NSW GOVERNMENT Planning & Environment

Geological Survey of NSW

Water & mining: current projects and future direction

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Contents

About the Geological Survey (GSNSW)

- Oldest NSW Government agency - active since 1875
- Offices in Maitland, Orange, Londonderry (>150 staff)
- Field geologists, geophysicists, petrologists, economic geologists, palaeontologists, volcanologist and geospatial specialists
- Geology is mapped, indicating potential for mineral, coal, petroleum, water, construction material & renewable resources
- Data used in land use assessment, engineering construction, environmental management, natural hazard risk assessment
- Advice to government, industry and general public
- Publications (maps, books, brochures), data, online resources
- Library in Maitland and historical records, maps
- Drillcore libraries, state fossil and mineral collections

Role of GSNSW

How	The Geological Survey of NSW collects and manages geological, geophysical, geochemical and geospatial data…
What	to inform the government, resource industry and the community about the state's geology, and mineral, coal, petroleum and renewable energy resources….
Why	to facilitate the safe and sustainable development of NSW mineral and energy resources for the benefit of all NSW citizens.

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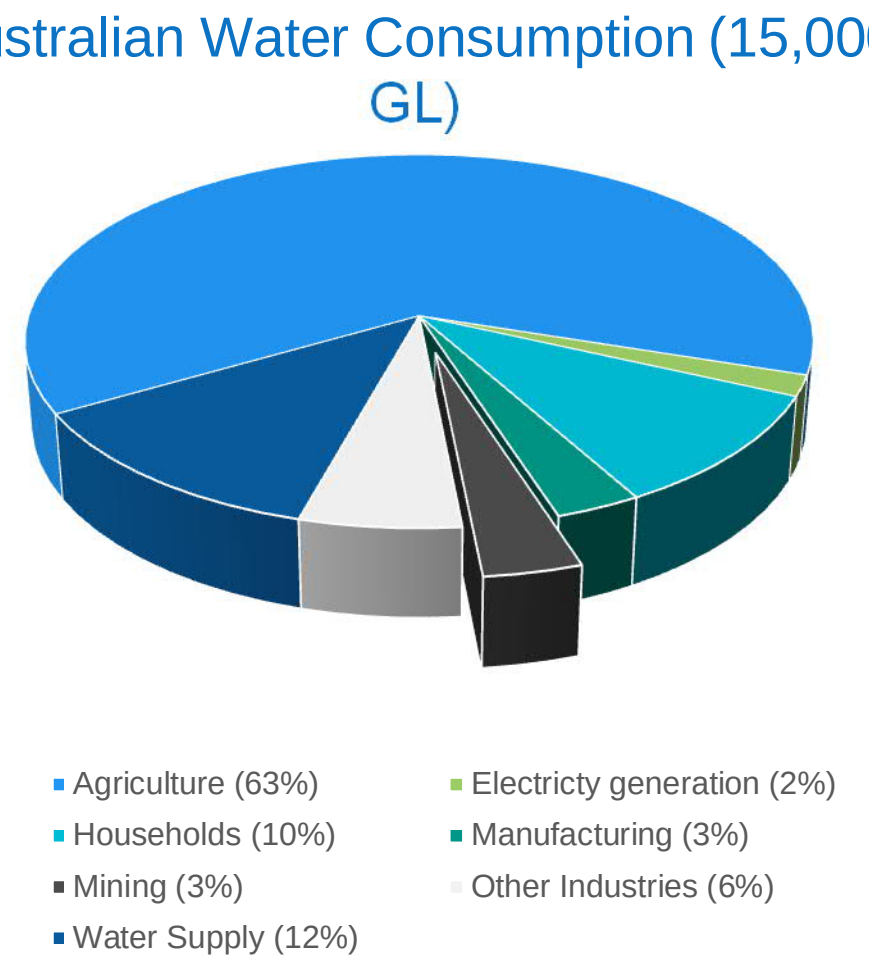
Pressure on NSW water resources

- Water is critical for mining operations
- Many competing demands are placed upon water supplies from agriculture, industry, towns and the environment
- Population of NSW expected to increase from 7.5 to 9.9 million over the next 20 years
- Increased demand on water supplies
- Exacerbated during drought conditions



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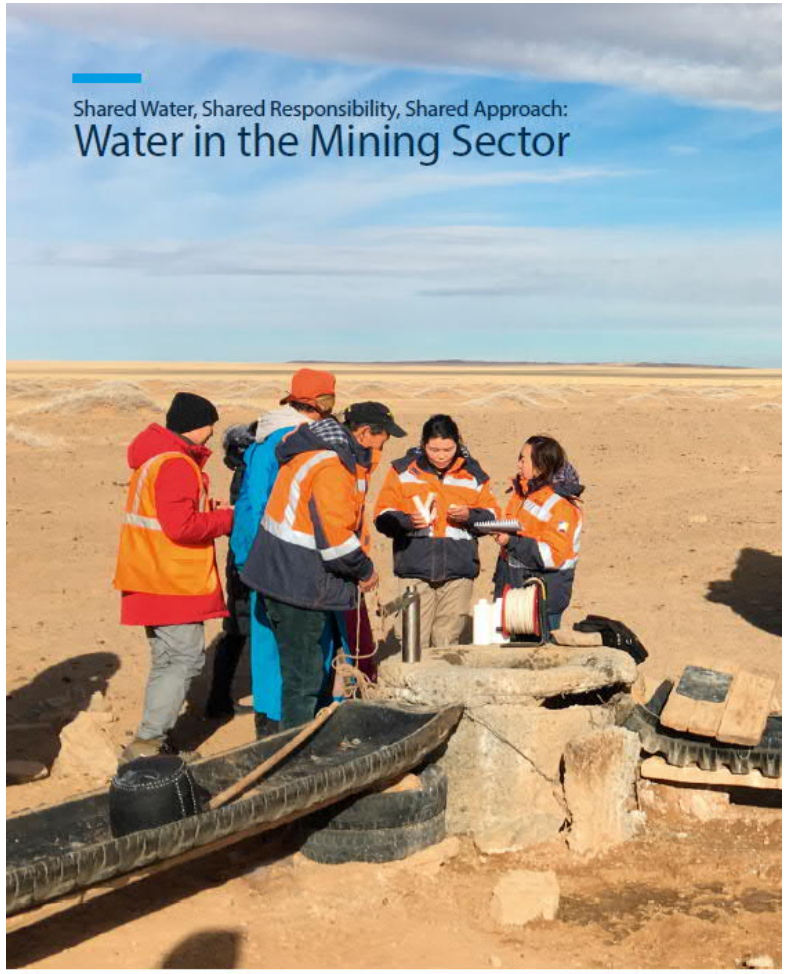
Global awareness



1. Water challenges are growing
2. Water is an asset
3. Water is expensive
4. Water is a growing source of conflict
5. Citizens have the tools to take action
6. Mining isn't the only activity that impacts a local water system
7. Pressure for more disclosure is mounting
8. Mining companies are seen as key partners in the global sustainable development agenda

ICMM International Council on Mining & Metals

IFC International Finance Corporation WORLD BANK GROUP

Role of Government

With increasing demand on NSW water resources, critical to:

- Understand and monitor water resources
  - Water monitoring strategy for NSW coal basins
- Understand water requirements of competing users
  - Water use in mining operations

Allow Government to:

- Assess the potential impacts of existing and proposed mines
- Develop regional water management plans that maximise water efficiency and reduce drought-related risks to mining operations

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Development of 3D geological models

- Groundwater studies

Work closely with DPI Water and Water NSW

- Mine site water requirements/balances
- Data reporting/capture – compulsory annual reporting
- Data analysis modelling, including
  - Cumulative impacts
  - Options to maximise water efficiency
  - Effects of drought on mine production/revenue

Current projects

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Water projects

NSW Land & Water Commissioner

- NSW status report project
  - Response concerns on coal mining & CSG
  - Compiles and presents data in a clear and concise format
- NSW Groundwater baseline project – Gunnedah Basin
  - Response concerns on water rights, licencing and use
  - Highlights water level behaviour for key groundwater sources

DPI Water / Water NSW

- Water monitoring strategy for NSW Coal basins
  - Response to community concerns – effects of CSG and coal mining on groundwater
  - Expand water monitoring network
  - Increased knowledge and improved decisions about water management

GSNSW

- Water use in mining operations
  - Assessing water requirements of NSW mining operations
  - Feeds into planning and approvals
  - Requires better capture of water data for mining operations

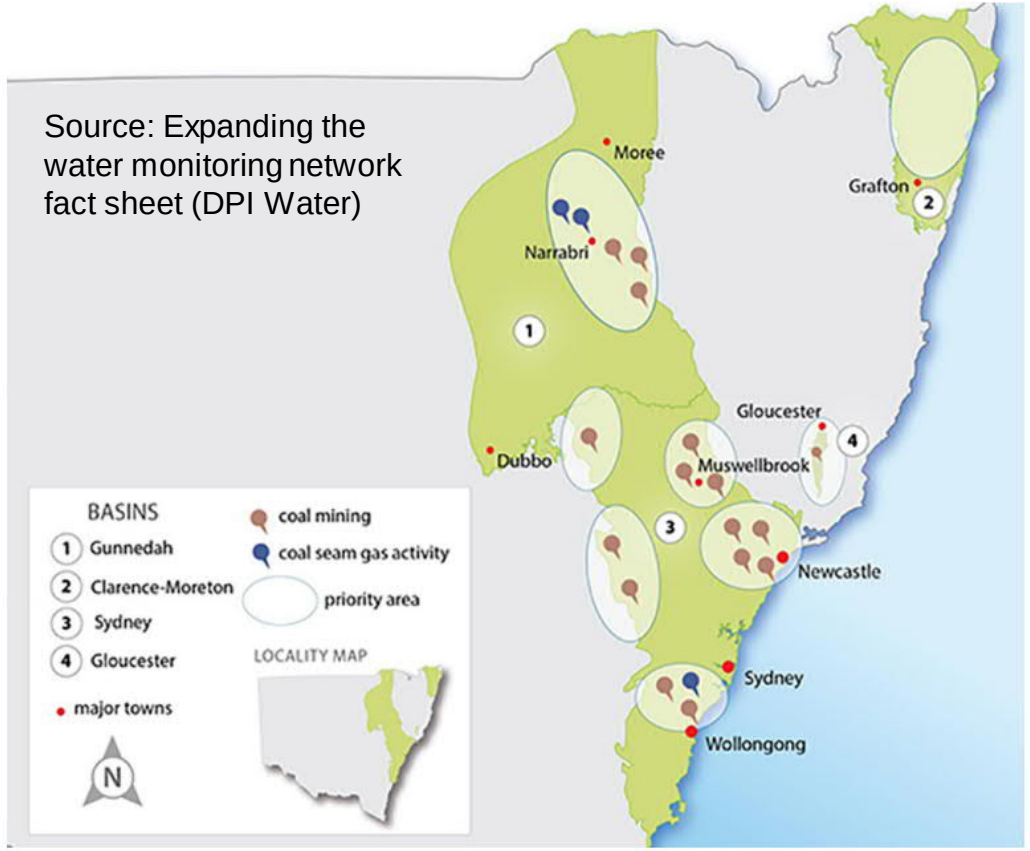
NSW Water Monitoring Framework (WMF)

