Department of Primary Industries
Water

WATER MONTORING STRATEGY FOR COAL BASINS IN NSW

Methodology for Monitoring Point Selection

1 Introduction

1.1 Project background

The Water Monitoring Strategy for Coal Basins in NSW (the Strategy) describes actions proposed to enhance water monitoring, and improve the creation and dissemination of water information and knowledge products in the NSW coal basins. It addresses the recommendations of the NSW Chief Scientist and Engineer relating to water monitoring and information management and the NSW Government's commitment to invest in better monitoring and more accessible information made in the NSW Gas Plan. A business case identifies 5 key areas of activity:

- Expanding the groundwater monitoring network
- Expanding groundwater and surface water quality monitoring network
- Harnessing industry and government agency information
- Growing the existing modelling and analysis programs to better characterise groundwater systems
- Making water information and knowledge products available to the community.

The Water Monitoring Expansion project is a sub-component of the Water Monitoring Strategy for Coal Basins in NSW. The sub-project relates to two key strategies:

- Expanding groundwater monitoring by drilling new groundwater monitoring bores in the deeper strata of NSW coal basins
- Expanding groundwater and surface water quality monitoring programs into coal basins with current or potential new coal and CGS development

1.2 Monitoring Network Expansion

This document describes an approach for selecting new water monitoring sites for an expanded water monitoring network in the NSW coal basins. The report covers the following:

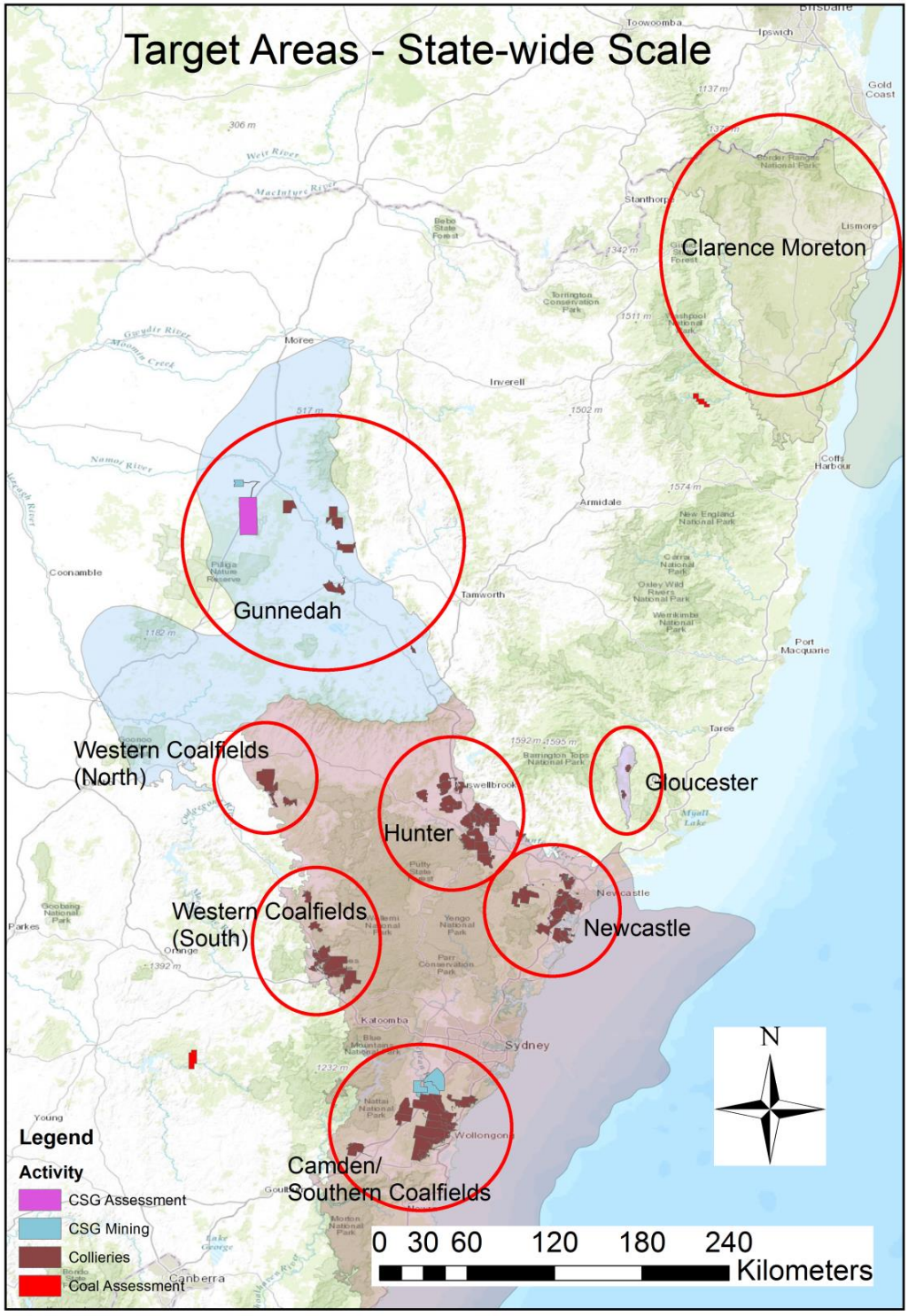
1. Background to the development of the project to expand water monitoring in the NSW coal basins and the areas targeted (Section 1)
2. Statements of monitoring network purpose, objectives and scope (Section 2)
3. Identification of data and information needed to characterise coal basins and inform monitoring point selection (Section 3)
4. Discussion on potential impacting activities, impact pathways and processes, sensitive receptors and how this informs monitoring needs and options (Section 4)
5. Site selection and prioritisation (Section 5)

