Australasian Groundwater and
Environmental Consultants Pty Ltd

Report on

Integra Underground Mine LW17-LW20 Extraction Plan Groundwater Assessment

Prepared for
HV Coking Coal Pty Ltd

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Report on

Integra Underground Mine – LW17 - LW20 Extraction Plan Groundwater Assessment

1 Introduction

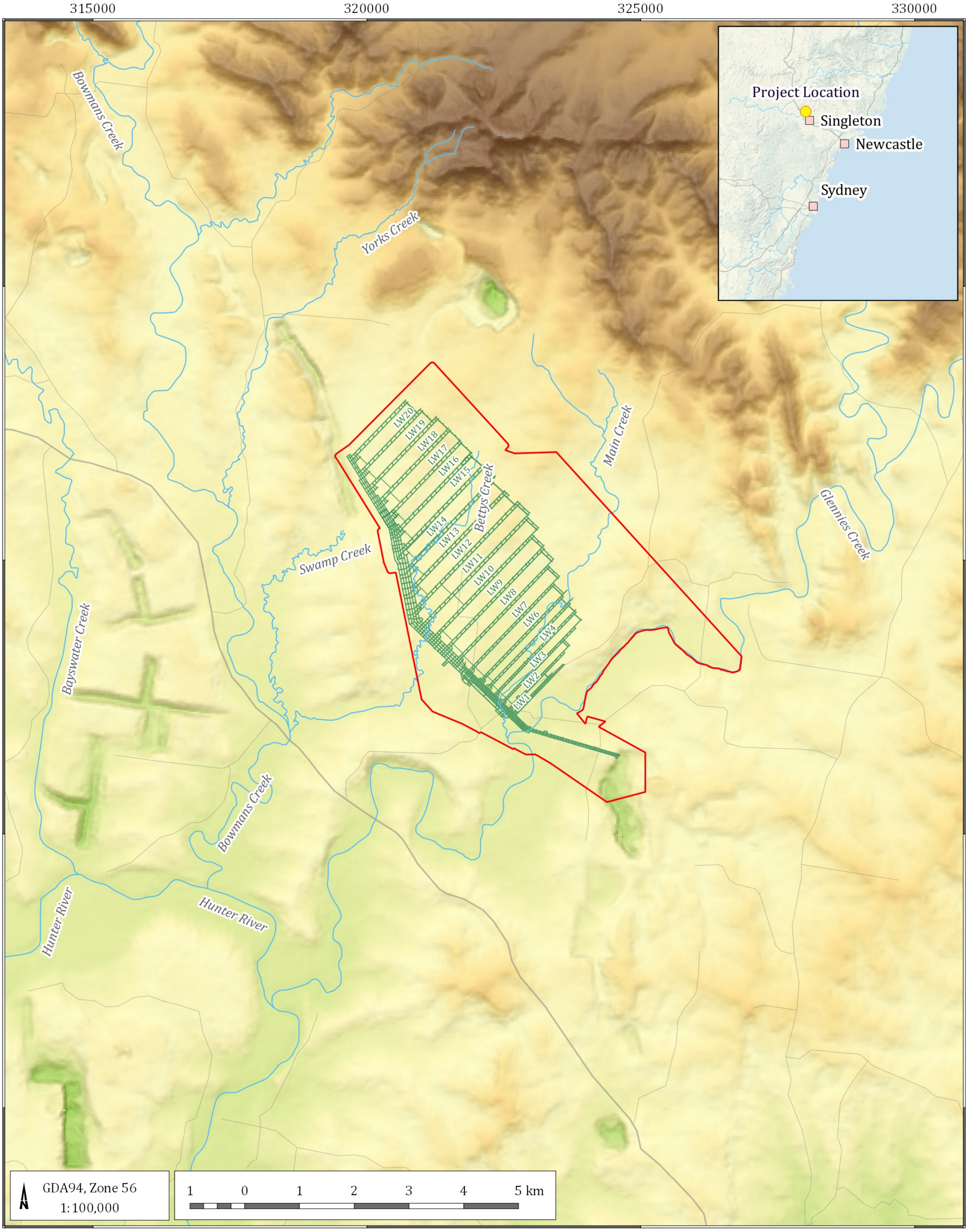
HV Coking Coal Pty Ltd (HVCC) (a 100% Glencore-owned Company) operate the Glencore Integra Underground Mine (IUG), which is located approximately 12 km north-west of Singleton, in the Singleton Local Government Area of NSW (Figure 1.1).

HVCC are in the process of preparing an extraction plan for LW17 - LW20, as approved in Modification 8 (MOD8) of Project Approval 08_0101. As part of this process, HVCC require a groundwater assessment on the proposed subsidence assessment that can be used to inform their Extraction Plan, and subsequent management plans. To achieve this, Glencore engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to assess the impacts of the extraction plan of LW17 - LW20 on the groundwater environment and confirm that they are consistent with the impacts described in Project Approval 08_0101 and water licence allocations held by operation.

1.1 Scope of work

The objective of this assessment is to review the predictions for groundwater impact from proposed extraction of LW17 - LW20 to the satisfaction of the NSW government departments. To this end, the scope of work comprises:

- review and reporting of current conceptualisation (after AGE, 2017);
- review the potential impacts specifically related to the mining of LW17 - LW20 on groundwater levels (in the alluvium and fractured rock aquifers), groundwater quality, stream baseflow, groundwater dependent ecosystems (GDEs) and other groundwater users;
- review drawdown at the completion of LW20, on top of any cumulative impacts from proceeding or adjacent mining;
- review the estimated groundwater inflow to LW17 - LW20, volume of water loss from the alluvial aquifer and from baseflow in creek and river systems over the life of LW17 - LW20;
- review the uncertainty analysis, previously undertaken, on the key parameters affecting the model; and
- review of monitoring, mitigation and management strategies in MOD8 Groundwater Assessment to confirm these are still suitable.



LEGEND

- Drainage
- Road
- Integra underground workings
- Approved Project boundary
- Underground mine area – Middle Liddell

Integra Groundwater Subsidence Assessment (G1285H)

Site location (as per 2019 mine plan)

AGE

DATE 04/06/2020

FIGURE No: **1.1**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
N:\Groundwater Jobs\G1285H.Integra_LW17_LW20_groundwater_subsidence_assessment\3_GIS\Workspaces\001_G1285H_LW17_LW20_Extraction_plan\01.01_G1285H_Project_location.qgs

1.2 Regulatory framework

The Project Approval 08_0101 considered the following NSW government legislation, policies and guidelines for groundwater:

- Water Management Act 2000 and the Water Sharing Plans (WSP) for:
  - the Hunter Regulated River Water Source 2016;
  - the Hunter Unregulated and Alluvial Water Sources 2009; and
  - North Coast Fractured and Porous Rock Groundwater Sources 2016.
- Groundwater Quality Protection Policy (1998);
- Groundwater Dependent Ecosystems Policy (2002);
- Groundwater Quantity Management Policy (1998); and
- Aquifer Interference Policy (2012).

1.3 Water licensing

HVCC currently holds groundwater licences to dewater, from the underground workings, up to 950 megalitres per year (ML/year). The groundwater take comprises groundwater ingress to the underground mining areas, under the Water Sharing Plan (WSP) for the North Coast Fractured and Porous Rock Groundwater Sources – Sydney Basin as summarised in Table 1.1 below.

Table 1.1 Water licensing - North Coast Fractured and Porous Rock WSP

Licence No.	Units	Abstraction purpose
WAL41562	450 units total	dewatering of groundwater
		dewatering of groundwater
WAL41563	500 units total	dewatering of groundwater
		dewatering of groundwater

Notes: [1] Allocation previously held under Water Licence Numbers 20BL169862 and 20BL169864

[2] Allocation previously held under Water Licence Numbers 20BL172505 and 20BL172506

HVCC monitor the volume of groundwater pumped from the underground mine with flow meters. Figure 1.2 below shows the volume of water pumped from the underground mine during the care and maintenance period from HVCC records. The volume of water pumped generally averages 0.8 ML/day, which is equivalent to 292 ML/year. As no water was being pumped underground for mining purposes during this time, the measurements provide a good estimate of the volume of groundwater inflow into the underground mine.