- Response to community concerns – effects of CSG and coal mining on groundwater
- Commitment by the NSW Government – expand groundwater monitoring bore network
- More informed government decision making and policy development ➔ improved decisions about water management
- Make water data, information and knowledge products readily available to the community

Water monitoring strategy for NSW coal basins

Background

- Part of Water Monitoring Framework
- Over 4000 monitoring bores (>3000 locations)
  - In areas of large-scale water use (eg irrigation)
- Need for expansion into the coal basins
  - Independent monitoring
  - Monitor changes over time
  - Overlap with Bioregional Assessments



http://www.water.nsw.gov.au/water-management/groundwater/water-monitoring-framework

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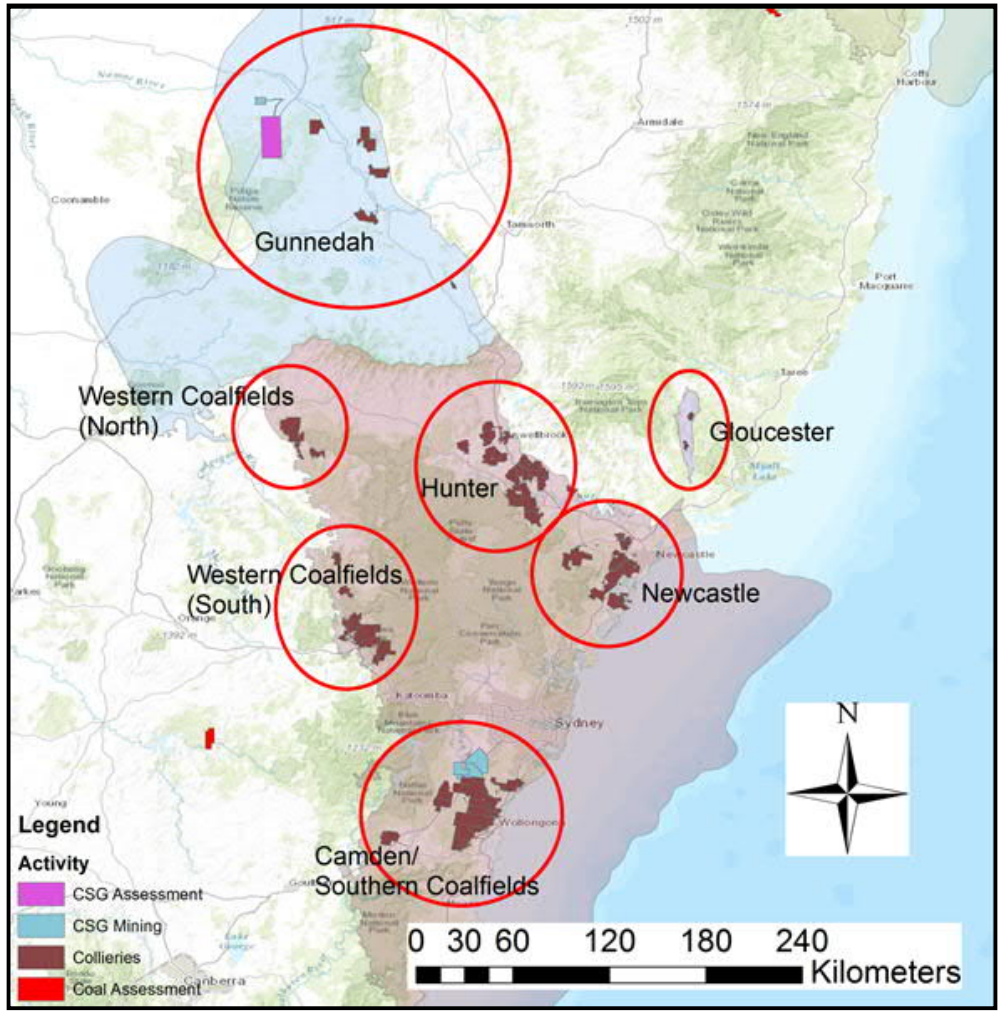
Water monitoring strategy for NSW coal basins

Expanded network

- 50-90 new monitoring bores
  - Shallow and deep aquifers
  - Rigorous selection process
- Capture pre-mining baseline water quantity and quality data to compare with post-mining characteristics
- $22.8M to deliver the strategy
- 2020 expected completion
- GSNSW supporting DPI Water & Water NSW



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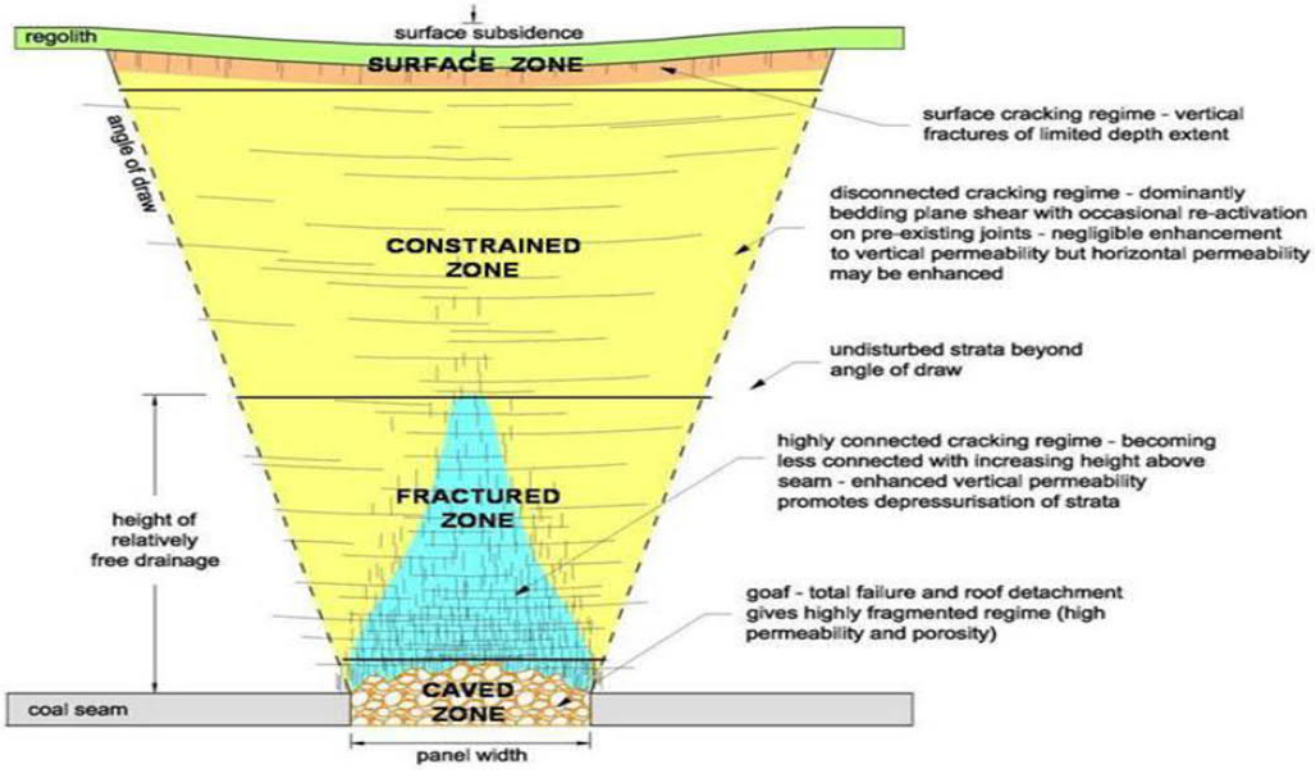
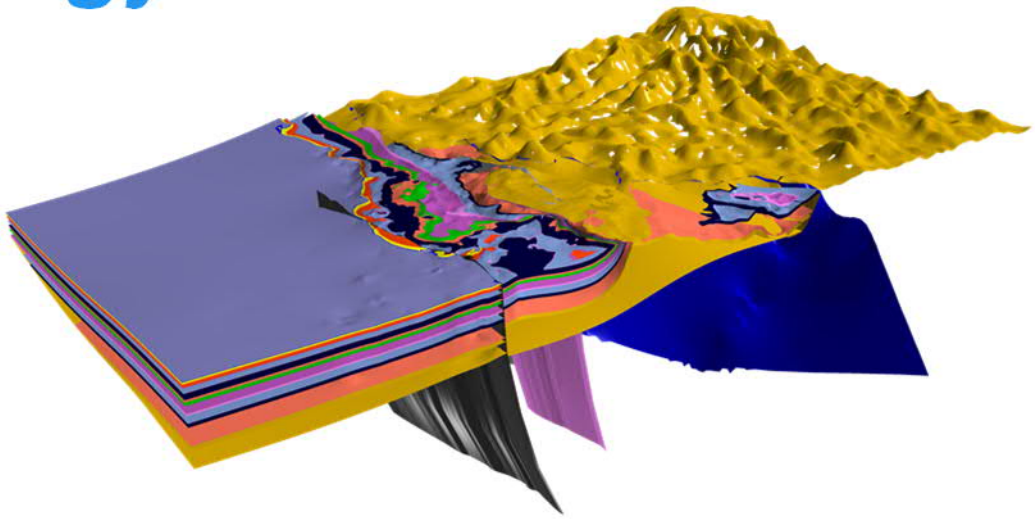
Potential mining impacts

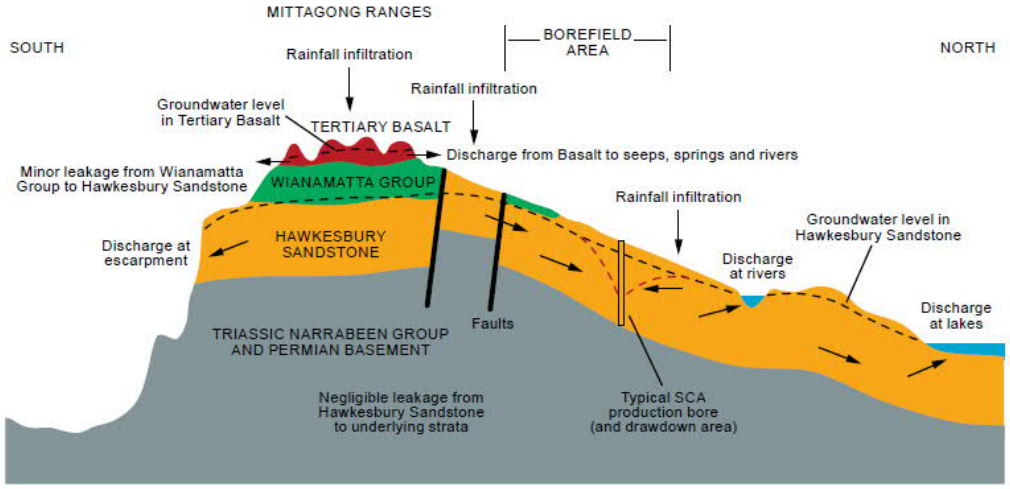
- Loss of surface water and shallow groundwater resources
- Adverse environmental impacts
- Important to understand effects of mine-induced dewatering in underlying rock units to assess the long-term security of the upper aquifers
- Need pre-mining baseline water quantity and quality data to compare with post-mining characteristics