This report does not provide detailed instruction on the practice and quality assurance of water monitoring, sampling and sample handling, laboratory-related activities and the verification and validation of data. This is to be provided in a separate Implementation and Quality Assurance Project Plan.

1.3 Project areas

Eight areas are identified for expanded water quality monitoring: Clarence Moreton, Gloucester, Gunnedah, Newcastle, Hunter, Western Coalfields (North), Western Coalfields (South) and Camden/Southern Coalfields (considered part of the greater Sydney Basin) and are shown in Figure 1.

Figure 1 – Target areas for expanded water monitoring in the NSW coal basins



2 Monitoring Network Purpose, Objectives and Scope

A clear statement of purpose, objectives, outcome and scope are vital for the successful design and implementation of the monitoring network expansion. For the Strategy, this is provided below.

2.1 Purpose

To monitor groundwater and surface water in the NSW coal basins to establish reference condition* water quantity and quality to allow the observation of water quantity and quality change over time.

*An alternative expression is *baseline*, but it needs to be understood that there are few water resources in NSW which have not already been affected by historic anthropogenic activities. Here reference condition means the condition of the water found upon its initial observation.

2.2 Objectives

1. Define the reference condition of surface and groundwater with respect to relevant quantity and quality parameters
2. Monitor water quality to identify:
    a. Water quality signatures of inter-aquifer or surface water and groundwater mixing
    b. Change from reference condition and trends
3. Provide fit-for-purpose, long term, statistically robust data with which to undertake water condition and trend analysis and reporting
4. Improve the conceptual understanding of water systems and their hydraulic linkages within the broader landscape and environment

2.3 Outcome

A robust monitoring program that establishes a reference condition for the long-term monitoring of the condition of water resources in the NSW coal basins.

2.4 Scope

In scope

- Groundwater and surface water
- NSW coal basins
- DPI Water's/WaterNSW monitoring infrastructure
- Quality and level/pressure parameters

Out of scope

- Industry or other non-DPI Water/Water NSW monitoring infrastructure
- Monitoring of other (non-water) ecological or environmental indicators

3 Information Requirements for Basin Characterisation

3.1 Information needs

In order to make informed choices in locating and prioritising water monitoring points the basins needs to be characterised. The information listed below can assist in this process (**Table 1**).