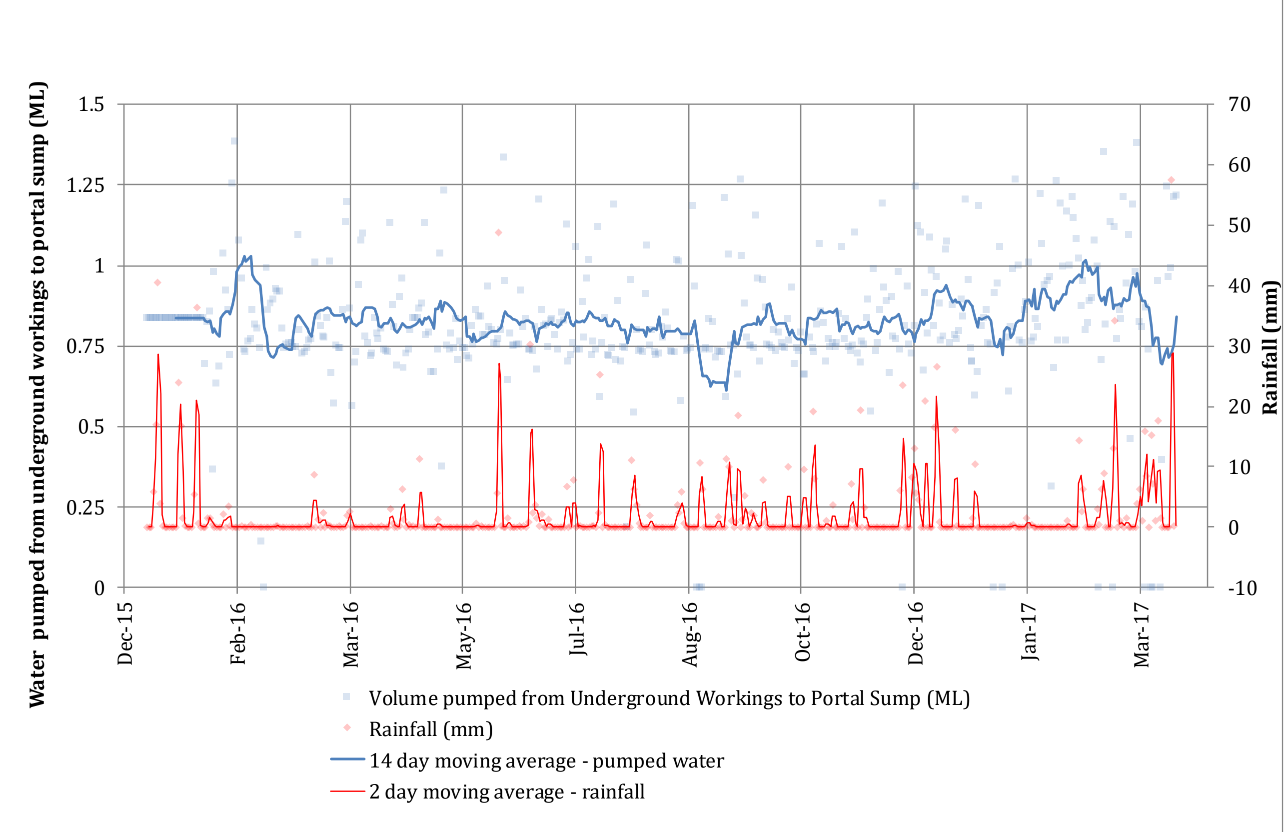


Figure 1.2 Rate of water pumped from IUG Middle Liddell seam workings

HVCC also hold licences to abstract up to 206 ML/year of high security water and 402 ML of general security water and 13 ML of Supplementary Water from Glennies Creek under the Hunter Regulated WSP (Table 1.2).

Table 1.2 Water licensing - Hunter Regulated River WSP

Licence No.	Units[1]	Location
WAL 484	3	High security (Glennies Creek)
WAL 485	99	General security (Glennies Creek)
WAL 960	50	High security (Zone 3A Glennies Creek)
WAL 961	150	High security (Zone 3A Glennies Creek)
WAL 1172	3	High security (Zone 3A Glennies Creek)
WAL 1173	303	General security (Zone 3A Glennies Creek)
WAL 1242	13	Supplementary Water (Zone 3A Glennies Creek)

[1] One units equals 1 ML/year

2 Regional geology

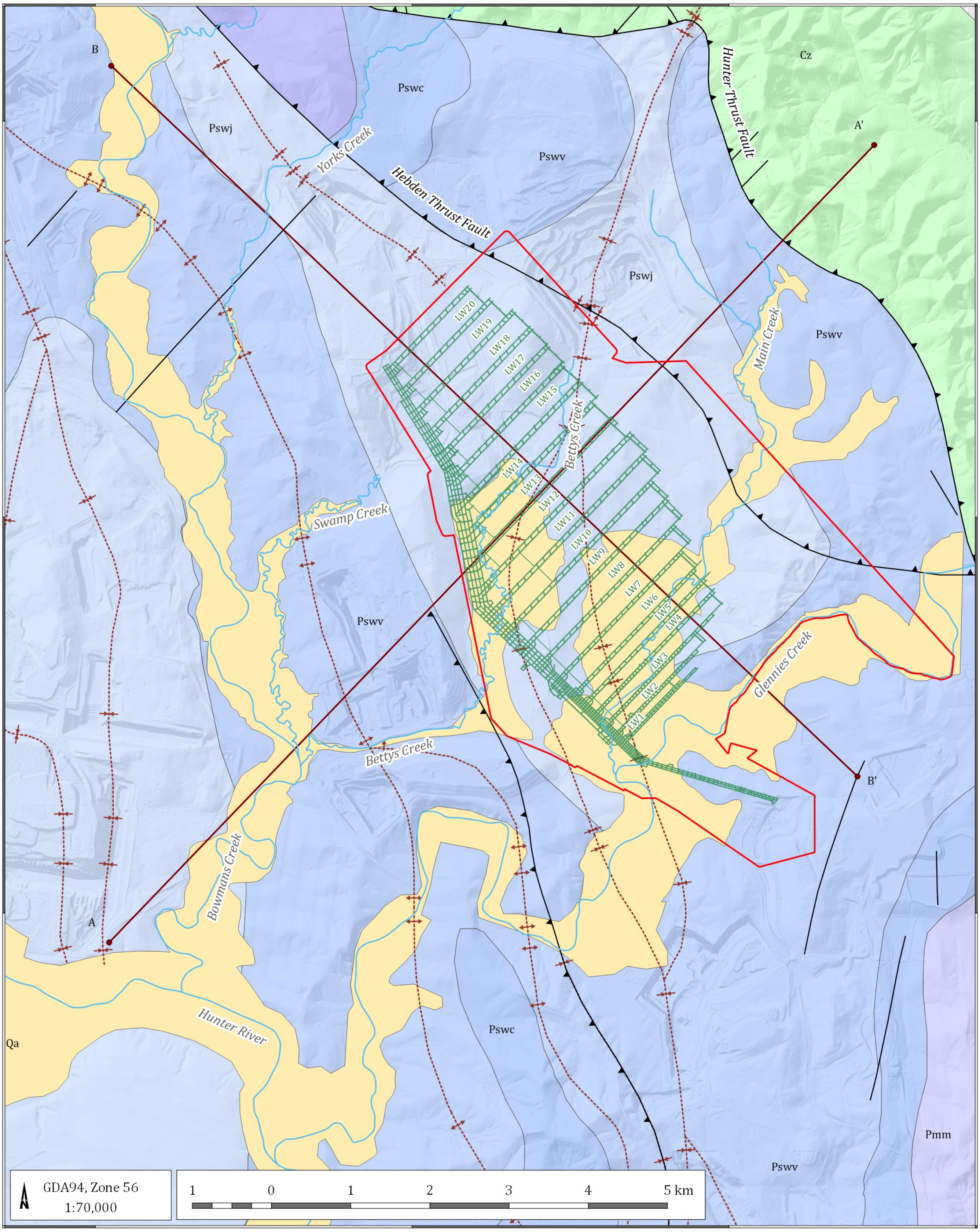
IUG is located within the Hunter Coalfield, towards the north-eastern margins of the Permian and Triassic Sydney Basin. A detailed analysis of the regional geology nearby to IUG is provided in the groundwater assessment for MOD8 (AGE, 2017).

Table 2.1 provides a summary of the regional geology and relevant stratigraphic units within IUG and surrounds.

Figure 2.1 shows the regional surface geology across the site and surrounds, based on the Hunter Coalfield Regional 1:100,000 scale geological map (Glen & Beckett, 1993). It should be noted that mining has removed Quaternary alluvium within and adjacent to IUG along Bettys Creek (which has since been diverted) since the geology map was prepared in 1993.

