consistent with the WMP (Centennial 2019), any overflow from the ROM Stockpile Dam is retained within the CES water management system and directed via internal drains to Sediment Dam 1 (see Figure 11). Section 6.2 of this report provides an updated water balance for the extension of the CES stockpile in association with the existing dirty water storages (ROM Stockpile Dam, Sediment Dam 1 and Sediment Dam 2).

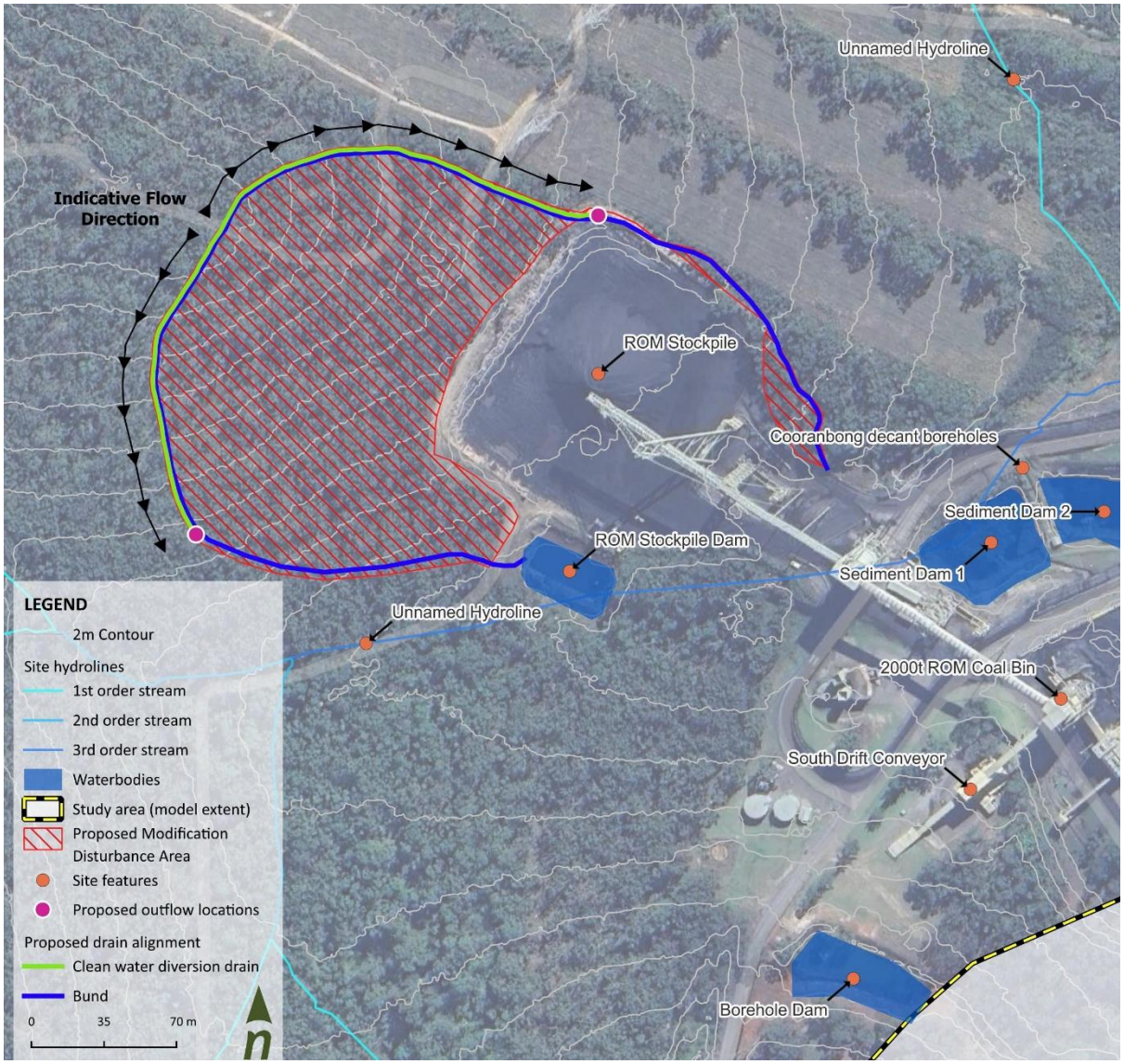

Figure 11. *Conceptual layout of surface water management for the Modification*

6 Impact Assessment

6.1 Potential impacts

Potential surface water impacts associated with the proposed extension of the stockpile at CES may arise in relation to increased runoff, sedimentation and erosion, contamination, altered hydrology and hydraulic behaviour, water quality parameters and ecological impacts.