It should be noted that this report does not characterise the NSW coal basins or identify the number and locations of monitoring sites. This will be done separately for each of the targeted eight coal basin areas (**Figure 1**).

Table 1 – Information Needs

Category	Details
Base Geographic Information	• Roads • Towns • Topography • Cadastre
Existing and Past Water Monitoring	• Public monitoring points • Industry monitoring points • Type of monitoring • Existing data inventory
Land use	• National Parks • State Forest • Crown land • LGA maps • Reserves • Cleared land • Soil types • Bio-strategic Agricultural Land
Mining Information	• Lease areas and status (DRE) • Companies • Existing mine sites & footprint • Mine status: active, care & maintenance, closed, derelict • Maps of abandoned underground coal works • Mining activity in the planning system • Exploration activity
Geology and Coal Resources	• Surface geology • Sub-surface geology contours • Coal resource - economic, future • Geological structural features • Subsidence mapping • Faults, sheer zones, folds • Geologic units
Hydrogeology	• Aquifers/ hydrogeological units • Horizontal and vertical potential difference • Potentiometric maps(per hydrogeological unit) • Recharge areas (artificial recharge from farm and mine dams or ponds) • Discharge areas (FLAG Upness Index map) • Hydraulic parameters • GW quality mapping • Hydrogeochemistry maps

Category	Details
Surface water features	• Rivers (permanent/epithermal) • Lakes • Surface-water groundwater interconnectivity • Highly vs less highly connected systems • Gaining/losing streams • Flood inundation mapping • SW quality
Water Resource Information	• Climate data • WSP Water Sources – GW and SW • Highly productive GW sources • Water licence data • Water use/take data
Ecology	• GDEs - BoM mapping - atlas • Cultural features • Native veg cover • Hanging swamps • Peat swamps • Sensitive water environments/receptors • Threatened and engaged communities
Stakeholder & Community Issues	• Water supply and catchment issues • Identifies politically sensitive hotspots • Activist groups

3.2 Previous studies and identified monitoring requirements

Previous studies into mining and water resources can also assist in identifying where water monitoring recommendation may have already been made. Any case put for additional water monitoring found in the literature should be incorporated into determining the priority of new monitoring points.

4 Activities, causal pathways and potential receptor impacts

Water monitoring is the basis for conceptualising and quantifying impacts from anthropogenic activities to water dependent receptors. To do this, impacts to receptors and thus impact pathways need to be understood. The monitoring network must then be designed to address potential impacts to receptors caused by present or foreseeable activities. To become part of the monitoring network, a monitoring point needs to contribute to understanding the impact pathways. A ranking approach may be applied to then prioritize the spending of funds on the monitoring network.

While there are similarities between activities and potential impacts across the state, there are basin-specific issues also. The table below (**Table 2**) illustrates the logic of thinking-through how activities, causal pathways, potentially impacted receptors and the monitoring needs and options that consequently arise relate. This approach will be for each of the target areas as a step toward designing an expanded water monitoring network in those areas.

Table 2: Examples linking activities to potential water impacts and the identification of monitoring needs and options