Table 2.1 Summary of regional geology

Age	Stratigraphic unit			Description
Quaternary	Quaternary sediments – alluvium (Qa)			Clay, silt, and sand overlying basal clayey sands and gravels in places.
Late Permian	Wittingham Coal Measures	Jerrys Plains Subgroup (Pswj)		Coal seams interbedded with claystone, tuff, siltstone, sandstone, and conglomerate.
		Vane Subgroup (Pswv)	Archerfield Sandstone	Bronze-coloured, well-sorted quartz lithic sandstone
			Foybrook Formation	Coal bearing sequences with wedges of sandstone and siltstone. Includes the economic coal seams for IUG
		Saltwater Creek Formation (Pswc)		Sandstone and siltstone, minor coaly bands, siltstone towards base.
Middle Permian	Maitland Group	Mulbring Siltstone (Pmm)		Fine-grained offshore sediments: siltstone, claystone, minor fine sandstone.
		Muree Sandstone (Pms)		Fine to coarse sandstone, conglomerate, and minor clay
		Branxton Formation (Pmb)		Conglomerate, sandstone, and siltstone



LEGEND

- Drainage
- Section lines
- Thrust fault
- Fault
- Synclines
- Anticlines
- Approved Project boundary
- Underground mine area – Middle Liddell

Geology (Hunter Coalfield 1:100k)

- Pswj - Jerrys Plains Subgroup
- Pswv - Archerfield Ss., Vane Subgroup
- Pswc - Saltwater Creek Formation
- Pmm - Mulbring Siltstone
- Pmb - Braxton Formation
- Cz - Carboniferous tuff and ignimbrite

Integra Groundwater Subsidence Assessment (G1285H)

Regional surface geology

DATE 26/06/2020

FIGURE No: **2.1**

Source: Glen R.A. and Beckett J., 1993, Hunter Coalfield Regional Geology 1:100 000, 2nd edition. Geological Survey of New South Wales, Sydney;
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3 Conceptual model

This section briefly describes the conceptual hydrogeological model in the vicinity of IUG and provides a reference to model predictions and groundwater impacts discussed later in the document. The processes that control and influence the storage and movement of groundwater in the hydrogeological systems in vicinity to IUG and the broader region are described in detail in the Groundwater Impact Assessment (GIA), submitted as part of the Environmental Assessment (EA) for MOD8 (AGE, 2017). The current conceptualisation of the groundwater system remains unchanged from that presented in MOD8. Figure 3.1 and Figure 3.2 provide conceptual geological cross-sections showing the relative distribution of key stratigraphic units across IUG.

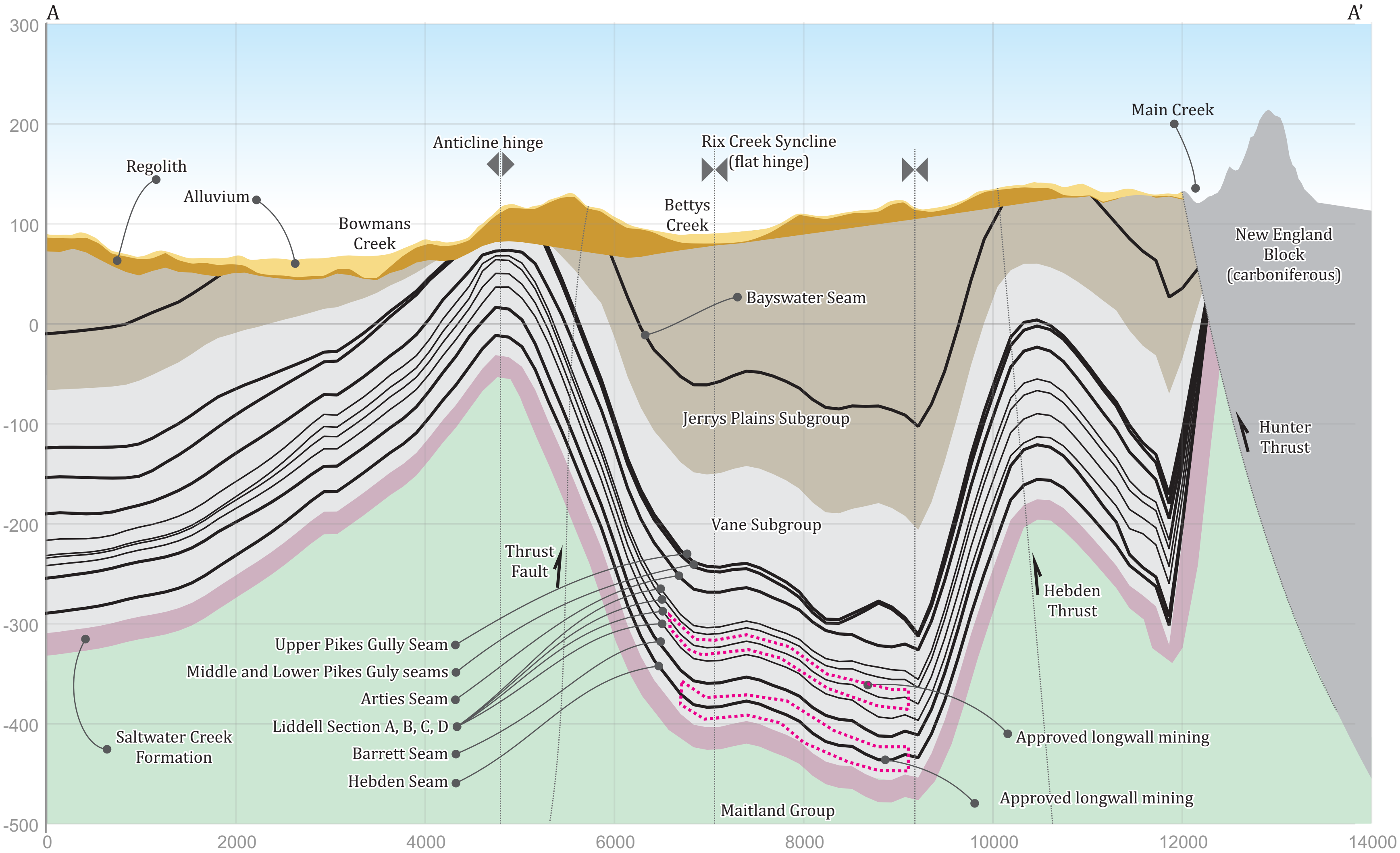
Depressurisation of the Permian strata below the level of the alluvial aquifers is evident in the monitoring bore network, indicating a reduced flow of Permian groundwater towards the Quaternary alluvium. Groundwater impacts as drawdown are discussed further in Section 5.3.

The Main Creek and Bettys Creek alluvium appear to have not been historically exploited for groundwater extraction due to the yield and salinity limiting productivity. The available data indicates these systems do not meet NSW government criteria to be classified as a "highly productive" groundwater source, which requires Total Dissolved Solids (TDS) concentrations less than 1500 mg/L and contain water supply works that can yield water at a rate greater than 5 L/s. Potential impacts on water quality as a result of LW17 – LW20 extraction are discussed further in Section 5.4.

The location of mapped GDEs and potential impacts on GDEs due to LW17 – LW20 dewatering is discussed further in Section 5.5.

The alluvial sediments along Glennies Creek have historically been tapped for agricultural purposes using shallow wells. Whilst this practice has decreased with the growth of mining in the region, a single well remains active within the Glennies Creek alluvium to the east of the IUG on Glennies Creek. There is no recorded abstraction of groundwater from the Permian strata for agricultural or other uses, due to yield and salinity limiting productivity. Potential impacts on existing groundwater users due to LW17 – LW20 dewatering is discussed further in Section 5.6.