This impact assessment includes an evaluation of several important aspects of surface water management. Firstly, a site-specific water balance analysis has been undertaken to assess the existing hydrological behaviour and predict the potential changes resulting from the Modification. This analysis includes an assessment of water inputs, outputs and storage dynamics to understand CES water management practices and storages.

A desktop water quality assessment has been completed to evaluate any potential impacts on surface water quality resulting from operational activities associated with the Modification. This assessment considers relevant environmental standards and regulatory requirements to mitigate and minimise adverse effects on water resources.

Additionally, a flooding assessment has been conducted to evaluate the potential impacts on local hydrology and hydraulics. A TUFLOW model consistent with ARR 2019, has been developed from existing information and topography data, to provide a thorough and accurate evaluation of flood impacts and stormwater issues. This modelling provides information for an impact assessment on creeks and consideration of changes to geomorphic conditions that may result from the proposed modification.

6.2 Site water balance

A water balance of the ROM Stockpile Dam has been completed to assess whether the increase in dirty water associated with the increased stockpile area can be accommodated within the existing CES water management system without additional discharges to the environment. A summary of the three dirty water storages associated with the water management of the stockpile is provided in Table 4. The location of these storages is shown on Figure 8.

Table 4. *Summary of relevant dirty water storages for water balance (Centennial 2019)*

Storage	Maximum capacity at outlet level	Function	Treatment	Required capacity	Dewatering and overflow type	Discharge Location
ROM Stockpile Dam	1.9 ML	Capture dirty water and coarse material from stockpile	Settlement	5 day, 95th percentile rainfall depth	Manually operated valve / weir	Sediment Dam 1
Sediment Dam 1	5 ML	Dirty water storage			Decanted to Cooranbong Underground Storage / Weir	Sediment Dam 2
Sediment Dam 2	2.58 ML	Dirty water storage			1. Decanted to Cooranbong Underground Storage 2. Pumped to Sediment Dam 1 3. Emergency Overflow	Cooranbong LDP001 (Via Culvert)

In water balance modelling, percentile scenarios have been used to represent different levels of probability or frequency at which rainfall events occur. These scenarios are derived from a statistical analysis of the historical rainfall data. As shown in Table 5, for this water balance modelling, the three percentile results provided were:

- 10th percentile: Drier than average conditions
- 50th percentile: Average or normal conditions

- 90th percentile: Wetter than average conditions

Modelling these three difference percentile scenarios is important for assessing the range of hydrological responses of the water storages at the CES.

Table 5. *Updated Annual Water Balance for ROM Stockpile Dam*

Years assessed		Annual Volumes (ML) (based on 1900 to 2023 data)					
Scenario		Existing			Proposed		
Percentile result		10th Percentile	50th Percentile	90th Percentile	10th Percentile	50th Percentile	90th Percentile
Inflows (ML/year)	Dust suppression	0.90	0.90	0.90	2.69	2.69	2.70
	Rainfall inflow	0.79	1.06	1.52	0.79	1.06	1.52
	Runoff inflow	3.51	6.75	12.07	11.19	21.23	36.73
Total Inflow (ML/year)		5.22	8.71	14.50	14.69	24.98	40.95
Outflows (ML/year)	Transfer to Sed. Dam 1	4.60	7.50	12.40	11.30	17.50	25.85
	Evaporation	0.52	0.54	0.58	0.55	0.59	0.63
	Overflow	0.00	0.00	0.90	0.22	4.77	13.48
Total outflow (ML/year)		5.12	8.04	13.88	12.07	22.86	39.96
ROM Average Daily Dam Volume (ML/day)		4.60	8.00	13.34	13.90	22.42	37.20
Average # of days with spills each year from ROM Stockpile Dam		1.1 daily spills per year			11.7 daily spills per year		