From geology to hydrogeology

Planning	• Intended use of model & objectives • Investigation scale / confidence level • Exclusions
Geological model	• Distribution of porosity and hydraulic conductivity • Dominant pathways of connectivity • Fracture networks
Conceptual model	• Simplified representation of site • “Best” idea of how system works • Quick, cheap and easy to change
Groundwater model	• Understand hydrogeological processes • Simulating or predicting groundwater flow • Supporting groundwater resource management





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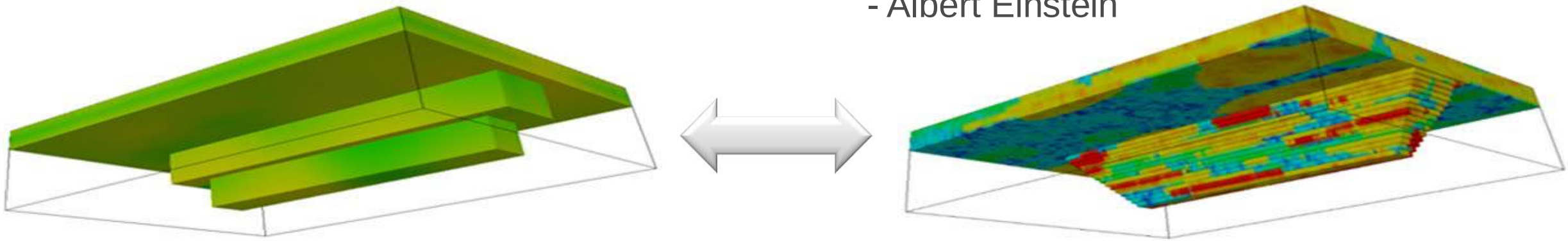
Strive for parsimony

- Models need to be complex enough to provide a reasonable approximation of the system under study
- Should not contain unnecessary complexity
- Remain computationally manageable

Defined from geological & conceptual models

"Everything should be made as simple as possible, but not simpler"

- Albert Einstein



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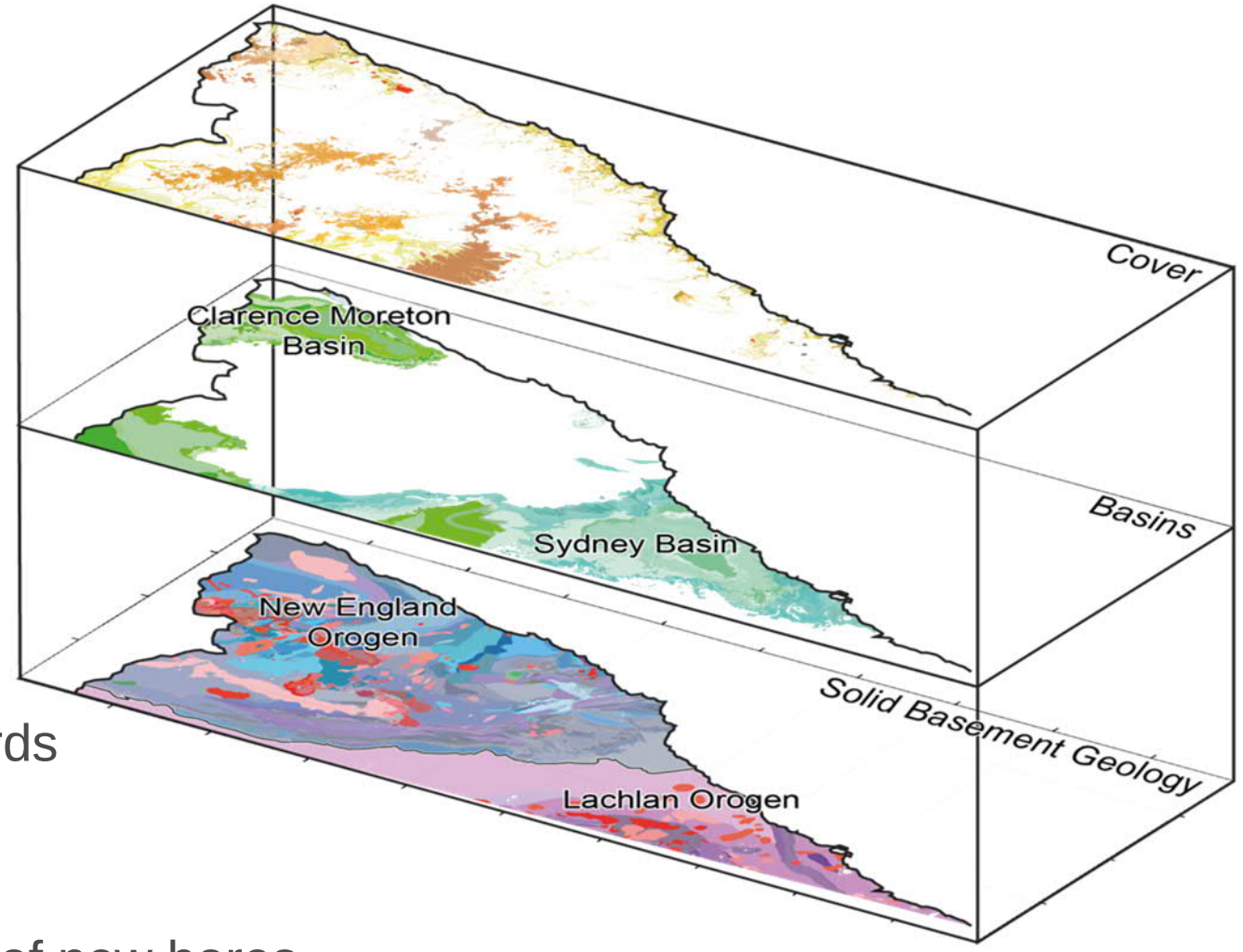
Geological models

Input data

- 30m SRTM
- Drill holes and water bore data
- NSW seamless geology
- Geophysical data
- Mine record tracings

Purpose

- Visualise geometry of basin
- Distribution of aquifers & aquitards
- Identify data gaps
- Locate potential drill sites
- Constrain drilling depths / costs of new bores



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Southern Coalfield

Why

- Current and proposed coal mining activity occurs very close to major water storages
- Mostly industry bores

Proposed – based on technical merit

- Fills a gap in the regional monitoring network
- Complements existing sites
- Contributes to modelling
- Addresses stakeholder issues
- 13 new bores & refurbish 3 existing bores

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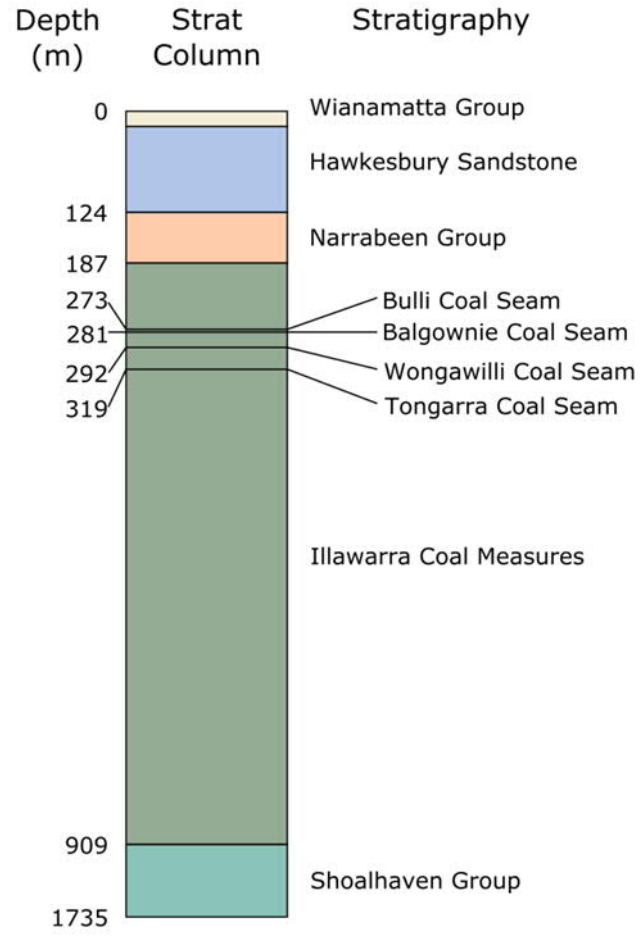
http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/731066/Southern-Coalfield-Fact-Sheet.pdf

Basin stratigraphy



Hawkesbury Sandstone

- Regionally significant aquifer across a considerable portion of the Sydney Basin
- Maximum thickness of 180 m

Narrabeen Group

- The Bald Hill Claystone – regionally significant aquitard up to 24 m thick

Illawarra Coal Measures

- Up to 500 m thick in centre of basin
- Includes all of the economic coal seams (Tongarra, Wongawilli, Balgownie and Bulli)

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Aquifer properties

Group	Geological unit	Yield	Hydraulic conductivity	Quality
	Alluvium	Low	Moderate (0.2 to 0.8 m/d)	Poor to good
Wianamatta Group	Bringelly Shale	Low (0 to 1 L/s)	Low to moderate (8.6×10^{-8} to 1.7 m/d)	Poor to very poor (>3,000 to<5,000 mg/L)
	Ashfield Shale		Low to moderate (9×10^{-4} to 1.8 m/d)	
Hawkesbury Sandstone		Low to high (0.3 to >40 L/s)	Low to high (0.017 to 73.2 m/d)	Very good to good (40 to 1,730 mg/L)
Narrabeen Group	Bulgo Sandstone	Low	Low to moderate (7×10^{-3} to 5.7 m/d)	Fair to poor
	Scarborough Sandstone	Low	Low (9×10^{-4} to 0.2 m/d)	Fair to poor
	Coal Cliff Sandstone	Low	Low (0.02 m/d)	Fair to poor
Illawarra Coal Measures		Low (0.3 to 1.0 L/s)	Low (8.6×10^{-4} to 0.13 m/d)	Poor
Shoalhaven Group		Low (0.3 to 1.2 L/s)	Low (9×10^{-5} to 3×10^{-3} m/d)	Good to very poor (500 to 5,000 mg/L)