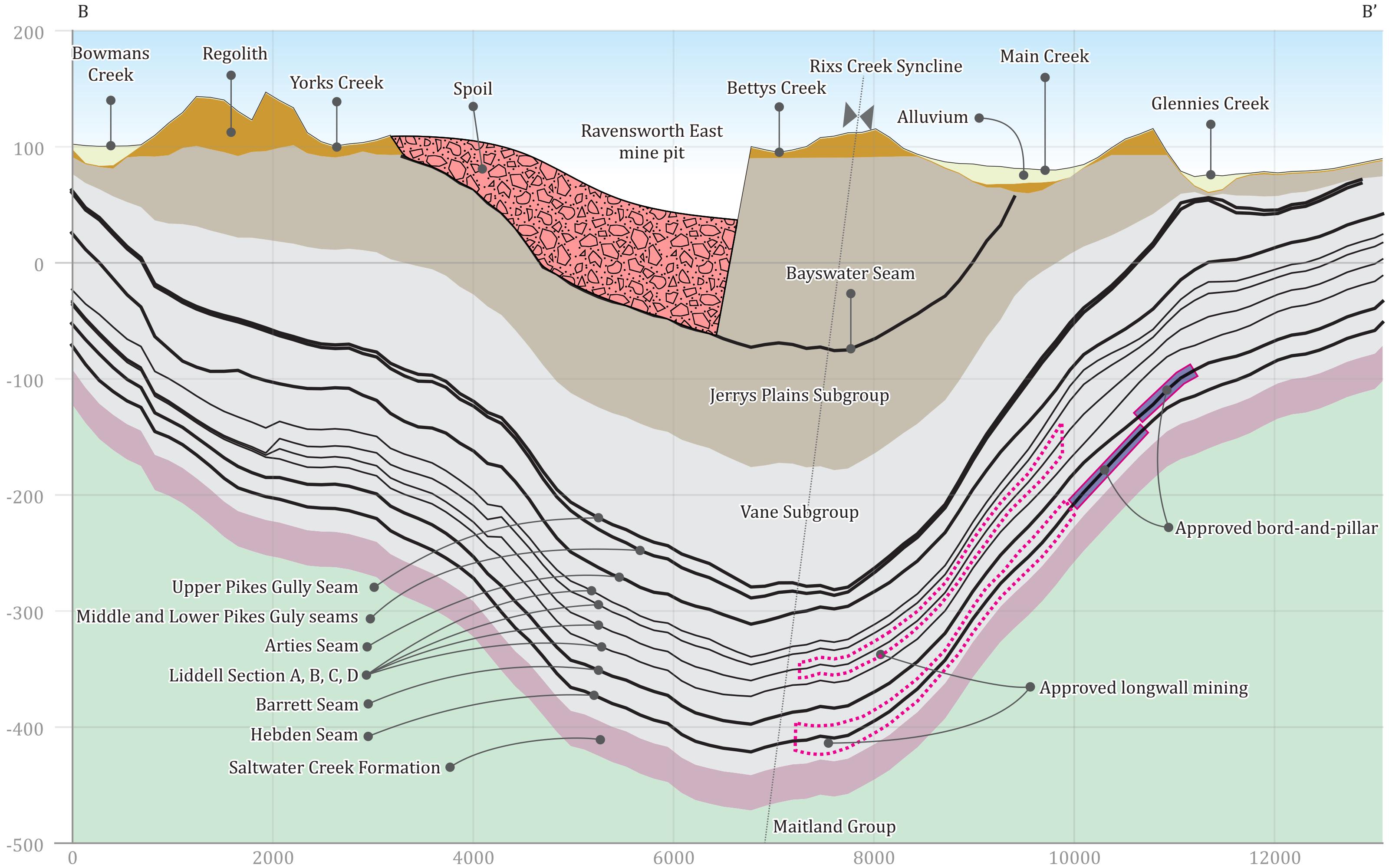
A series of thrust faults occur to the east of the IUG, with a large fault defining the eastern limit of IUG (refer Figure 2.1). Whilst the potential to transmit groundwater through the faults has not been established, it is expected to be relatively limited given the limited cross-sectional area of the fault zone and the potential for the fault gouge sediment to retard groundwater flow. When groundwater levels are compared at monitoring points either side of the fault there is a notable difference, suggesting limited connectivity and supporting the concept that the faults retard groundwater flow across the fault plane, rather than enhancing flow.



Conceptualised south-west - north-east geological cross-section

Figure 3.1

Integra LW17+ Groundwater Subsidence Assessment (G1285H)



Conceptualised north-west - south-east geological cross-section

Figure 3.2

Integra LW17+ Groundwater Subsidence Assessment (G1285H)

4 Numerical model

In order to address the scope of works outlined in Section 1.1, the following tasks were completed:

- updating the groundwater flow model with LW17 – LW20 removed;
- running the model to simulate both the approved Middle Liddell mining and a modelling run without LW17 – LW20; and
- processing the model results to provide estimates for:
    - groundwater inflow to the LW17 – LW20 longwall panels over time;
    - indirect 'water take' from the overlying water sources from the LW17 – LW20 panels; and
    - groundwater drawdown in the overlying alluvial aquifer from the LW17 – LW20 panels.

4.1 Background and model set up

The numerical groundwater flow model for the IUG was developed for MOD8 and is described by AGE (2017). An update of the model was undertaken in January 2019, removing the Middle Liddell first workings and realigning the Hebden Longwalls.

The model represents the main geological formations through 21 individual model layers (Table 4.1). Separate layers are included within the model to represent the Quaternary alluvial, interburden units and coal seams mined at IUG, which include the Middle Liddell, Barrett and Hebden seams. The basal layer in the model is the sandstone-dominated Saltwater Creek Formation, on which the overlying Vane subgroup of the Wittingham Coal Measures rests. The model provides estimates of groundwater inflow to the underground workings, drawdown in overlying Quaternary alluvium aquifers and indirect take of water from regulated water sources.

The model considers all cumulative impacts from neighbouring mines within the model domain. The surrounding mines included approved and foreseeable operations at IUG, Rixs Creek North, Mount Owen Mine, Ravensworth East, Glendell Mine, Ravensworth Operations, Liddell Mine, Ashton Underground, and Hunter Valley Operations (HVO) North mine. The simulation of mining at these sites using the AGE 2017 model was based on the 2014 version of the numerical model which was updated for IUG and mines within the Mount Owen Complex that are proposing to modify approved mining operations.

Table 4.1 Numerical model layers

Geological age	Stratigraphic unit		Description	Model layer
Quaternary	Alluvium (Qa)		alluvial deposits surrounding the major rivers	1
Permian (Wittingham Coal Measures)	Alluvium (Qa)/Regolith		basal alluvial sediments surrounding the rivers and regolith (weathered rock) elsewhere	2
	Overburden		strata between the base of weathering and the top of the Bayswater seam - can include seams, but mostly sandstone, claystone and/or siltstone	3
	Jerrys Plains sub-group	Bayswater seam	all the Bayswater Seams plys including the upper Bayswater 1, upper Bayswater 2 and Lower Bayswater at Liddell - also includes interburden between these seams	4
	Vane Sub-group	interburden	strata between the base of the Bayswater seam and the top of the Upper Pikes Gully seam (includes Lemington Seam)	5
		interburden	strata between the base of the Bayswater seam and the top of the Upper Pikes Gully seam including Lemington seam	6
		Upper Pikes Gully seam	Upper Pikes Gully seam plys	7
		interburden	strata between the base of the upper Pikes Gully seam and the top of the middle Pikes Gully Seam	8
		Middle and lower Pikes Gully seam	strata between the top of the middle Pikes Gully seam and the base of the lower Pikes Gully seam including interburden between the two seams	9
		interburden	strata between the base of the lower Pikes Gully seam and the top of the Arties seam	10
		Arties seam	all Arties seams plys including the Arties A, Arties B, Arties L1 and Arties L2 at Liddell	11
		interburden	strata between the base of the Arties seam and the top of the Liddell seam	12