According to Table 5, the water balance results indicate an increase in the frequency of daily spills from the ROM Stockpile Dam, rising from 1.1 spills annually to 11.7 spills. These spills are directed to Sediment Dam 1 and Sediment Dam 2, as outlined in Table 4 and in the WMP (Centennial 2019). To maintain a controlled storage level, water from Sediment Dam 1 and Sediment Dam 2 will continue to be decanted to the Cooranbong Underground Storage through the Cooranbong decant boreholes. These transfers aim to mitigate the risk of overflow from Sediment Dam 2 to LDP001, during less frequent but larger rainfall events (Centennial 2019) noting that the current EPL 365 discharge volume limit (LDP001) for CES is 5 ML/day and the estimated increase in overflow due to the Modification is 12.58 ML/year. Therefore, it is anticipated that the increased annual flow volumes to the ROM Stockpile Dam resulting from the Modification, are able to be effectively managed within the framework of the current CES site water management system and are unlikely to result in any impacts to the downstream environment.

6.3 Surface water quality

The existing water quality monitoring program at the CES (summarised in Section 4.2), provides a framework for monitoring and managing water quality within and surrounding the site. The proposed stockpile extension of the stockpile is expected to increase the volume of dirty water requiring management within the CES site water management system (refer to Table 5). However, as noted in Section 6.2, the additional volume of water reporting to the site water management system is not anticipated to result in increased discharges to the external environment. The existing CES water management system is capable of effectively accommodating and treating the increase in dirty water runoff through sediment management processes and the transfer of water to the Cooranbong Underground Storage.

Clean water from the external catchment will be diverted around the modified stockpile via a catch drain/channel and discharged to the existing unnamed watercourses (refer to Figure 11). This is consistent with existing conditions prior to the establishment of the modified stockpile and associated diversion infrastructure, where runoff from the catchment flowed to the unnamed watercourses before flowing to Muddy Lake. Therefore, no significant impacts to surface water quality of the nearby water courses are anticipated due to the Modification.

The Modification will increase the CES disturbance area by approximately three hectares. This equates to an approximate two percent reduction in the natural catchment within the study area and a reduction of less than a 0.002% of the overall Lake Macquarie catchment. Therefore, the Modification is unlikely to result in significant water quality impacts.

During development of the modified stockpile, construction work may pose risks of erosion and sedimentation impacts on surface water. However, these risks can be effectively managed through the implementation of sediment control structures outlined in relevant guidelines such as the 'Blue Book' (Landcom 2004) and a robust construction management plan. These measures aim to manage and mitigate the potential for increased pollutant concentrations and sediment in surface water runoff during construction, thereby safeguarding water quality in surrounding waterways.

In conclusion, while the Modification may lead to changes in local surface water behaviour, the existing CES water management system and the implementation of mitigation measures are expected to mitigate and minimise any potential for significant impacts on surface water quality. Centennial will continue the program of surface water monitoring in place for CES to confirm that these measures remain effective during the development and operation of the modified stockpile.

6.4 Hydraulic assessment

TUFLOW model background

An uncalibrated two-dimensional (2D) hydraulic model was built using the TUFLOW software based on current catchment conditions. A Direct Rainfall approach was employed for this study where rainfall is applied to the entire model extent (which covers the local catchment). A direct rainfall modelling approach allows for detailed mapping of small shallow overland flow paths which are typical of small local catchments as seen on this site.

The TUFLOW model adopted a two metre grid cell size which is considered adequate for the purposes of the 2D flood model while also having manageable run times given the number of runs required for this analysis.

Desktop analysis identified the locations of cross drainage structures underneath the Cooranbong Private Haul Road at the CES and under the conveyor belt at the 1200t Coal Bins. No information was available to model the culverts so at both culvert locations, cuts were made through the base topography using TUFLOW Z Shape features. These features were typically created with a width of 1.5 times a grid cell and are designed to simulate the role of a culvert.

A design scenario model was then built using the proposed Modification Disturbance Area (refer to Figure 2), in order to compare the differences to the existing case.

Hydraulic Roughness

Manning's n roughness coefficients were adopted based on mapped land use information as the primary information source, with a visual assessment of the ground cover using satellite imagery used to fill gaps in information. Details of the roughness coefficients are provided in Table 6.