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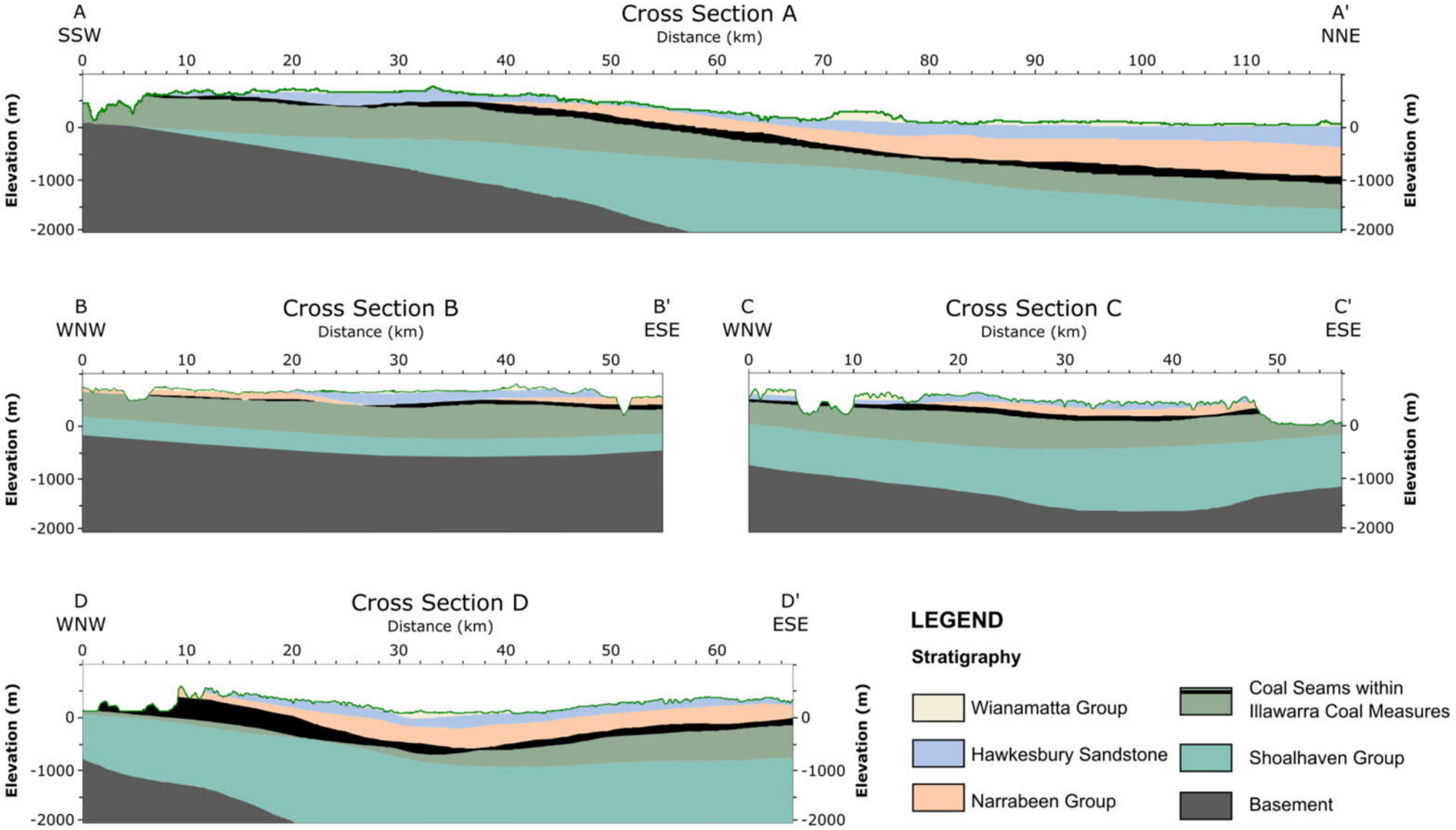
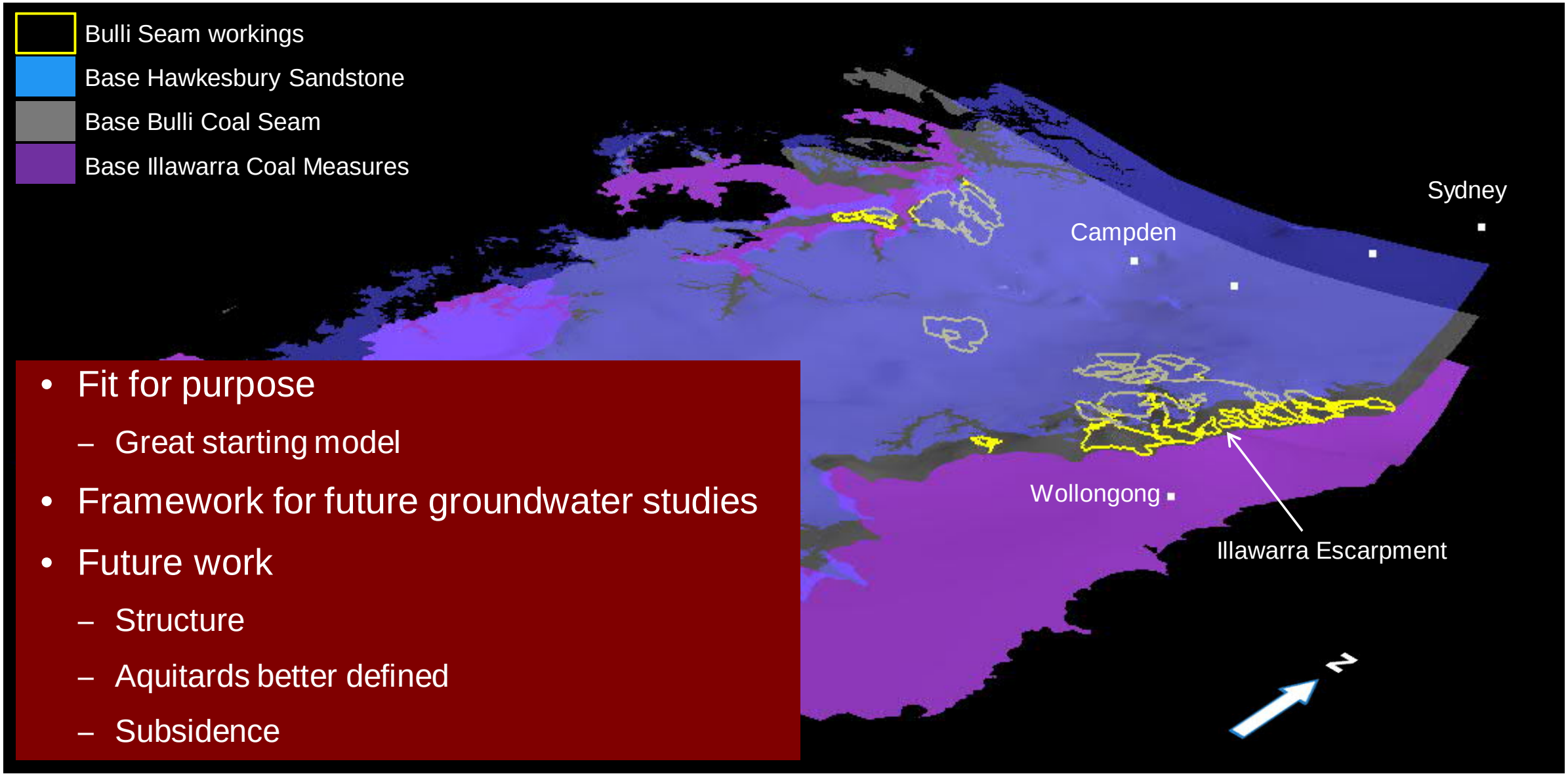
Cross sections



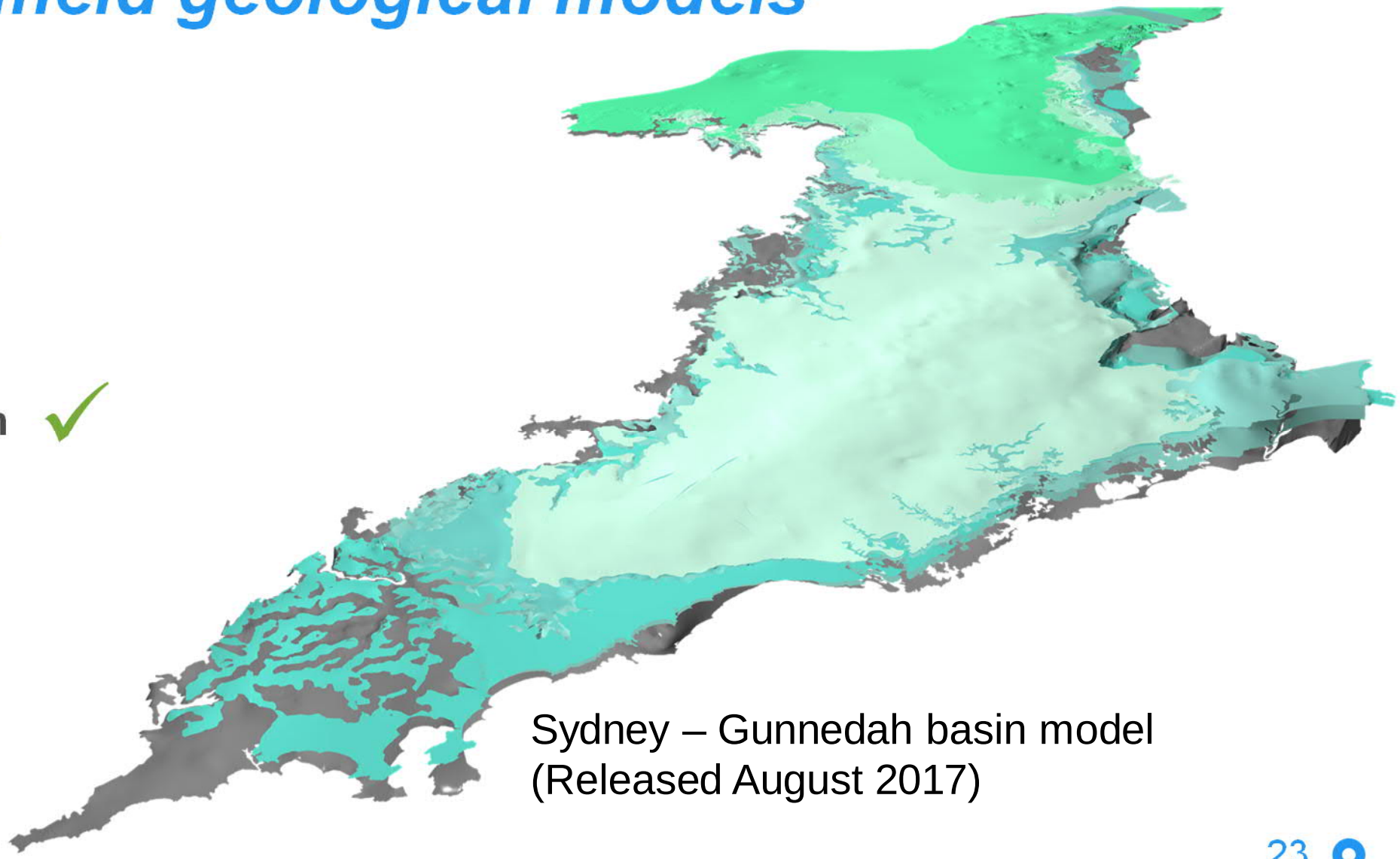
3D model



- Fit for purpose
  - Great starting model
- Framework for future groundwater studies
- Future work
  - Structure
  - Aquitards better defined
  - Subsidence

