Department of Planning and Environment

Narrabri Special Activation Precinct

Hydrogeology and Water Demand Structures Report

April 2023

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Narrabri Special Activation Precinct
Hydrogeology and Water Demand Structures Report

Department of Planning and Environment

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WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Acknowledgement of Country

We acknowledge country and pay respects to the Gomeroi/Gamilaroi/Gamilaraay/Kamilaroi people as the Traditional Owners and Custodians of the land and waters on which the Narrabri Special Activation Precinct is located on.

We recognise their continued connection to Country and that this connection can be seen through stories of place and cultural practices such as art, songs, dances, storytelling and caring for the natural and cultural landscape of the area.

We also recognise the continuing living culture of Aboriginal people, and the significance of Narrabri in that living culture. We recognise the contemporary stories of displacement and the cultural significance of Narrabri in the continued journey of self-determination in Australia.

Executive summary

The Narrabri Special Activation Precinct (SAP) is one of the six distinctive areas throughout regional NSW to bring together planning and investment to stimulate economic growth across a range of industries including freight and logistics, manufacturing, waste management and recycling, energy generation and agricultural and food processing activities. Narrabri SAP was declared the sixth and final SAP investigation area as its location has a strong reputation and proximity to one of Australia's highest productive grain regions and strong transport linkages to road and rail including the future Inland Rail.

The hydrogeology and water demand technical assessment are the focus for this report and provides a key technical input for the overall Narrabri SAP Structure Plan.

Overview of the key stages of work

The hydrogeology and water demand assessment for the Narrabri SAP was completed in a stepwise approach over three stages, with the work in each stage building on the last.

Stage 1 – Hydrogeology and water demand baseline assessment: This stage was designed to provide context, baseline analysis and information regarding hydrogeology and water demand constraints and opportunities to the SAP technical study groups and stakeholders.

Stage 2 – Water demand scenario analysis: This stage quantitatively assessed the water supply and demand requirements for three development scenarios developed for the Narrabri SAP Master Plan.

Stage 3 – SAP structure plan water balance report: A water balance assessment based on the final SAP structure plan has been developed and is the focus of this report. This stage consolidates the previous investigations. It aims to quantify the water demands for the SAP and identifies the potential water supplies required. The feasible volumes of water that can be provided, and respective treatment methods, are also considered.

Assessment and findings

Water demand estimates

A water demand estimate based on the land-use category and area of development within the SAP for the 40-year planning horizon was developed using the demand rates and water quality requirements for different types of industries. The Structure Plan land use area considers the opportunities and constraints identified during the master planning process and final Enquiry by Design (EbD) workshop.

SAP master plan water balance results

The key findings of the water balance assessment for land uses within the SAP are:

- **Stage 1** – SAP water demands can be met by using the 300 ML/yr available from the existing Narrabri Shire Council (NSC) town water supply. There is not a requirement to develop and access to the full entitlement from the Pilliga sandstone (Southern Recharge groundwater source).
- **Stage 2** – SAP water supply can meet the minimum water demand development (i.e., lower water intensive industries) using the 300 ML/yr available from the existing NSC town water supply. There is a supply gap of around 364 ML/yr to meet the demands of the more water intensive industries (maximum water demand assessment). This supply gap includes the assumption that the Pilliga sandstone (Southern Recharge groundwater source) is developed and access to the full entitlement is approved. Any approval and use of less than 610 ML/yr from the Pilliga sandstone will increase the supply gap.

— **Stage 3** – SAP water supply can meet the minimum water demand development (i.e., lower water intensive industries) using the 300 ML/yr available from the existing NSC town water supply. There is a supply gap of around 870 ML/yr to meet the demands of the more water intensive industries (maximum water demand assessment). This gap includes the assumption that the Pilliga sandstone (Southern Recharge groundwater source) is developed and access to the full entitlement is approved. Any approval and use of less than 610 ML/yr from the Pilliga sandstone will add to the supply gap.

Recommendations

Maximise use of existing water supplies

The use of existing water supplies provides an economically sustainable method of servicing the SAP area as there is a baseline amount of infrastructure in place. It is therefore recommended that the SAP maximise the use of existing town water supplies prior to investing in new supplies and enabling infrastructure.

SAP water demand action and response plan

A water demand trigger, action and response plan for water uses within the SAP should be developed. This will enable the new water supplies to be planned and delivered in time, and based on actual demand triggers, when required, as the SAP land uses are built.

Stormwater capture, storage and use into SAP land uses

A recycled stormwater supply for the SAP would require capture/storage/treatment and reticulation infrastructure. Treated stormwater would ideally be used for non-potable uses such as irrigation or industrial processes. Investigation of the feasibility of different storage options is also required including private tanks, constructed wetlands and Managed Aquifer Recharge (MAR).