Activity	Pathway/Process	Receptor	What needs Monitoring?	Monitoring Options
Underground Coal Mining	Surface subsidence and fracturing of swamp sediments and swamp bedrock >>> Loss of downstream flows, reduction in flow regulation capacity, water quality impacts, increased sediment erosion >>> Alteration of swamp water balance and functions	Surface water resources (quantity and quality)	Gauge streams downstream of swamps in comparable mined and unmined catchments Shallow aquifers adjacent to swamps in comparable mined and unmined locations.	Monitoring of downstream flows and water quality parameters Concurrent groundwater level monitoring in swamp sediments and shallow bedrock
Open-cut Coal Mining	Aquifer depressurisation >>> Reversal of flow direction between alluvium and hardrock >>> Interception of potential baseflow and/or induced river recharge >>> Reduced water to water dependent assets >>> Possible trigger of WSP pumping restrictions	Water dependent assets SW users	Permian aquifers	Nested piezometers Monitoring/reporting of take River stage/flow
CSG Production	Depressurisation of coal seams >>> Alteration of subsurface hydrology including groundwater levels (pressures), gradients and flow paths >>> Enhanced inter-aquifer connectivity, leakage between aquifers and alteration changes of water quality	Shallow and intermediate groundwater resources (quantity and quality)	Multi-level or nested piezometers in a number of settings relative to escarpment, basin and mining, focussing on shallow and intermediate depths in Hawkesbury Sandstone and in Narrabeen Group aquifer(s)	Shallow, intermediate and deep groundwater levels

5 Site Selection and Prioritisation

5.1 Site Selection

Criteria have been developed to guide, assess and prioritise the siting of water monitoring points, both in location and target depths. Water monitoring points should be chosen that meet as many as the criteria as possible whilst remaining consistent with the general principles described above. Logistics (such as site access) and funding availability will always constrain the eventual number and location of sites, so the criteria can be applied to ranking priority.

The site selection criteria are:

1. Identifies or confirms the existence, depth, thickness and other characteristics of strata. Option to take core provides further information on the characteristics of coal seams or other strata.
2. Identifies or confirms the existence, depth, thickness and other characteristics of aquifers and aquitards. Measures head (pressures/levels) and/or water quality parameters that contribute to understanding hydrodynamics.
3. Placed in a location or at a depth that provides data that is valuable for numerical modelling, in particular that optimises statistical representativeness and minimises model uncertainty.
4. Placed in a location and/or at a depth where there is an important data gap and current information is deficient.
5. Provides valuable leverage by complementing existing monitoring infrastructure, especially where a long record of water data exists eg. Adjacent to surface water gauging site; offset vertically from existing monitoring bore.
6. Placed in a location and/or at a depth that considers the current, known future and potential longer term location of industry activity that could have potential water impacts on high value water resources, and/or water users, or ecosystems that rely on water.
7. Placed in a location that addresses concerns and issues important to stakeholders and local community.
8. Are there logistical (including future industry development), environmental or cultural constraints that make siting monitoring infrastructure difficult or prohibitive?

5.2 Site Prioritisation

The priority of a potential monitoring point can be assessed against alternative monitoring point locations by testing the suitability of the point's location against each of the criteria listed above.

The proposed method is to score the degree to which each monitoring point meets each criteria as high (3 points), medium (2 points) or low (1 point). Weightings can be applied to the site selection criteria to accommodate differences in relative importance governed by, for example, specific circumstances or purpose and objectives for monitoring in any particular area.

An example of the method's application is shown below in **Table 3**. A table like this will be completed for each of the eight areas.

Table 3: Example of methodology for prioritising monitoring sites

SITE	(1) Contributes to regional geological conceptual model?	(2) Contributes to regional hydro(geo)logical conceptual model?	(3) Contributes to certainty of regional numerical model?	(4) Fills a spatial gap in the regional monitoring network	(5) Compliments (not duplicates) existing sites?	(6) Intercepts impact pathway from human activity to environmental receptor?	(7) Addresses stakeholder identified issues	(8) Logistical constraints	Score (Rank)
Weighting	2	3	2	4	4	5	3	(Yes/No)	
Site A	2	3	3	3	3	2	3		62 (1)
Site B	2	2	2	1	1	2	2		38 (5)
Site C	2	2	2	3	3	2	1		51 (3)
Site D	2	2	2	3	3	2	3		57 (2)
Site E	2	2	2	2	2	2	2		46 (4)