NSW coalfield geological models

- Southern ✓
- Hunter ✓
- Newcastle ✓
- Western ✓
- Gunnedah Basin ✓
- Gloucester ✗



Sydney – Gunnedah basin model
(Released August 2017)

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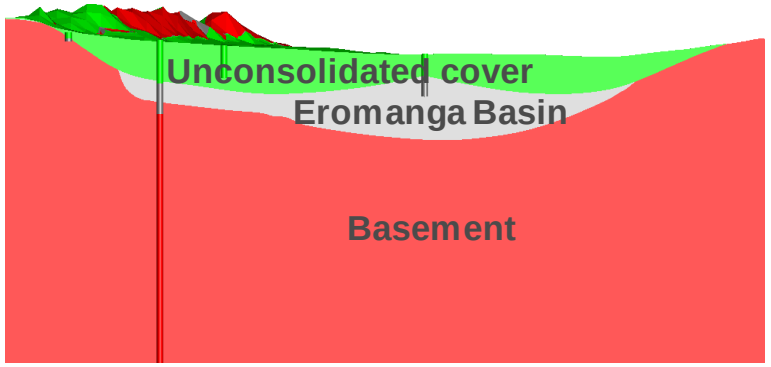
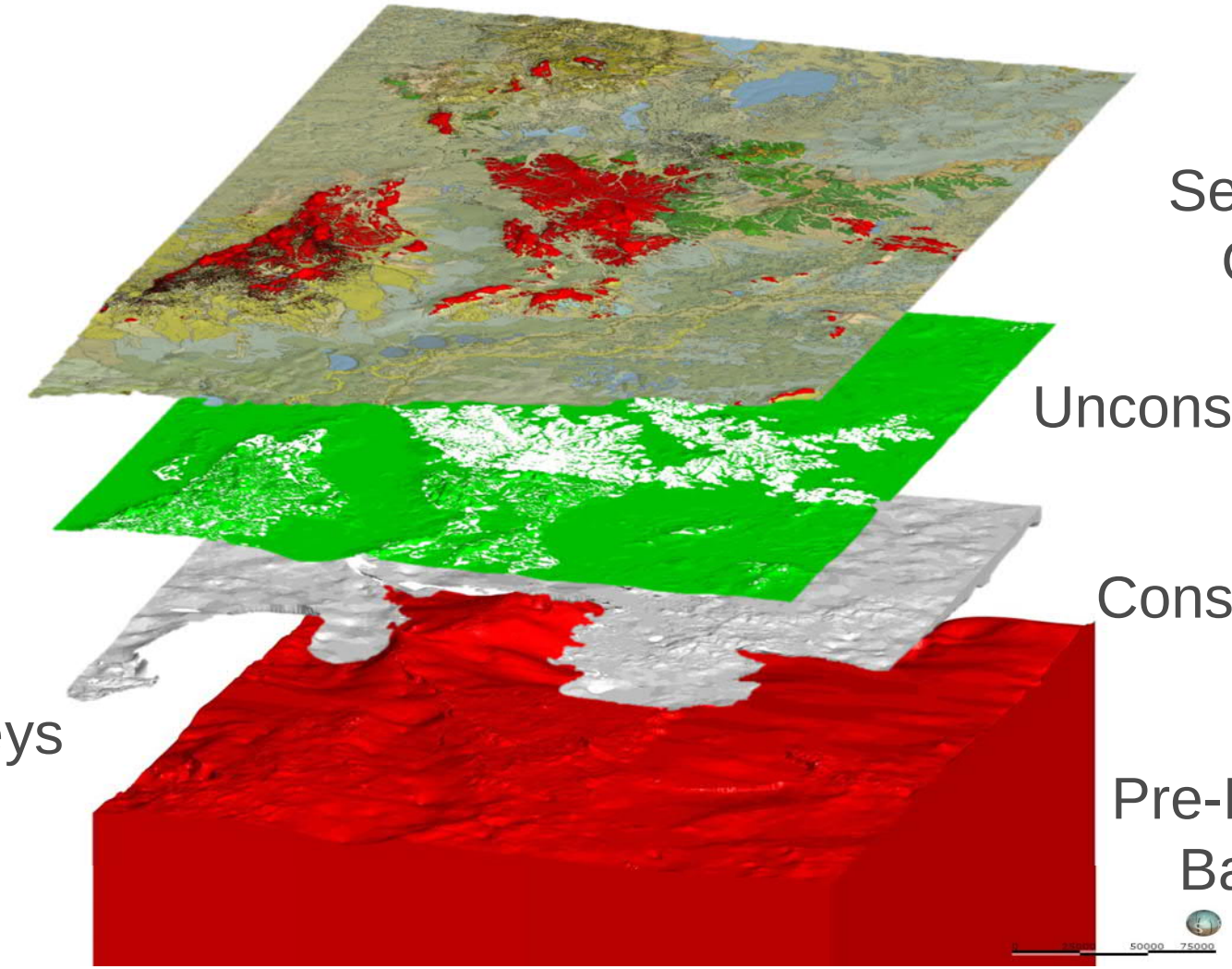
Statewide depth-to-basement model



Based on:

- Water bores
- Exploration drillholes
- Reflection seismic surveys
- Seamless geology map

Version 1 out now



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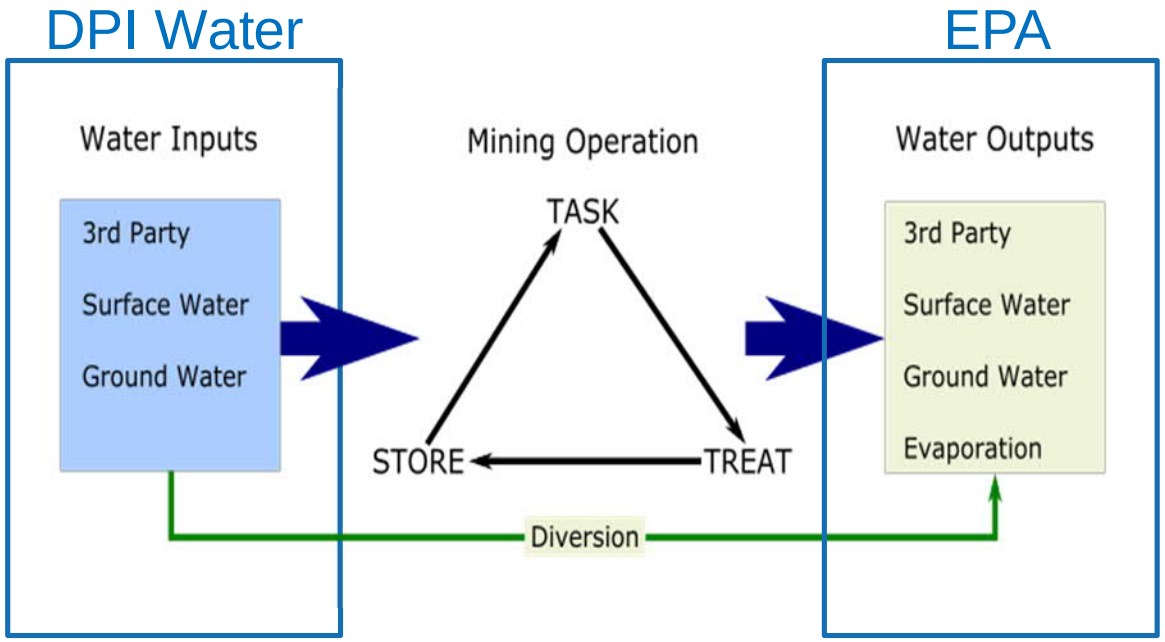
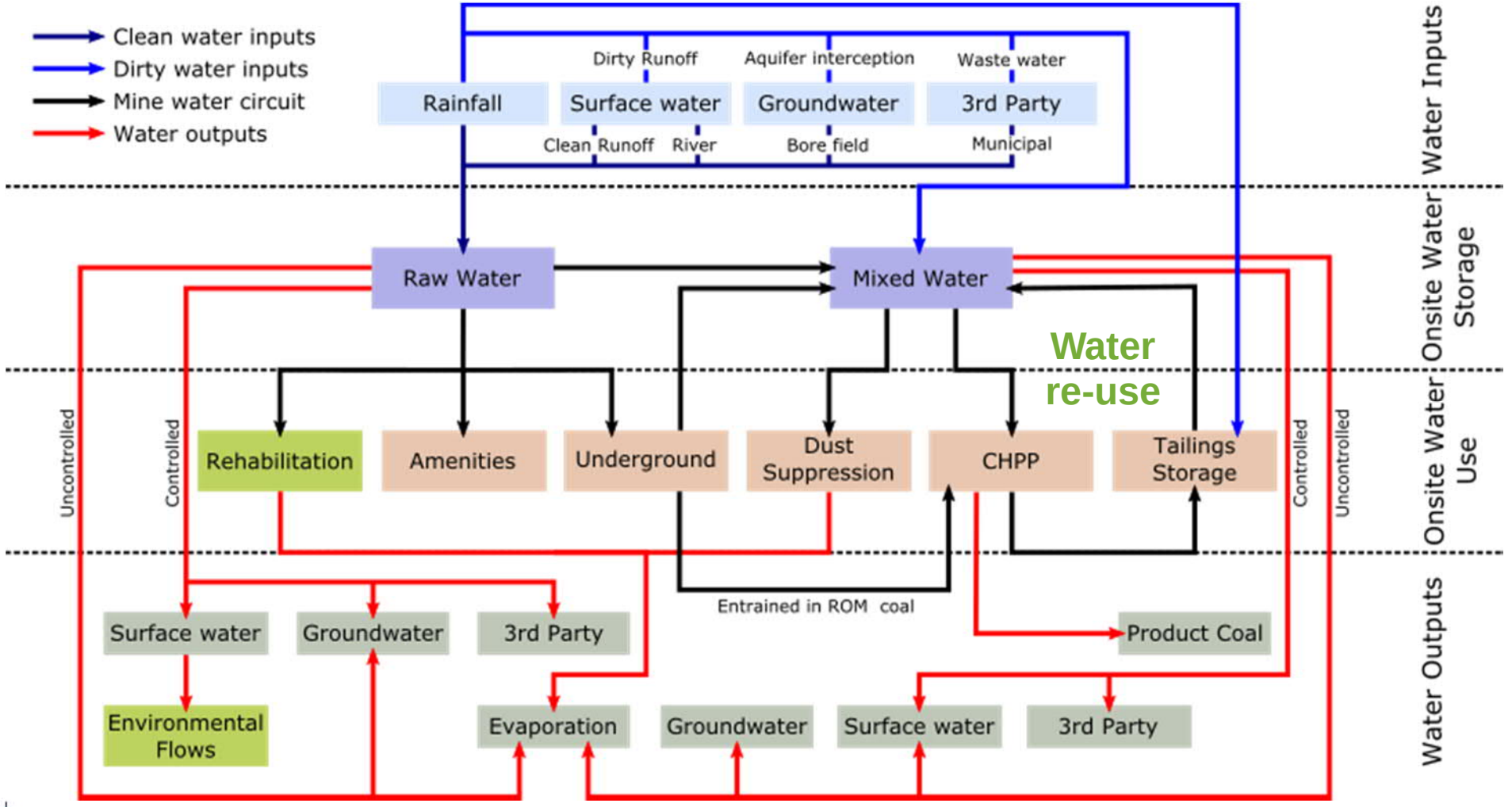
Water use in coal mining operations