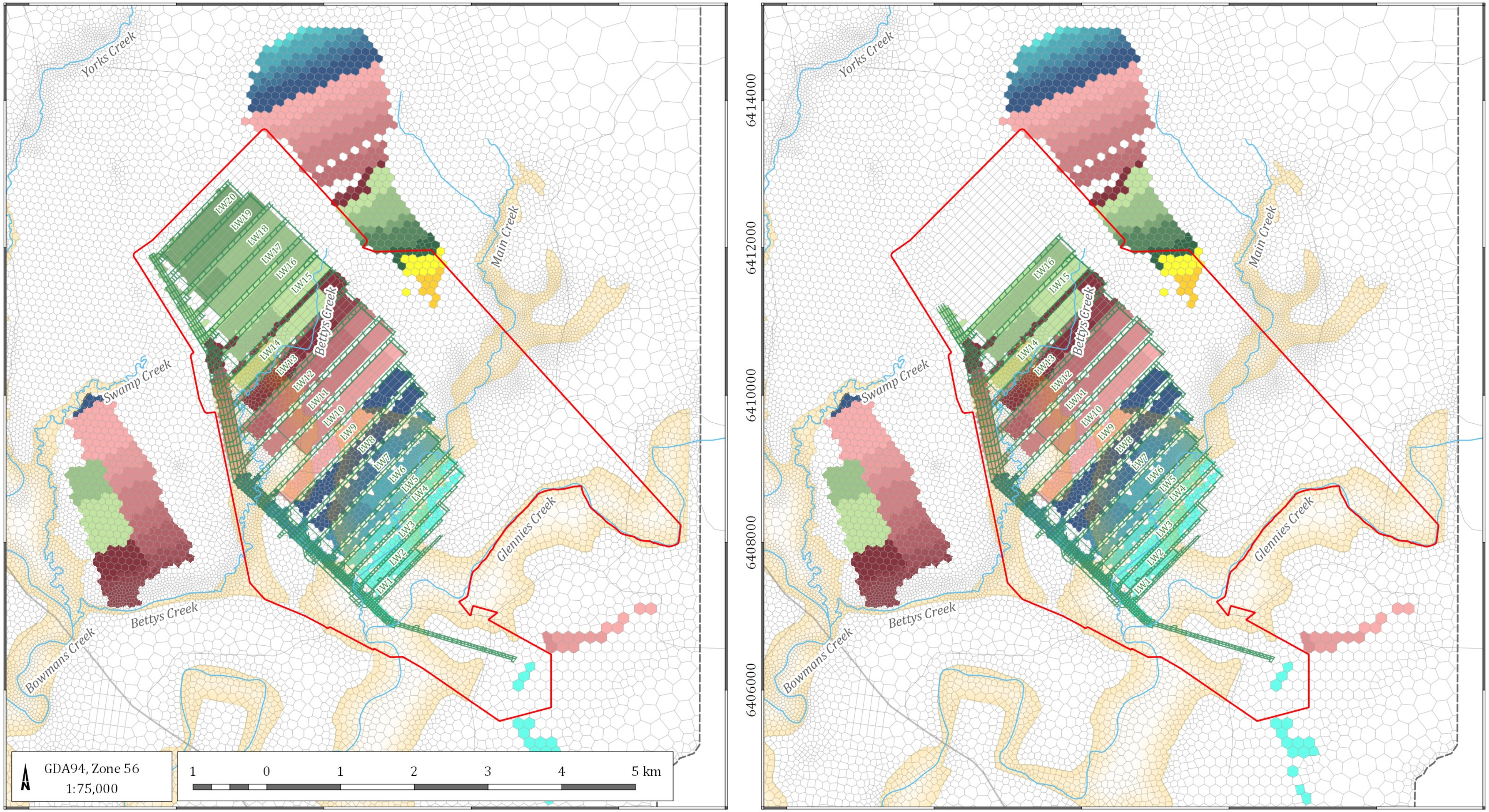
Geological age	Stratigraphic unit		Description	Model layer
		Liddell seam Sections A & B	all Liddell seam plys in Sections A and B including Liddell A1, Liddell Parting, Liddell B1, upper Liddell B2 and lower Liddell B2 at Liddell - also includes interburden between seam plys	13 & 14
		Liddell seam Section C	all Liddell seam plys in Section C including upper Liddell C1, lower Liddell C1 at Liddell, and interburden between seams	15
		Liddell seam Section D	all the Liddell seams plys in Section D including upper Liddell D1, lower Liddell D1 at Liddell, and interburden between the two seams	16
		interburden	all strata between the base of the Liddell seam Section D and the top of the Barrett Seam	17
		Barrett seam	all the Barrett seams plys including the Barrett A, upper Barrett B, middle Barrett B, lower Barrett B, Barrett C1, Barrett C2 and Barrett D at Liddell, and interburden between seams	18
		interburden	all strata between the base of the Barrett Seam and the top of the Hebden Seam	19
		Hebden seam	all the Hebden seam plys, including upper Hebden and lower Hebden at Liddell and interburden between seams	20
	Saltwater Creek Formation		upper section of the Saltwater Creek Formation	21

4.2 Mine progression

The sequence of mining in the model was adjusted to incrementally assess the effects LW17 to LW20 have on the groundwater system. Figure 4.1 compares the sequence of approved mining within the Middle Liddell seam for MOD8 (based on the current Glencore approval with 257 m wide panels) to the mine plan used to inform the extraction model (i.e. with LW17 - LW20 removed). Table 4.2 shows the mine schedule for all mined longwall panels at IUG (LW17 - LW20 are shown in bold text). In order to ascertain the impact that longwall panels 17 - 20 have in relation to the entire groundwater model, this 'incrementally updated model' essentially subtracts all the Middle Liddell LW panels (i.e. the left-hand window in Figure 4.1) from all other Middle Liddell LW panels excepting LW17 - LW20 (i.e. the right-hand window in Figure 4.1).

Approved mining – all Middle Liddell LW panels

Approved mining – LW17+ panels removed



LEGEND

- Drainage
- Road
- Approved Project boundary
- Underground mine area – Middle Liddell
- Alluvium extent
- Model boundary

Mine progression (Year)

1980, 1984, 1989, 1994, 2000, 2002, 2003, 2005, 2006, 2007, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034, 2036, 2038, 2040, 2042, 2043, 2045

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Approved mining – Middle Liddell seam – LW panel model inputs

DATE
26/06/2020

FIGURE No:
4.1

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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Table 4.2 Integra mine schedule (as at April 2020)

Seam	Longwall panel	Start date	End date	Duration (months)
Middle Liddell	LW5	Jan-2000	Jul-2000	6
	LW4	Jul-2000	Jan-2001	6
	LW1	Jan-2001	Jan-2002	12
	LW2	Jan-2002	Mar-2003	14
	LW3	Mar-2003	Sep-2004	18
	LW12	Sep-2004	Nov-2005	14
	LW6	Nov-2005	Nov-2007	24
	LW7	Nov-2007	Nov-2008	12
	LW8	Nov-2008	Apr-2010	17
	LW9	Apr-2010	Nov-2011	19
	LW10	Nov-2011	Mar-2013	16
	LW11	Mar-2013	Jun-2014	15
	LW13	Mar-2017	Jan-2018	11
	LW14	Mar-2018	Aug-2018	10
	LW15	Sep-2019	Apr-2020	9
	LW16	Jun-2020	Dec-2020	8
	LW17	Qtr1-2021	Qtr3-2021	8
	LW18	Qtr3-2021	Qtr1-2022	8
	LW19	Qtr2-2022	Qtr4-2022	7
	LW20	Qtr4-2022	Qtr2-2023	7
Hebden	HLW1	Sep-2023	Sep-2024	13
	HLW2	Sep-2024	Jul-2025	9
	HLW3	Jul-2025	May-2026	10
	HLW4	May-2026	Apr-2027	11
	HLW5	Apr-2027	Apr-2028	12
	HLW6	Apr-2028	Apr-2029	12
	HLW7	Apr-2029	Apr-2030	12
	HLW8	Apr-2030	May-2031	13
	HLW9	May-2031	Apr-2032	11
	HLW10	Apr-2032	Mar-2033	11
	HLW11	Mar-2033	Dec-2033	9
	HLW12	Dec-2033	Sep-2034	9
	HLW13	Sep-2034	Jul-2035	10
	HLW14	Jul-2035	Oct-2035	3
	HLW15	Oct-2035	Dec-2035	3
	HBP24	Jan-2030	Oct-2030	9
	HBP22	Oct-2030	Jun-2031	8
	HBP23	Jun-2031	Oct-2033	28
	HBP26	Oct-2034	Dec-2035	14
Barrett	BLW1	Mar-2035	Nov-2035	8

4.3 Representation of fracturing

SCT revised their prediction of fracture height underneath the Mount Owen rail loop area (under LW20) from 240 m to 280 m on 15 May 2020. The AGE groundwater model predicts a maximum fracture height of approximately 240 m above the coal horizon at this location, and whilst this is potentially 40 m lower than the maximum height predicted by SCT, a heightened fracture horizon is unlikely to have any significant impact to groundwater inflows or surficial impacts. This is partly because the *"base of the open cut void is approximately 170 m above the top of the zone of* (280 m) *depressurisation"* (SCT, 2020). It should also be noted that the wider longwall panels simulated in MOD8 resulted in a fracture height of 275 m above the coal horizon along LW20, producing similar inflows and surficial impacts.

5 Model predictions and groundwater impacts – LW17 - LW20

5.1 Direct inflow to mining areas

Figure 5.1 shows the total predicted flux of groundwater to the drain cells within the model for the approved mine plan. This represents the water directly intercepted from the Permian coal measures as seepage to the active longwall mining areas. The figure shows the volume of Permian water entering the Middle Liddell seam workings gradually rises as the footprint of mining increases to a peak of 778ML/year in 2028.

The model simulates increases to hydraulic conductivity above longwall panels as per the GIA (AGE, 2017) report. Increases to hydraulic conductivity are represented using an assumed connective fracture network, simulated using 'stacked drains' which simulate the connected system and drain the rock unit. The assumed height of fracturing and intensity of connective fracturing are a function of overburden thickness, panel width, and host hydraulic conductivity. The values pertaining to these systems are automatically recalculated given the new panel layout.

The peak inflows attributed to LW17 – LW20 progression peak at 97 ML/year in 2023, representing mining in LW20. The timing of inflow predictions is based on the provided mine plan submitted as part of MOD8 and are subject to change depending on scheduling and mine planning variations. All volumes of groundwater inflow to these panels after 2023 can be considered residual groundwater inflow to the recovering disturbed strata, as in reality this water will not be actively dewatered.