Table 6. *Manning's n roughness coefficients corresponding to land use*

Land use	Mining	Dirt road	Sealed road	Marsh/ wetland	Nature conservation
Manning's n value	0.015	0.025	0.03	0.035	0.08

Initial and continuing losses

The initial and continuing losses were calculated using NSW's hierarchy of approaches for ARR design inputs. Using the NSW Flood Frequency Analysis (FFA) reconciled losses map (ARR 2016) catchment area, initial loss (IL) and continuing loss (CL) values were extracted for selected catchments close to study area. However, these reconciled catchments are much larger (Table 7) than that of the catchment area used for the TUFLOW model (Figure 12). The ARR Data Hub initial loss values were also extracted for study area (IL of 28mm and CL or 1.6mm/hr). The IL and CL values of the reconciled catchments are much larger than the ARR Data Hub loss values. Therefore, the ARR Data Hub loss values were chosen as they are more conservative.

Table 7. *NSW FFA reconciled initial and continuing loss catchment data around site area.*

Gauge	IL (mm)	CL (mm/hr)	Catchment Area (km^2)	Quality code
Avondale - 211008 (H29)	3.9	12.19	66	FFA
Yarramalong - 211012 (H25)	18.2	5	181	Good
U/S Wyong R (Durren La) - 211010 (H27)	1.5	14.3	94	FFA
Gracemere - 211009 (H28)	50	3.92	238	Good
U/S Weir - 211013 (H26)	64.3	4.81	90	Good
AVERAGE ("good" quality only)	**44.17**	**4.58**		