- Understand water requirements
  - Actual vs allocated
  - Operational requirement
  - Water re-use/recycling
- Susceptibility to drought
  - Effect on production/revenue
- Data reporting
  - Mandatory vs voluntary



Water balance



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Reporting requirements

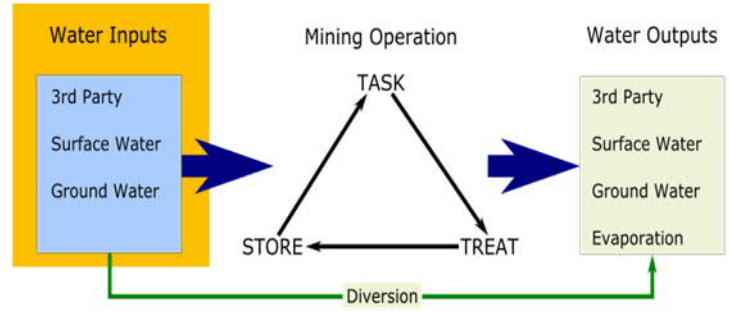
Mandatory - NSW Annual Review

Water Licence #	Water sharing plan, source and management zone (as applicable)	Entitlement	Passive take / inflows	Active pumping	TOTAL

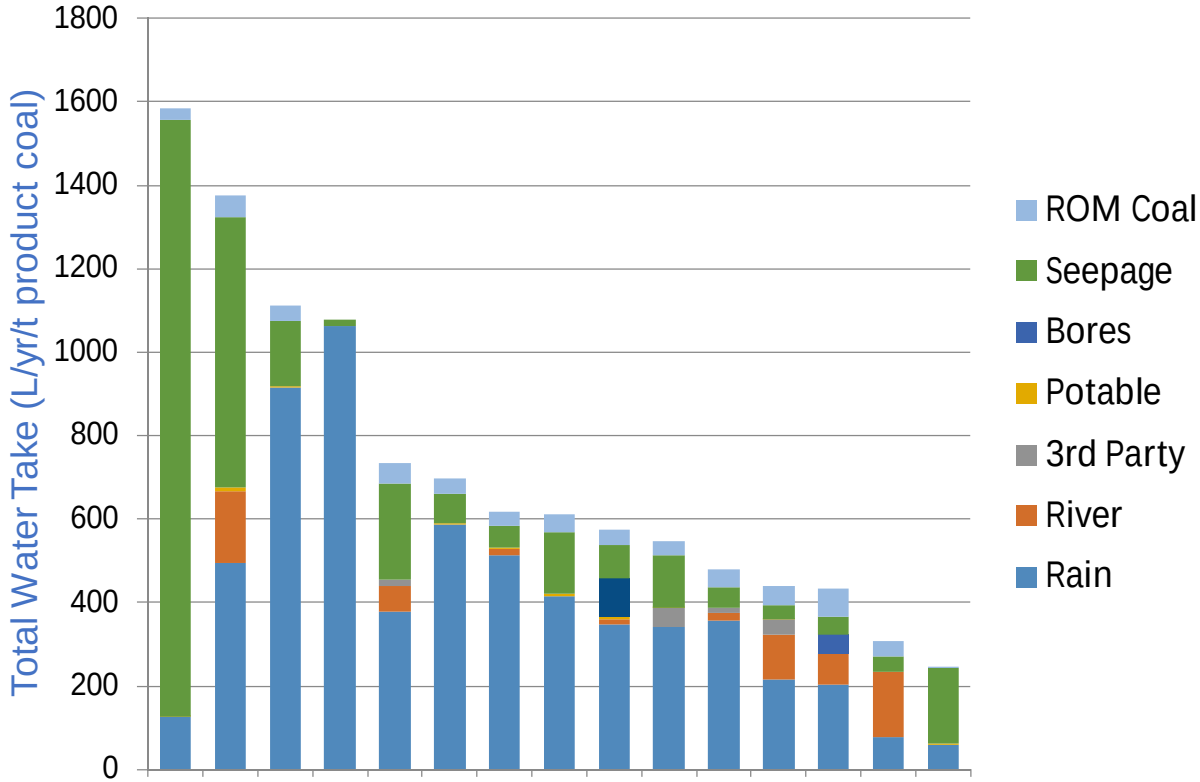
Voluntary - Global Reporting Initiative

- 303-1 (EN 8) Water withdrawal by source
- 303-2 (EN 9) Water sources significantly affected by water withdrawal
- 303-3 (EN 10) Water recycled and reused
- 306-2 (EN 22) Water discharge by quality and destination
- 306-5 (EN 26) Water bodies affected by water discharges and/or runoff

Water inputs



Source	Input	
3rd Party (≈8%)	Municipal	
	Waste water	
Surface Water (≈60%)	Rivers and creeks	
	External surface water storage	
	Rainfall and runoff	Clean
		Dirty
Groundwater (≈32%)	Bore fields	
	Aquifer interception	
	Entrainment	



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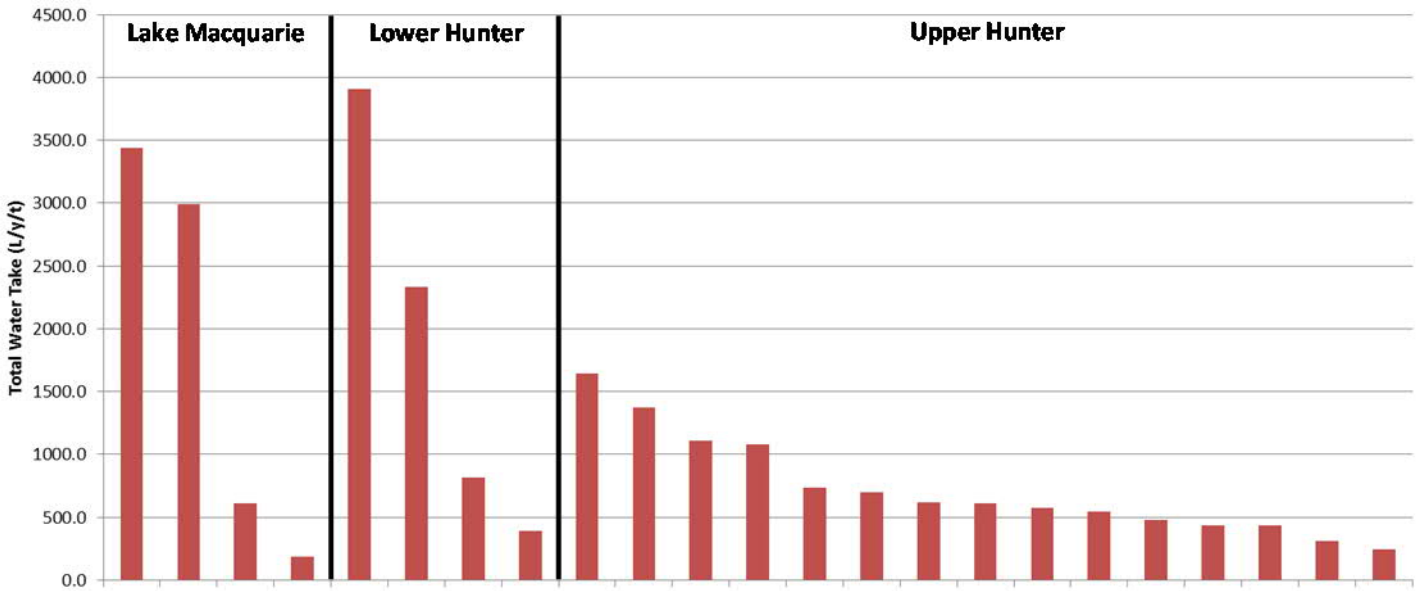
Total water take



- Main controls
  - Location
  - Mine size
  - Operational requirements
- In Upper Hunter
  - 21% surface water allocation
  - 62% groundwater allocation

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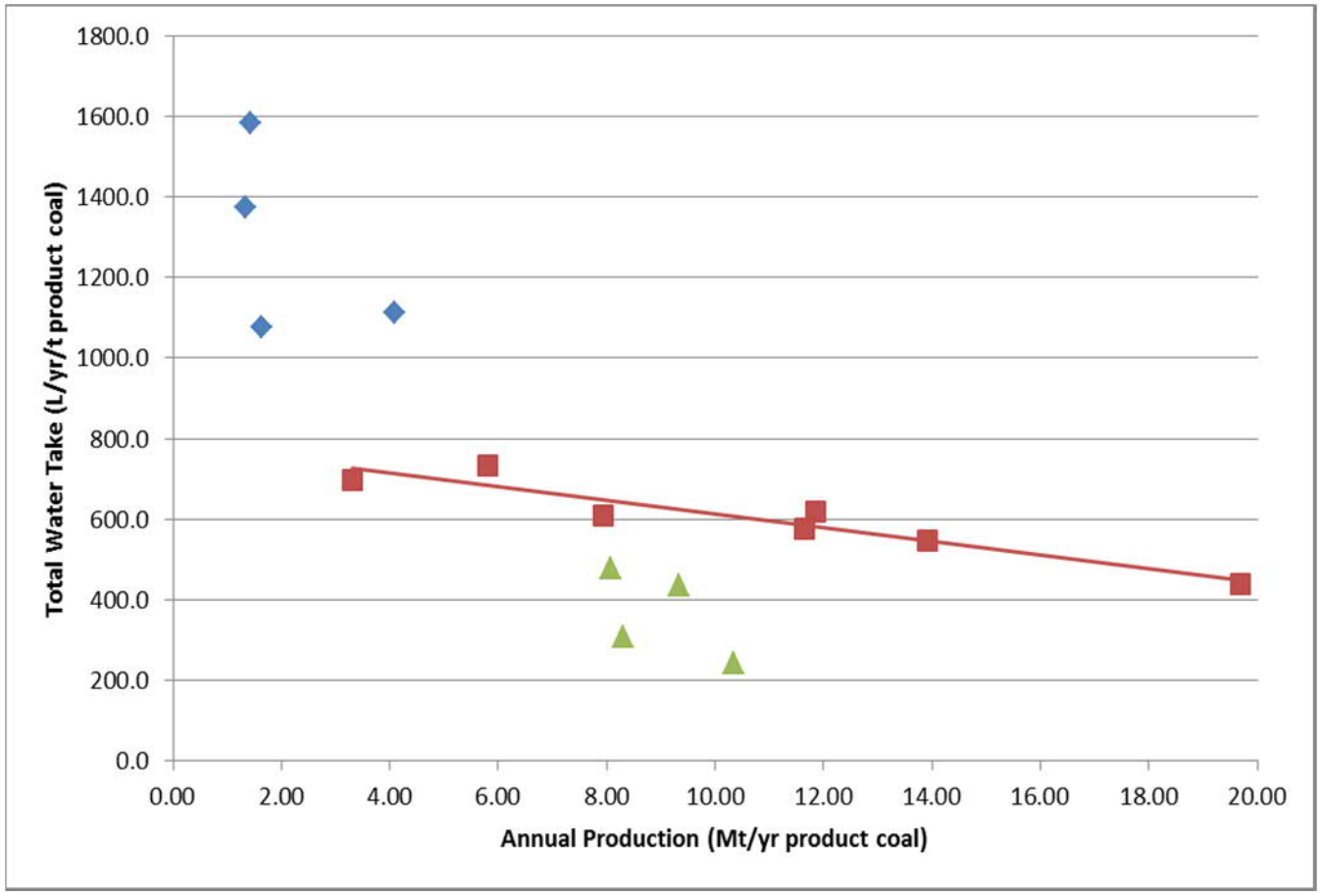
Mine size