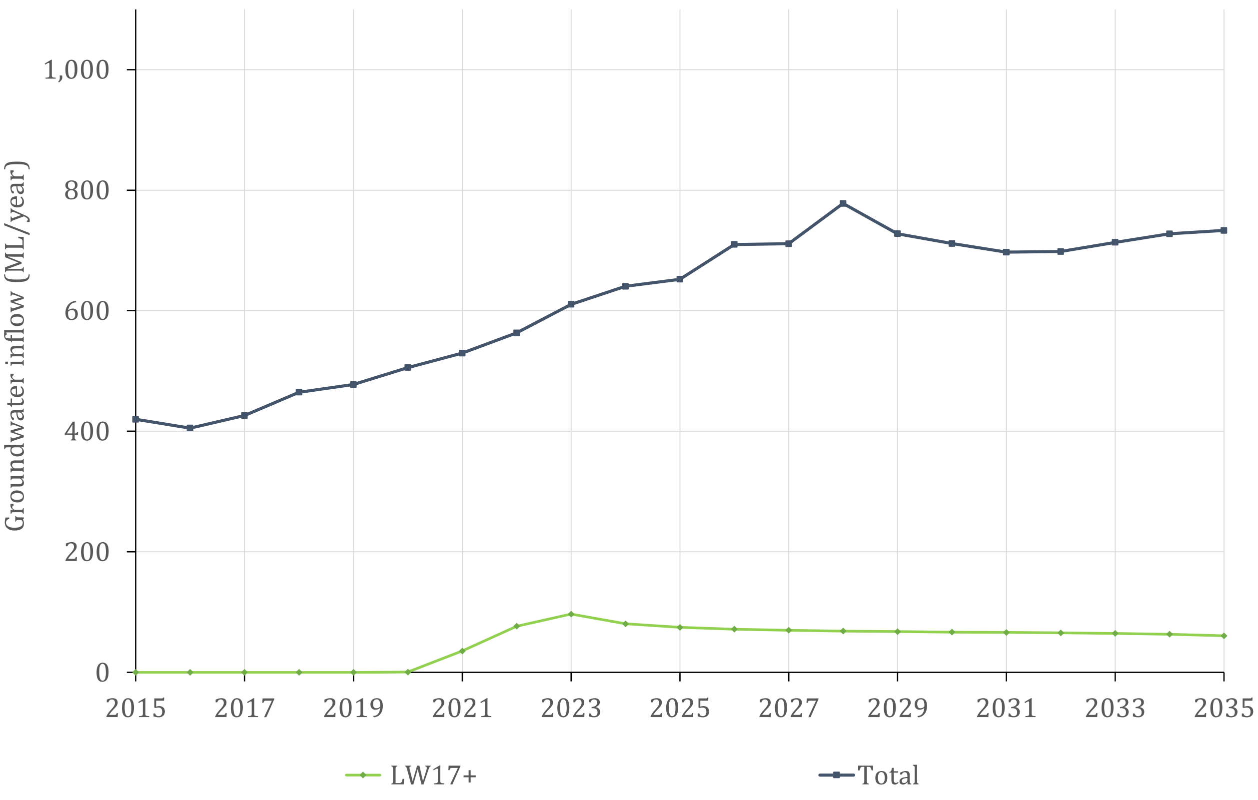


Figure 5.1 Groundwater inflow to mining areas

5.2 Indirect impact on alluvial systems

The model also provides information on the potential for mining to interfere with the overlying alluvial groundwater systems and to provide estimates of indirect 'water take'. Longwall mining and associated fracturing will not directly intercept alluvial aquifers; however, an indirect impact or 'water take' occurs as the Permian strata become depressurised and the volume of groundwater flowing from the Permian to the Quaternary alluvium progressively reduces. Whilst this alluvial groundwater does not necessarily enter the mine workings, the volume of groundwater entering the alluvial groundwater systems is reduced by lower pressures within the Permian due to mining, and this has been considered water take that needs to be accounted for with water licences according to the NSW Aquifer Interference Policy (AIP, 2012).

The AIP requires the accounting for all groundwater take, either directly or indirectly, from groundwater systems. Groundwater intercepted from the mining area is considered a direct take from the Permian groundwater system, whilst the changes in fluxes occurring within the Quaternary alluvium and rivers resulting from depressurisation of the underlying Permian is considered an indirect take.

The water take is calculated for each water source defined under NSW Water Sharing Plans (WSPs). Three WSP's apply to the aquifers and surface waters at IUG:

- Hunter Regulated River Water Source 2016 (Hunter Regulated WSP);
- Hunter Unregulated and Alluvial Water Sources 2009 (Hunter Unregulated WSP); and
- Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016 (North Coast Fractured and Porous Rock WSP).

The Hunter Unregulated WSP is divided into water sources that are largely based on catchment boundaries. IUG falls within the Jerrys Water Source and Glennies Creek Water Source. The Glennies Creek alluvium is within the Hunter Regulated River alluvial water source and is also regulated under the Hunter Unregulated WSP. Figure 5.2 shows the water sources within the vicinity of IUG.

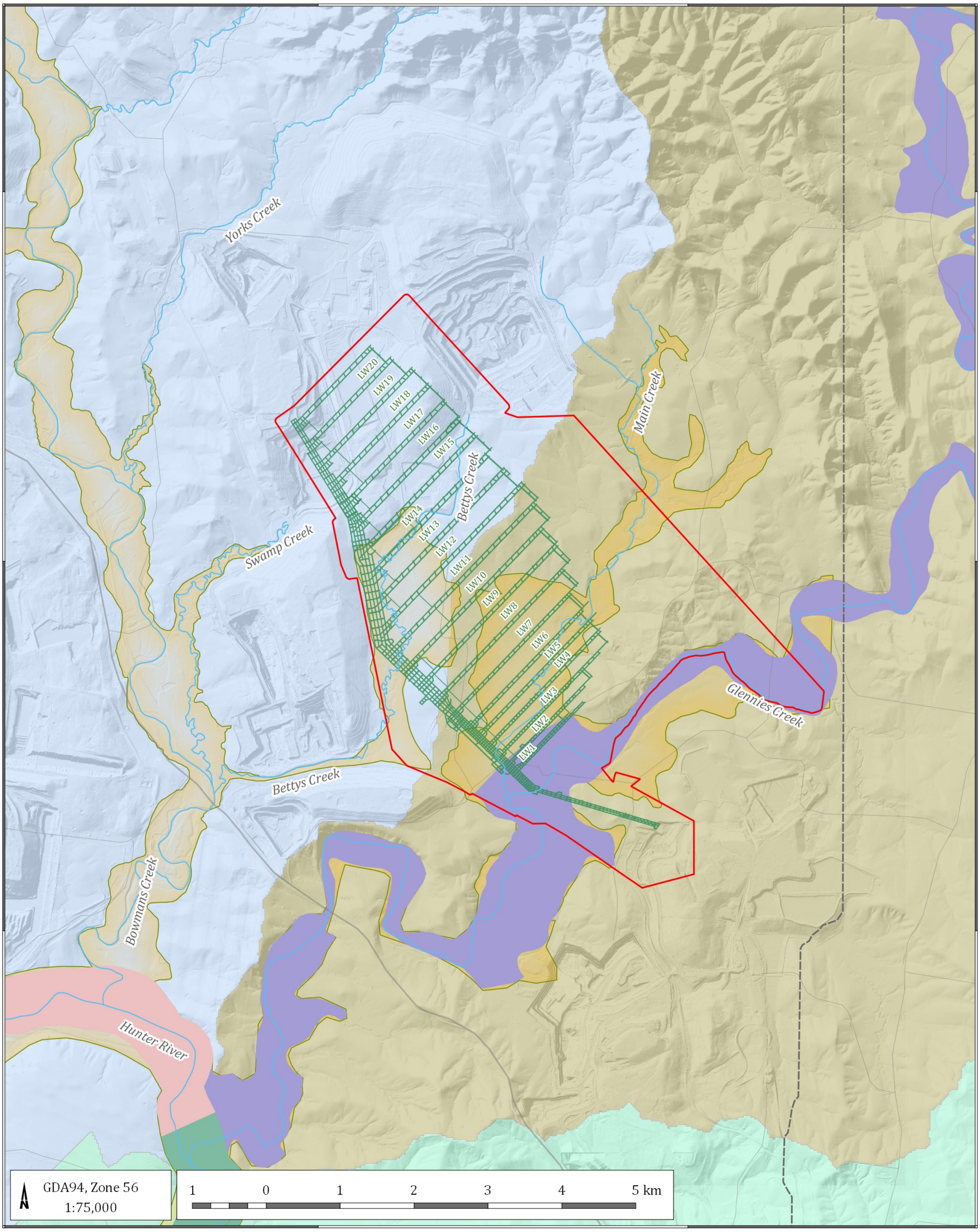
The change in flows to the water sources was determined by comparing versions of the numerical model that contained all approved mining at IUG with a modelled scenario that included all approved mining with the exception of LW17 – LW20. Table 5.1 present the predicted change in flux to each water source for the approved mining (MOD8) and the approved extraction of Middle Liddell LW17 - LW20 panels alone. The tables show that the extraction of LW17 - LW20 has a negligible impact on the alluvium and that any indirect water take has already occurred prior to LW17 - LW20 extraction.