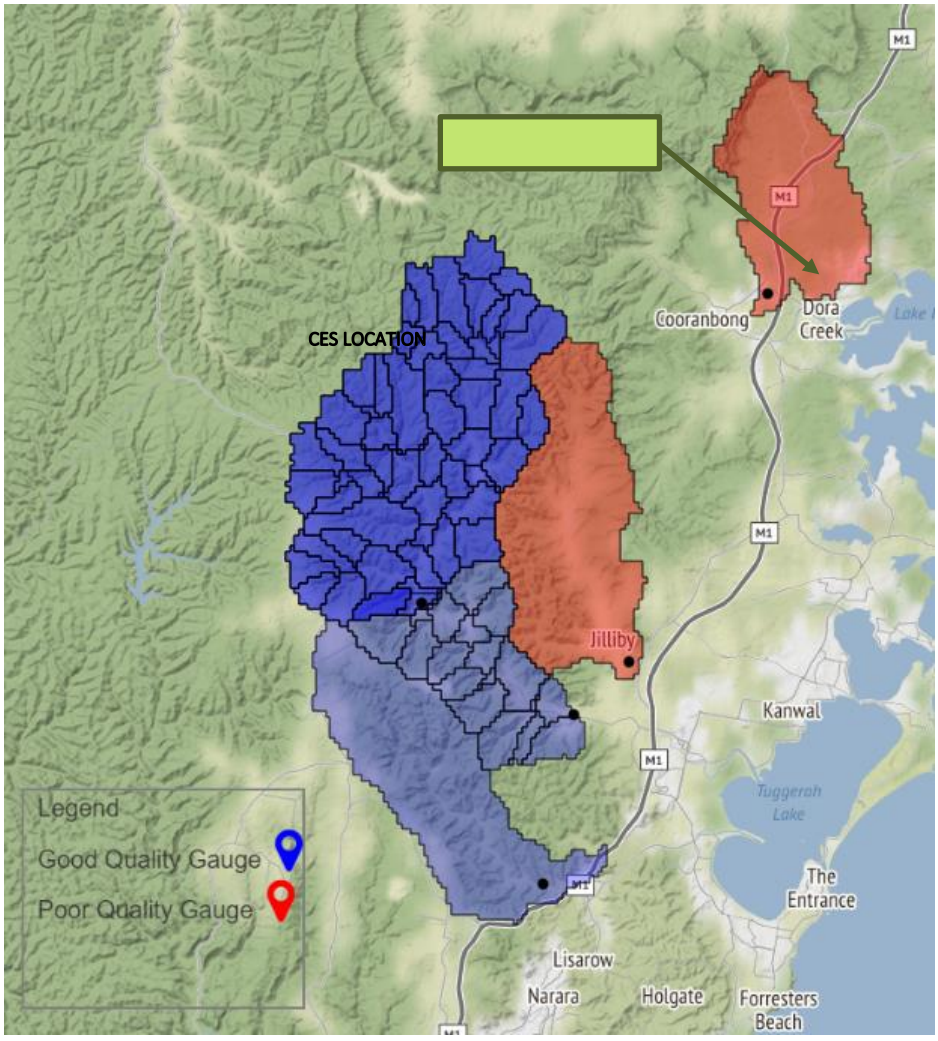

Figure 12. *Screenshot of interactive FFA reconciled losses map at site area*

Key model assumptions

- The critical durations/rainfall events were determined to be the; 5% Annual Exceedance Probability (AEP) 10min Temporal Pattern 07 and 5% AEP 15min Temporal Pattern 06;
- A maximum envelope of the two critical duration/rainfall was used and is presented in the flood modelling results;
- A 1-metre bund adjacent to a 0.5-metre-deep drain was modelled to simulate the provided cross-sections of the diversion drains around the modified stockpile. Given the 2-metre TUFLOW model cell size, this level of detail is considered acceptable for this stage; and
- Previous design stages informed the initial flow estimates.

Results

The peak flow rates for the proposed diversion drains around modified stockpile are documented in Table 8. These channels have small catchments and therefore the estimated flow is also less than 0.1 cubic metres per second.

The results from the simulations have been analysed to understand the impact the modified stockpile extent would have on flooding and surface water behaviour in the surrounding area. Figure 13 shows the proposed flood depths, while Figure 14 and Figure 15 show the modelled change in peak flood levels and velocity, respectively, between pre and post-modification scenarios. This was prepared by subtracting the peak "existing" flood results from peak "post-modification" flood results. The difference mapping shows the magnitude and location of changes in flood results, where a negative result represents a reduced peak flood level or velocity.

Overall, these results indicate that minimal change in flood behaviour within local catchments would result from the Modification. Therefore, it is reasonable to assume that the diversion channel dimensions adopted are sufficient.

Additionally, to mitigate and minimise potential impacts, it is recommended that drainage controls for the modified stockpile should incorporate level spreaders at the proposed outflow locations (refer to Figure 13). These level spreaders would facilitate controlled discharges into the nearby hydrolines, enhancing efficient water management and reducing erosion risks.