- Correlation between mine size and total water take
- Larger mines generally more water efficient
  - 243 L/t to 734 L/t (product coal)
- No clear correlation with mine type (underground vs open cut)

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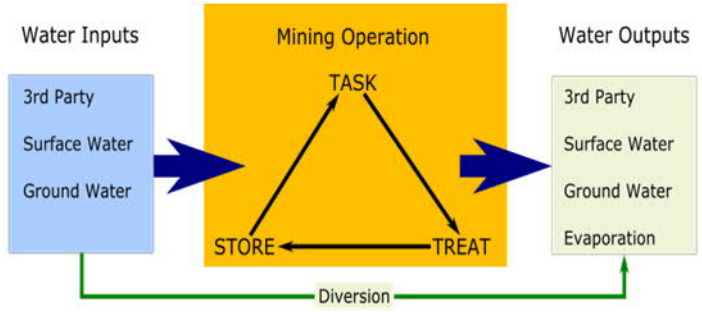
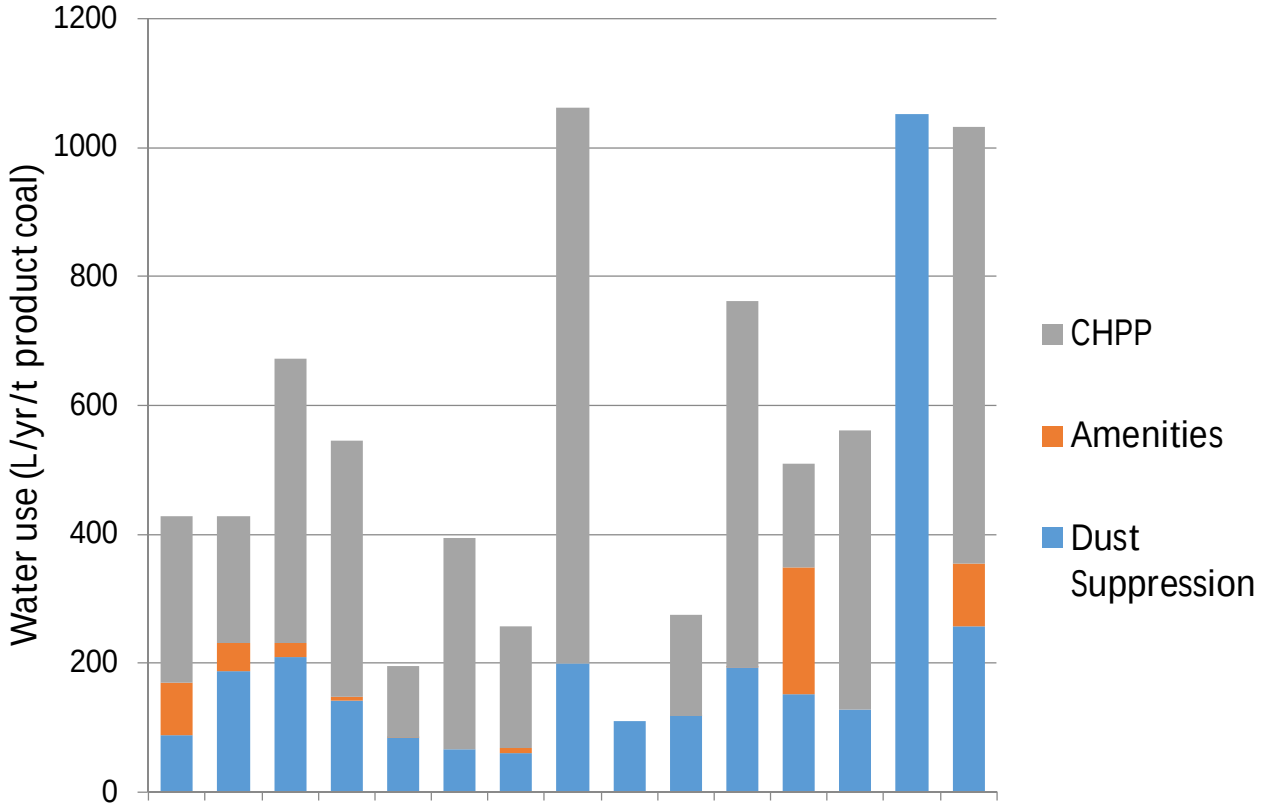
Operational requirements



Requirement	Task
Operations	Underground mining
	Coal handling and preparation plant (CHPP)
	Amenities
Environment	Dust suppression
	Environmental flows
	Rehabilitation



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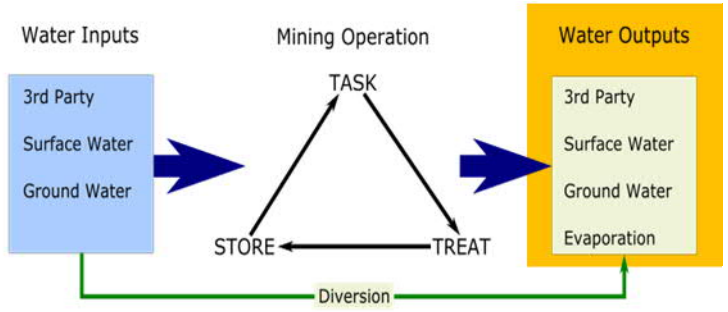
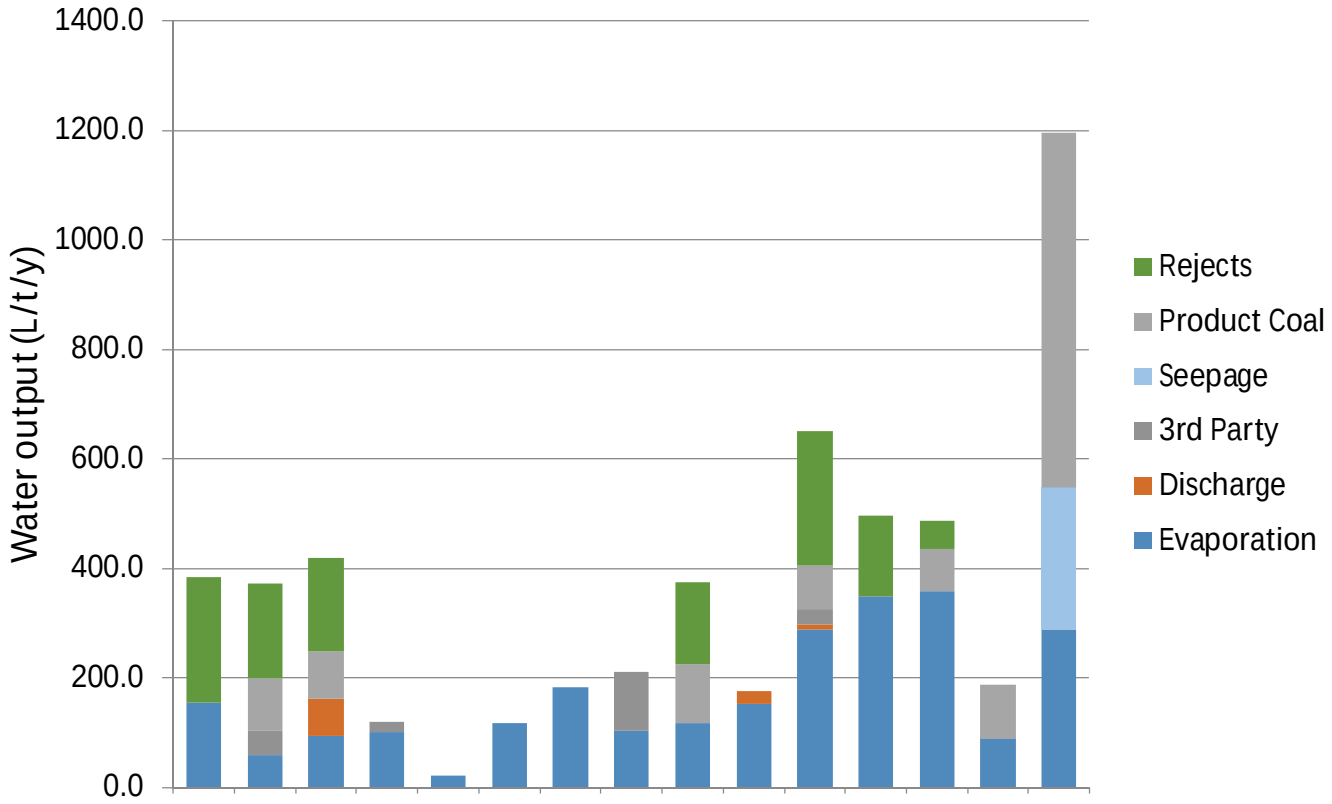
Water outputs



Destination	Output
3rd Party (≈9%)	Municipal
	Waste water
Surface Water (≈22%)	Discharge
	Environmental
Groundwater (≈40%)	Bore fields
	Aquifer interception
	Entrainment
Other (≈30%)	Evaporation



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Study findings

- Quality of data hamstrung study
- Operators providing mandatory information
  - Water take vs water licence
- Need for improved reporting
  - Operators collecting water balance data
  - Water accounting framework
  - Water re-use & efficiency
- 60% of water sourced from rainfall and runoff
  - Potentially susceptible to drought