Glencore hold a large volume of entitlements from the Hunter Regulated WSP (2097 units), which will readily account for 'water take' predicted from Glennies Creek baseflow which is within Management Zone 3A. Entitlements from the Jerrys Water Source, Glennies Water Source and the Hunter Regulated River Alluvial Water Source are required to account for the peak 'water take' from these water sources. As LW17 - LW20 impose only negligible water take (i.e. < 1 ML/yr) on the relevant alluvial aquifers nearby to IUG, no further water entitlements are required, and the current allocation is sufficient to cover extraction of these panels.

This water take is consistent with the approved impacts and total water allocations, being considered negligible at <1 ML/yr.

Table 5.1 'Water take' from each water source – MOD8 and LW17+

Water sharing plan	Water source/ management zone	Type	Peak volume requiring licensing during mining (ML/year)		
			Approved mining (MOD8)	April 2020 mine plan	LW17+ only
North Coast Fractured and Porous Rock WSP	Sydney Basin – North Coast	groundwater	840	778	97
Hunter Unregulated WSP	Jerrys	groundwater	1	1	<1
		surface water	1	1	0
	Glennies	groundwater	4	4	0
		surface water	1	1	0
	Hunter Regulated River alluvium	groundwater	36	34	0
Hunter Regulated WSP	Management Zone 3A - Glennies Creek + Station Creek surface water	surface water	21	20	0



LEGEND

- Drainage
- Roads
- Approved project boundary
- Underground mine area – Middle Liddell
- Alluvium extent
- Model boundary

Groundwater management area

- Downstream Glennies Creek Management Zone
- Glennies Creek Management Zone
- Upstream Glennies Creek Management Zone

Water Source

- Glennies Water Source
- Jerrys Water Source
- Singleton Water Source

Integra Groundwater Subsidence Assessment (G1285H)

Hunter Unregulated WSP water sources

DATE 26/06/2020

FIGURE No: **5.2**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
N:\Groundwater Jobs\G1285H.Integra_LW17_LW20_groundwater_subsidence_assessment\3_GIS\Workspaces\001_G1285H_LW17_LW20_Extraction_plan\05.02_G1285H_Hunter Unregulated WSP water sources.qgs

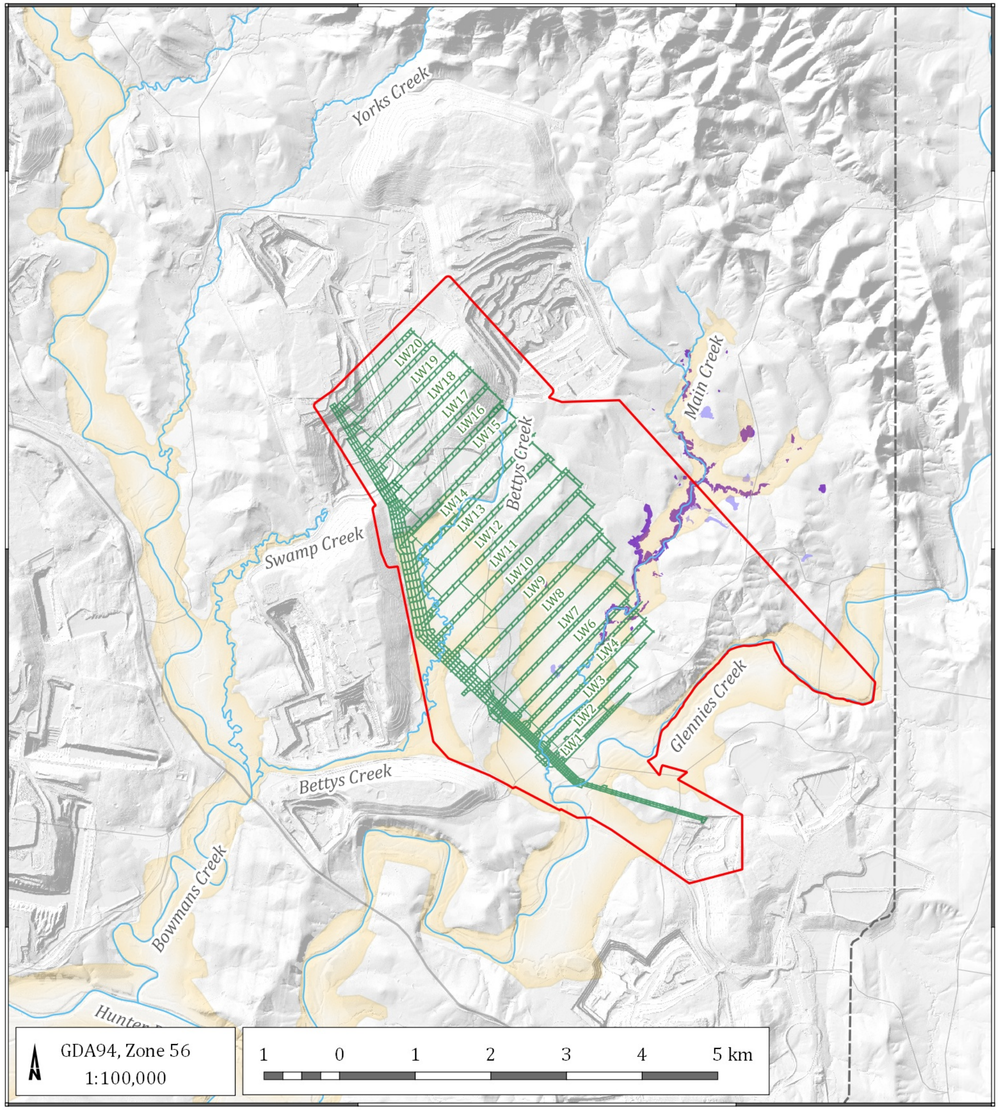
5.3 Groundwater impacts as drawdown

Figure 5.3 shows the predicted maximum drawdown occurring during the 18-year simulation period as a result of LW17 – LW20 extraction for both the Quaternary alluvium (left window) and Middle Liddell seam (right window). The location of mapped GDEs are also shown on Figure 5.3 and are discussed further in Section 5.5.

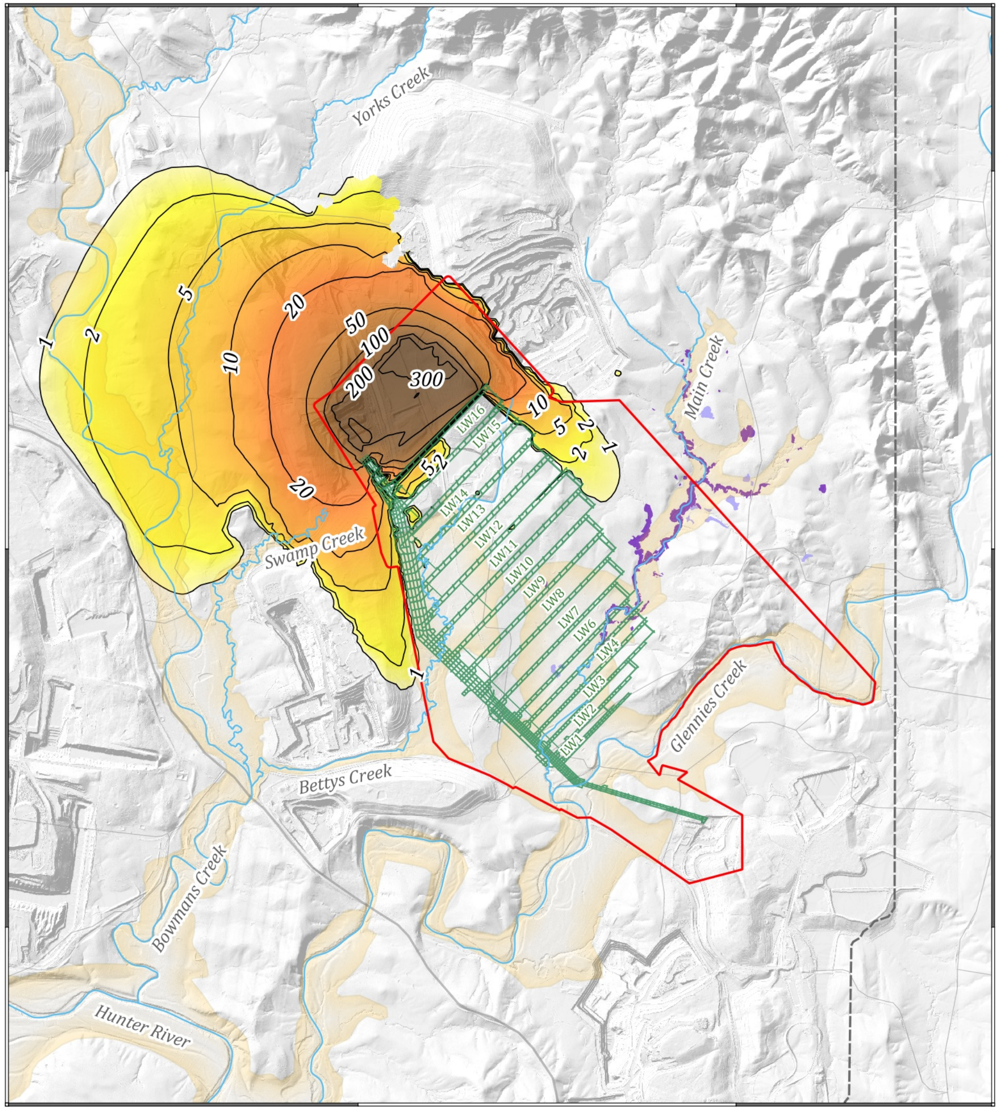
Figure 5.3 shows that the numerical model predicts no drawdown within the Quaternary alluvium as a result of LW17 – LW20 extraction. This is due to the westward progression of longwall panels away from alluvial areas that have already been subject to a slight amount of drawdown (< 1 m; refer AGE 2017) due to previous longwall extraction.