Table 8. *Clean water diversion flow due to the modified stockpile*

Location	Estimated flow(m^3/s)
South-West Channel	0.06
North-East Channel	0.08

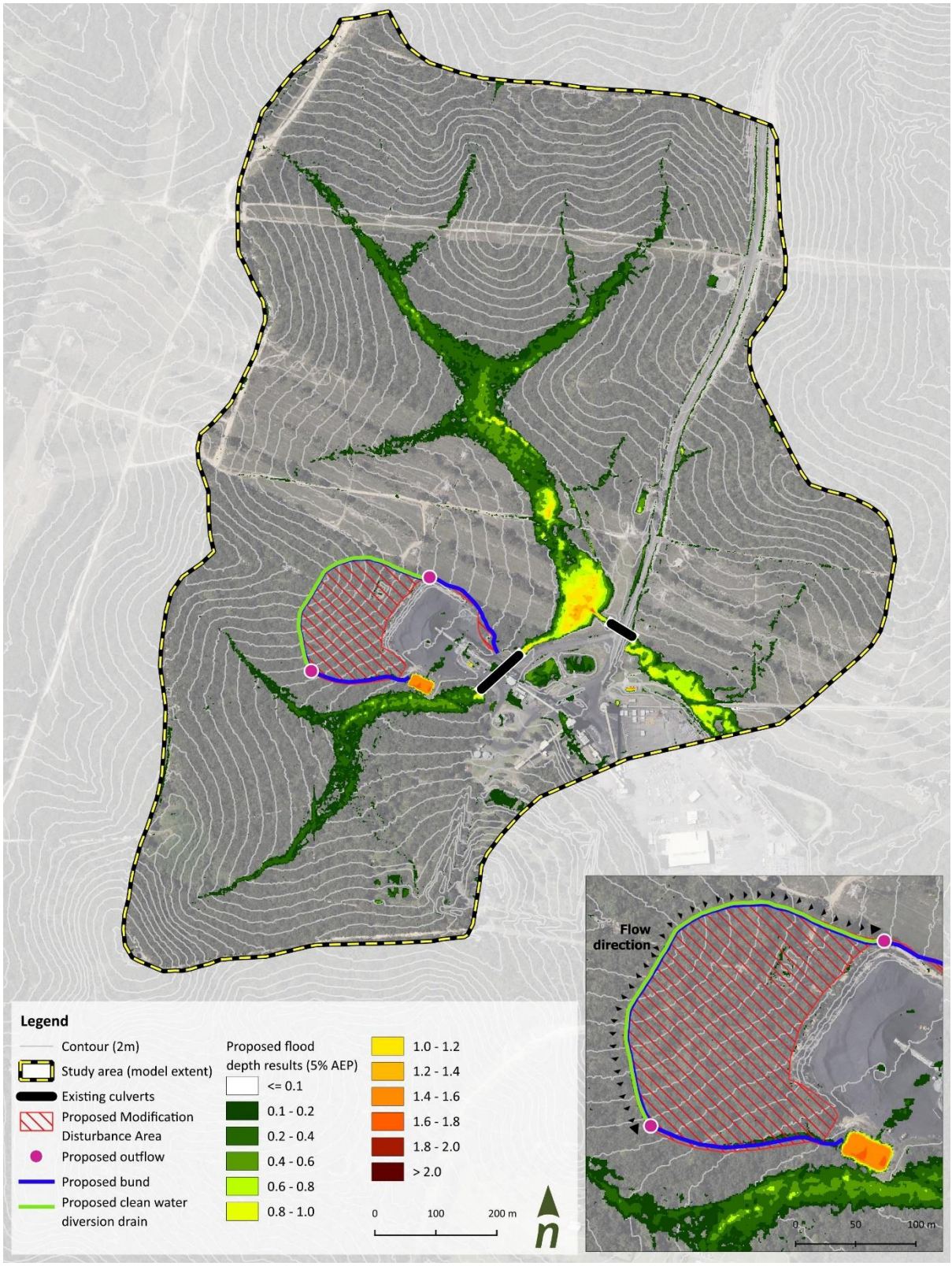

Figure 13. *Flood model results – proposed depths (5% AEP maximum envelope)*

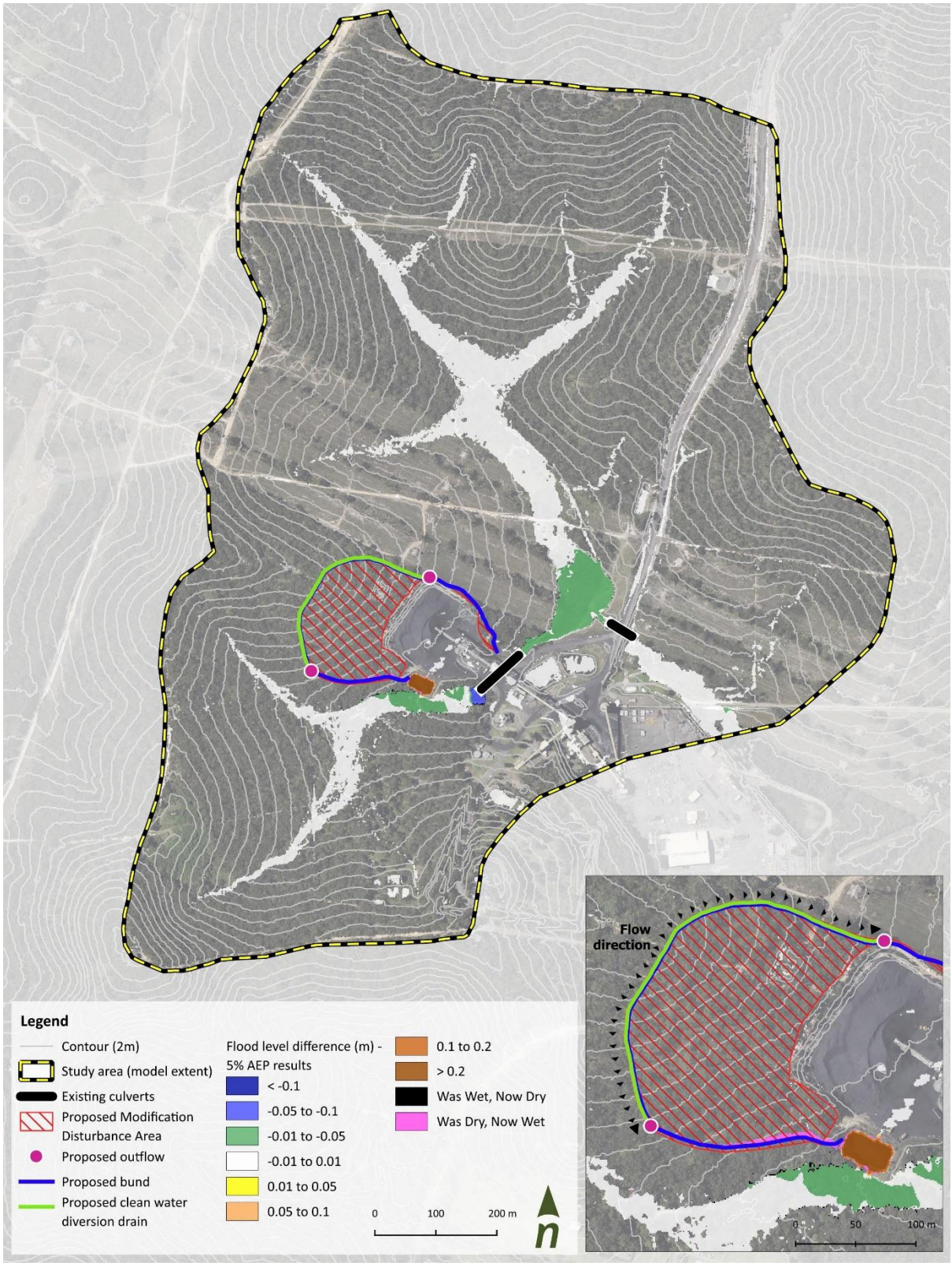

Figure 14. *Flood model results – change in flood levels (5% AEP results)*

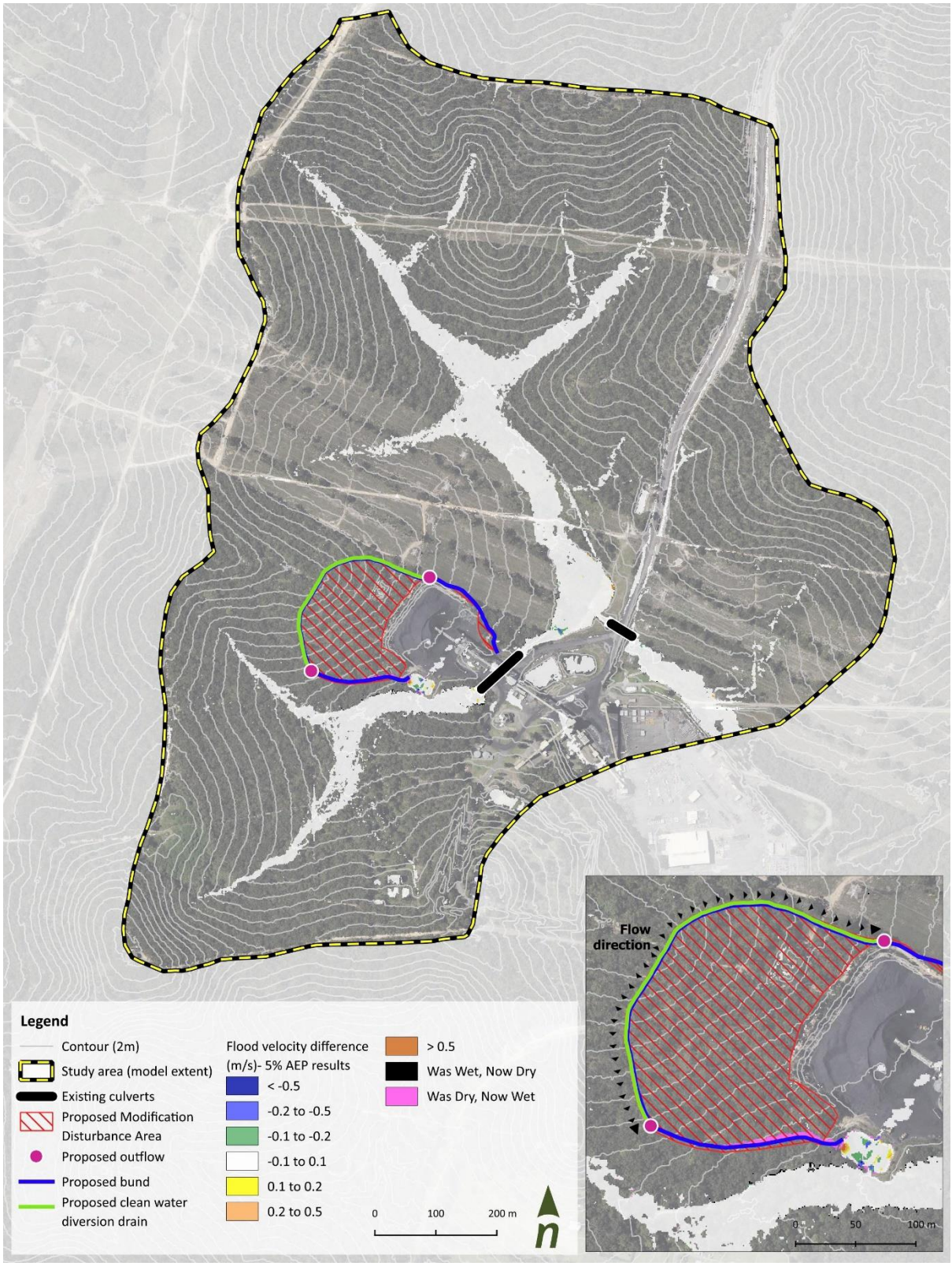

Figure 15. *Flood model results – change in flood velocity (5% AEP results)*

7 Mitigation and management measures

It is recommended that Centennial continue to implement current surface water management and monitoring programs for the CES. Additional dirty runoff generated from the ROM Stockpile Dam as a result of the Modification should be contained and treated through the existing surface water management system as detailed in the WMP (Centennial 2019).

The impact assessment indicates that current management measures will need to accommodate the increased dirty runoff from the modified stockpile footprint. It is recommended that the WMP is updated to reflect the modified stockpile.