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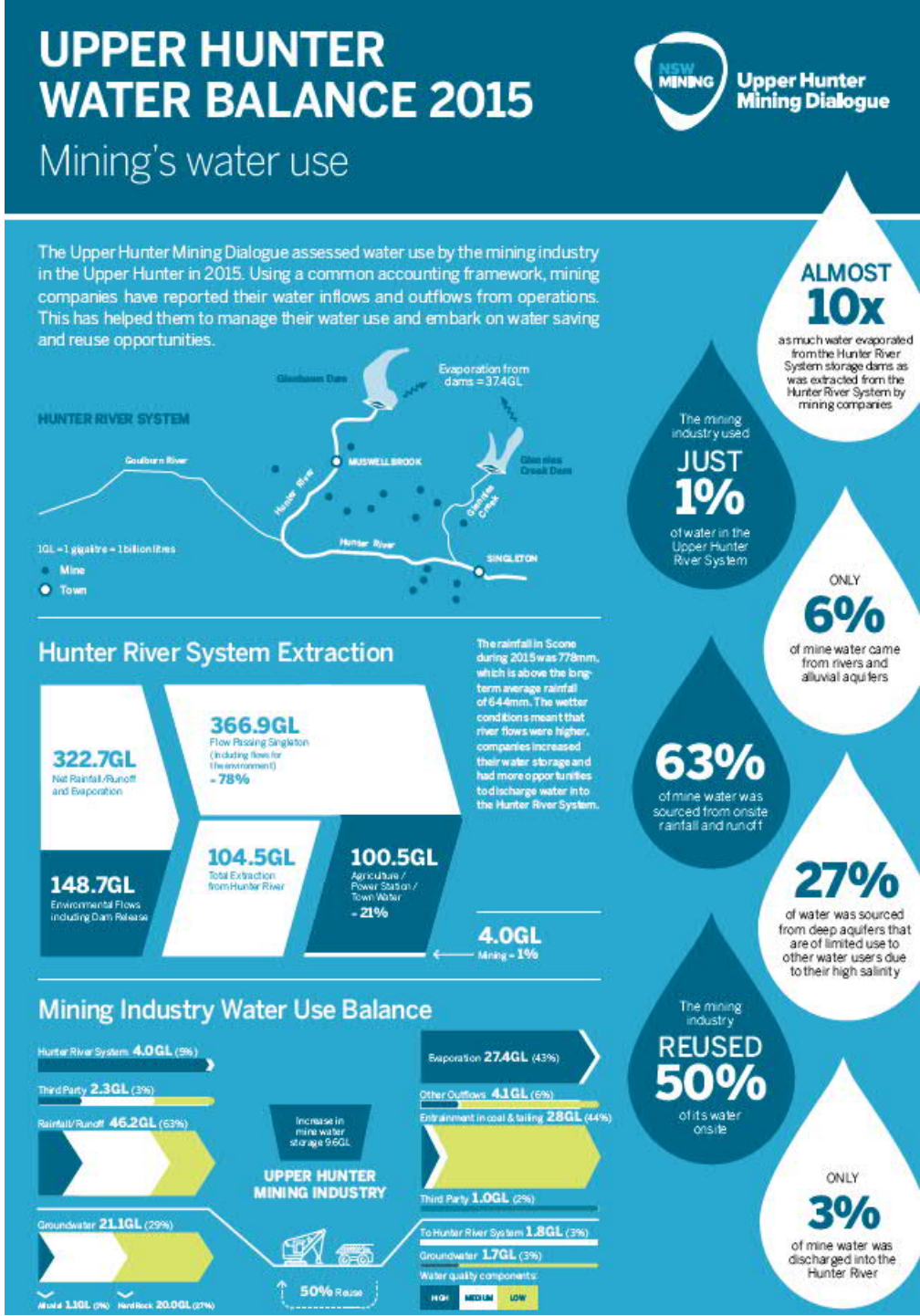

Future direction

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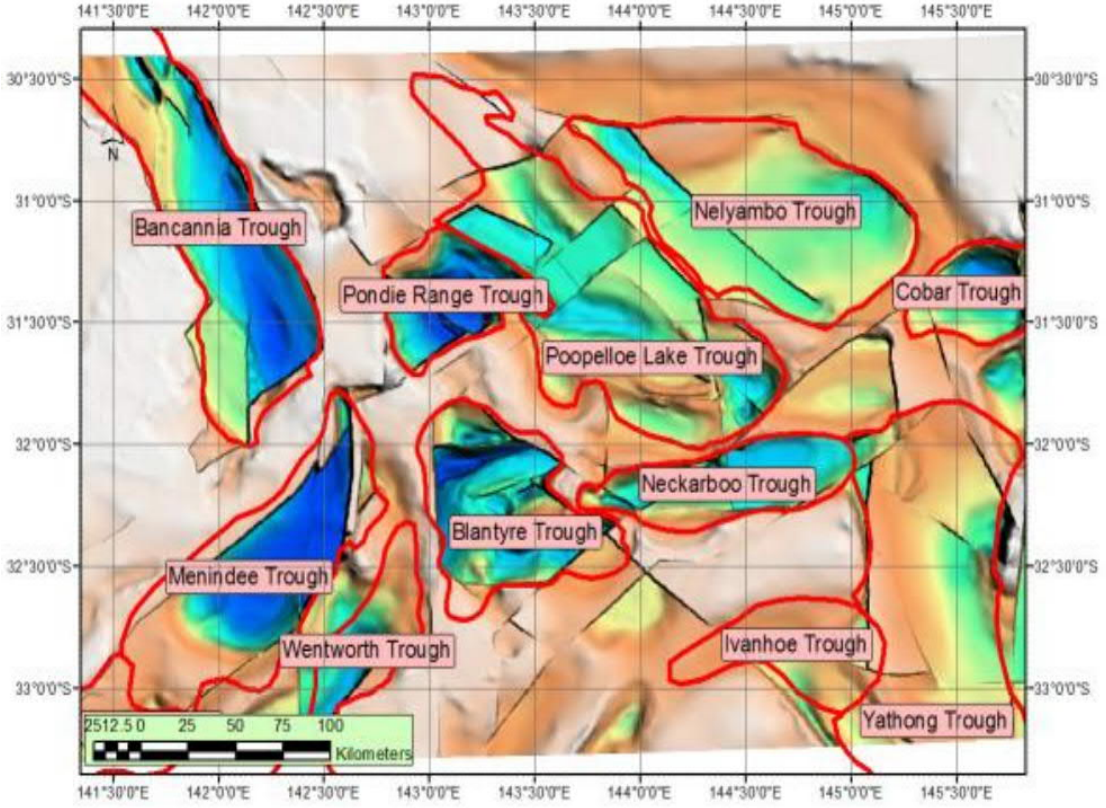
Moving forward

In progress

- Seamless geology
- Drill hole database
- Geological models

For discussion

- Better representation of uncertainty in geological models?
- Water balance data capture and reporting
  - Understanding water requirements of mines



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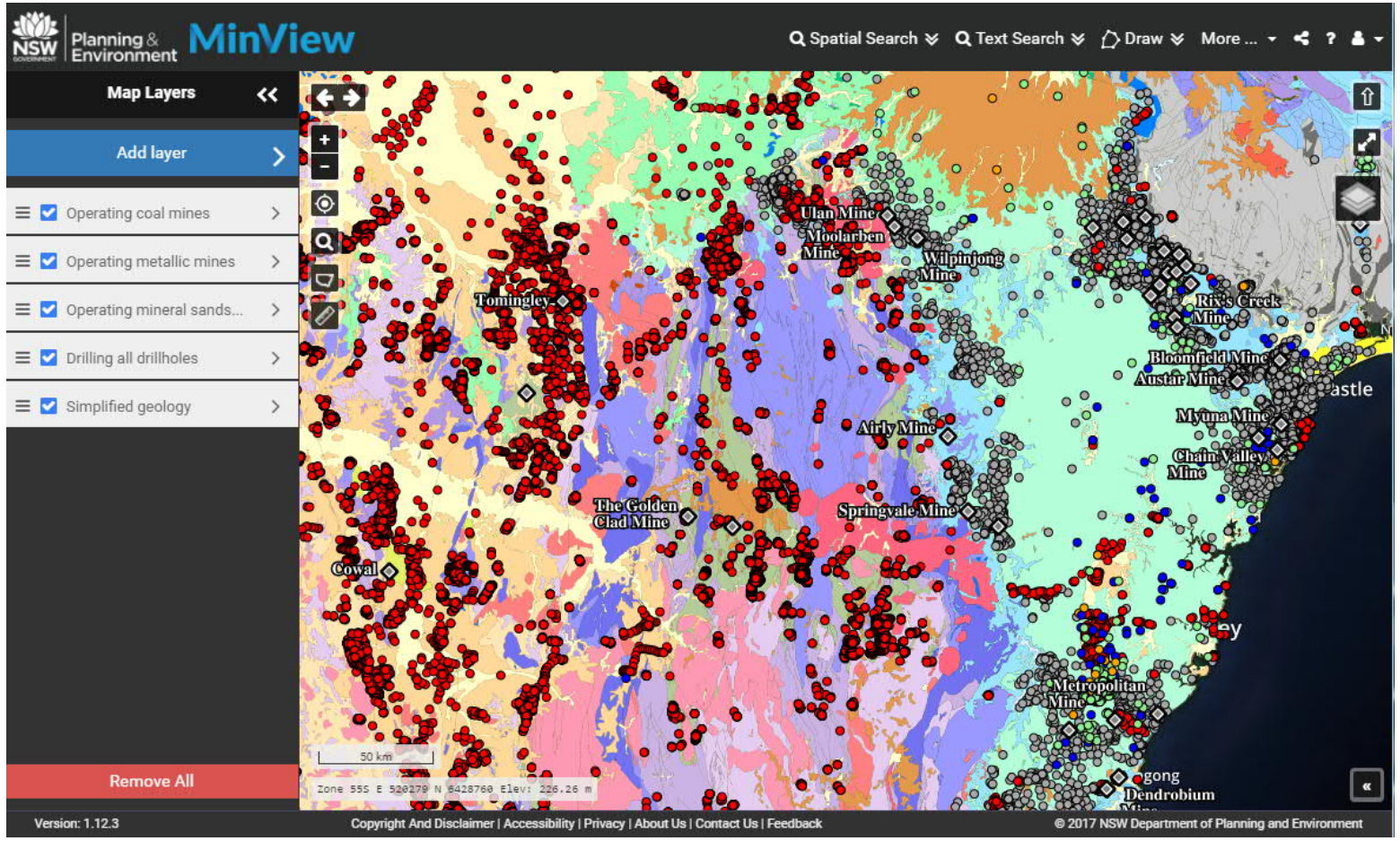
GSNSW will continue to…

- Capture and disseminate high quality geoscientific data
- Support other agencies
- **Facilitate the safe and sustainable development of NSW mineral resources**



Explore NSW

GDW
GEOSCIENTIFIC DATA WAREHOUSE

MIN VIEW

DiGS

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