The second window in Figure 5.3 shows a cone of depressurisation radiating approximately 4 km out from the north-western boundary of LW20. Predicted drawdown does not extend to the south-east in this scenario as LW panels 1 to 16 have already depressurised the Middle Liddell seam in these areas. The cumulative impacts of LW17 – LW20 extraction when compared to a mining scenario in which all Middle Liddell LW panels are extracted (refer AGE, 2017), is reduced in both magnitude and distance from IUG.

Alluvial drawdown



Middle Liddell drawdown



LEGEND

- Drainage
- Road
- Drawdown contour (m)
- Approved Project boundary
- Underground mine area – Middle Liddell
- Alluvium extent
- Model boundary
- Hunter lowland red dum forest
- Central hunter swamp oak forest

Drawdown (m)

0	20
1	50
2	100
5	200
10	300

Integra Groundwater Subsidence Assessment (G1285H)

Maximum drawdown – Alluvium and Middle Liddell seam

DATE
26/06/2020

FIGURE No:
5.3

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
N:\Groundwater Jobs\G1285H.Integra_LW17_LW20_groundwater_subsidence_assessment\3_GIS\Workspaces\001_G1285H_LW17_LW20_Extraction_plan\05.03_G1285H_Maximum drawdown – Alluvium and Middle Liddell seam.qgs

5.4 Potential impacts on water quality

AGE (2017) describes the groundwater quality and beneficial use of groundwater within the Quaternary alluvium and Permian groundwater systems in detail, with salinity found to be the key constraint to groundwater use.

Mining activities at IUG promote a downward vertical hydraulic gradient due to underground dewatering and subsidence. This minimises the potential risk of saline groundwater from the Permian strata flowing into alluvium and creeks. Therefore, the extraction of LW17 – LW20 is not expected to cause an increase in the groundwater salinity of creeks and alluvial aquifers; however, there may be a slight decrease in salinity due to the reduced discharge from the Permian strata associated with mining at IUG.

5.5 Potential impacts on GDEs

GDEs are defined by ARMCANZ/ANZECC (1996) as ecosystems which have their species composition and their natural ecological processes determined by groundwater.

As outlined in AGE (2017), potential GDEs have been identified primarily in riparian vegetation along Bettys Creek and Main Creek. Figure 5.3 shows the location of identified GDEs along with the maximum cumulative drawdown predicted within the Quaternary alluvium as a result of LW17 – LW20 extraction.

As the limited amount of alluvial drawdown has already occurred and no drawdown is predicted with the alluvium as a result of LW17 – LW20 extraction, no impacts to GDEs are anticipated.

5.6 Potential impacts on existing groundwater users

The majority of bores within the region are located on land owned by mining companies and are either used for monitoring the impact of mining or are former water bores/wells no longer in use. Only one bore potentially in active use was identified as being located on private property and in proximity to the project. Bore GW067291 is a well located on the northern bank of Glennies Creek near the Middle Falbrook Road Bridge and is drawing water from the Glennies Creek alluvium.

Given that no drawdown is predicted within the alluvium, there are no expected impacts to private bores as a result of LW17 – LW20 extraction.

5.7 Model uncertainty

The uncertainty in the AGE (2017) model conceptualisation was assessed using a traditional sensitivity analysis where model assumptions were adjusted individually to assess the impact upon the predictions. A more complex non-linear uncertainty analysis was also undertaken where numerous model parameters were changed at the same time using 179 model realisations. The majority of the 179 model realisations developed for the uncertainty analysis produced groundwater inflows representative of rates observed during 2016 at around 300 ML/year. The uncertainty analysis indicated future inflows up to 888 ML/year at 1 standard deviation above the median in year 2032. Predicted alluvial drawdown from LW15 to LW19 produced drawdowns less than 0.1 m for all uncertainty realisations.

Although the uncertainty analysis was undertaken using the MOD8 mine plan, which has wider longwall panels and therefore a higher fracture height, the uncertainty methodology employed for the MOD8 study is considered acceptable for this assessment, as it conforms to groundwater modelling uncertainty guidelines outlined by the IESC (IESC, 2019). Groundwater impact uncertainty analysis predictions due to LW17 – LW20 will be less than the predictions outlined in MOD8 report.

6 Assessment against Project Approval Requirements

Schedule 3 Condition 17 and 30 of the Project Approval outlines the groundwater conditions/performance measures from the Project Approval. Table 6.1 also includes a commitment from Appendix 7 of the Project Approval regarding groundwater impacts (Statement of Commitments).

Table 6.1 Project Approval groundwater conditions/performance measures

Aspect	Performance Measure	Proposed Impact
Glennies Creek alluvial aquifer (Schedule 3 Condition 17)	Negligible impact	Negligible impact predicted for LW17 – LW20. Refer Section 5.3.
Glennies Creek and Station Creek alluvial aquifers (Schedule 3 Condition 30)	Negligible environmental consequences to the alluvial aquifer (as shown in Appendix 6) beyond those predicted in the documents referred to in conditions 2 and 3 of Schedule 2, including: - negligible change in groundwater levels; - negligible change in groundwater quality; and - negligible impact to other groundwater users	Negligible impact predicted for LW17 – LW20. Refer Section 5.3 – water levels. Refer Section 5.4 – water quality. Refer Section 5.5 and 5.6 – GDEs and existing groundwater users.
Groundwater Management (Statement of Commitments)	Operations are managed such that adverse impacts to local and regional groundwater resources are prevented, minimised and/or offset.	Proposed mining in LW17 – LW20 not predicted to generate adverse impacts. TARP process in place to assess and manage unexpected impacts to the groundwater system.

7 Discussion, management and mitigation strategies

This assessment was essentially a comparison between the predicted impacts of the AGE groundwater model (2017) and the impacts modelled assuming extraction of all longwall panels except LW17 – LW20. In this manner, the effects of LW17 – LW20 extraction were able to be determined via the difference between groundwater models with and without LW17-20 extraction.

Contributions to mining area inflows from LW17 – LW20 are expected to peak at 97 ML/year in 2023.

The incrementally updated model predicts drawdown in the Permian strata to predominantly propagate to the north-west away from already depressurised strata. As the direction of mining is away from the alluvium, previously mined longwall panels provide a buffering effect and no impacts to the alluvium are expected. Groundwater impacts as drawdown are consistent with Project Approval 08_0101 as they are less than those predicted for MOD8.

Water quality beneficial use categories are not expected to be downgraded in any way.

As no impacts to the alluvium are anticipated and GDE's are primarily associated with riparian vegetation and alluvium along Bettys Creek and Main Creek, no impacts are expected in relation to GDEs. Likewise, as the only private bore in the area targets the Glennies Creek alluvium and as no impacts to the alluvium are predicted, no impacts to private bores in the area are anticipated.

Predicted inflows to mining areas and indirect groundwater impacts on alluvial systems are less than those predicted for MOD8. Extraction of L17 – LW20 is therefore in accordance with the project approval and groundwater impact predictions remain compliant with the requirements under the NSW AIP. IUG hold sufficient water licence allocations to account for the predicted groundwater take associated with extraction of LW17 – LW20.

No additional groundwater management or mitigation measures or changes to the monitoring bore network are required beyond those outlined in MOD8 (AGE, 2017). Groundwater levels and quality should continue to be monitored in accordance with the approved Water Management Plan (WMP).

8 References

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