To further mitigate potential impacts on surface water, the continued implementation of effective management practices such as erosion and sediment control measures, proper containment and treatment of runoff, along with ongoing monitoring of water quality parameters and adherence to regulatory guidelines, is essential.

During construction, erosion and sedimentation should be effectively managed with erosion and sediment control structures as outlined in relevant guidelines such as the 'Blue Book' (Landcom 2004) and incorporated into a site-specific construction environmental management plan.

The proposed diversion drain has been adequately sized to minimise changes in local flood behaviour within the catchment and successfully diverts clean runoff around the modified stockpile. Additionally, to mitigate and minimise potential impacts, it is recommended that level spreaders are developed for the diversion drain, including at proposed outflow locations. These level spreaders will regulate controlled clean water discharges into nearby hydrolines, improving water management efficiency and reducing erosion risks effectively.

8 Summary of Findings

The activities proposed for the Modification generally align with relevant environmental regulations and existing NCS approvals relating to surface water management.

This surface water impact assessment confirms that the Modification may lead to an increase dirty water runoff volumes and sedimentation within the CES water management system. However, it is anticipated that the existing water management system will effectively mitigate and manage these potential impacts. This conclusion is supported by the updated water balance assessment. The flood modelling also suggests that the development of the modified stockpile and associated clean water diversion drains will result in minimal change to local flood behaviour.

It is recommended that Centennial continue the surface water monitoring and implement erosion control measures during both the construction and operational phases of the Modification to minimise and manage potential surface water impacts. The ongoing implementation of water quality and flow monitoring as part of the WMP will confirm that the proposed mitigation measures are effectively managing potential surface water impacts associated with the Modification.

It is also recommended that the WMP (Centennial 2019) is updated to reflect the changes to the site water management system associated with the extended stockpile, should the Modification be approved.

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