New groundwater extraction from the Pilliga sandstone

Additional water supply will need to be connected to the SAP for stage 2 and 3 to be developed. New groundwater supply would most likely be developed in the Pilliga sandstone (Southern Recharge groundwater source). The Pilliga sandstone is a regional aquifer system and directly beneath the SAP area from a depth of around 15–20 m. The NSC currently has an entitlement of 610 units from the Southern Recharge groundwater source (Table 4.1).

Recycled wastewater

To utilise recycled water generated within the SAP, a new local STP will be needed, which also forms part of the recommendations for the Infrastructure Study Report. Treatment infrastructure will be dictated by the water quality requirements for the specific SAP end-uses. This infrastructure has significant approvals and regulatory requirements/measures which also need to be considered.

Conclusion

As a result of the water balance assessment, the early stages of the SAP Structure Plan are able to be supplied with water from the existing town water supply, with a new reticulated connection. Additional water supplies will need to be developed to meet the full water demand for the Structure Plan over the next 40 years. There are various options available regarding the potential mix of new supplies. Water quality of new sources (and the ability of development to utilise non-potable water) is an important consideration as only a limited additional volume from potable water sources has been identified for use within the SAP.

Demand for the expected development outside of the SAP (residential and light industry) can be met using the separate 1,200 ML/yr volume allocation which NSC have reserved for this purpose.

Indicative timing

The indicative timing of flooding and water quality infrastructure upgrades is shown in Figure ES.1. The timing is based on the nexus between the upgrade and land use generating the need for the upgrade. This timing is influenced by the rate of development and the staged release of land within the SAP and the Mt Kaputar residential area.

Infrastructure	Discipline	Stage
Recycled Water System – Pump station at STP site – 100 L/s	Hydrogeology & Water	Stage 1
Recycled Water System – DN150–300 recycled water mains – 5 km	Hydrogeology & Water	Stage 1
On site water storage – water tanks x 2 (2.5 ML)	Hydrogeology & Water	Stage 1
On site water storage – Booster pump station and chlorination 100 L/s (each water tank)	Hydrogeology & Water	Stage 1
On site water storage – Water mains x 15 km	Hydrogeology & Water	Stage 1
Wastewater network – Sewer pump stations x 3 – 50 L/s	Hydrogeology & Water	Stage 1
Wastewater network – Rising mains (DN 150) – 5 km	Hydrogeology & Water	Stage 1
Wastewater network – Trunk gravity sewer (DN 300) – 15 km	Hydrogeology & Water	Stage 1
Ground Water Drilling Test – Test Bore – 6 inch drill hole, up to 200m deep	Hydrogeology & Water	Stage 2
Ground Water Drilling Test – Groundwater production bore – Up to 200m deep, 12 inch drillhole, 8 inch Class 18 PVC casing	Hydrogeology & Water	Stage 2
Ground Water Drilling Test – Submersible pump, rising pipe, and headworks including control box, meter – x 1	Hydrogeology & Water	Stage 2
Production Bore for Water Supply – Bores similar to existing town water bores – x 2 – 50 L/s each, 100m deep	Hydrogeology & Water	Stage 2
Production Bore for Water Supply – Bore from Pilliga Sandstone source with additional treatment processes – 20 L/s	Hydrogeology & Water	Stage 2
New Sewerage Treatment Plant (STP) Daily flow treatment – 3 ML/d	Hydrogeology & Water	Stage 2
New Sewerage Treatment Plant (STP) Treatment process unknown at this stage. Future tertiary treatment to produce Class A recycled wate	Hydrogeology & Water	Stage 2
New Sewerage Treatment Plant (STP) Recycled water storage (PE lined and covered earth embankment type storage) – 100 ML capacity	Hydrogeology & Water	Stage 2
New Sewerage Treatment Plant (STP) Emergency discharge pipeline (DN200 or similar) – 3 km	Hydrogeology & Water	Stage 2

Figure ES.1 Overview staging of hydrogeology and water demand infrastructure for Narrabri SAP across three stages

1 Introduction

1.1 Narrabri strategic significance/context

The New South Wales (NSW) Government, through its introduction of the Special Activation Precincts (SAPs) has identified six distinctive areas throughout regional NSW to bring together planning and investment to stimulate economic growth across a range of industries including freight and logistics, manufacturing, waste management and recycling, energy generation and agricultural and food processing activities. The planning and creation of these areas is partially facilitated and funded through the $4.2 billion Snowy Hydro Legacy Fund.

The establishment of SAPs is a joint NSW Government Agency initiative by the Department of Regional NSW, Department of Planning and Environment (DPE) and the Regional Growth NSW Development Corporation (RGDC) as part of the 20-Year Economic Vision for Regional NSW. DPE is responsible for preparing the planning framework whereas the Department of Regional NSW manages each precinct.

1.2 Scene setting (local context)

Narrabri is located in the heart of the Namoi Valley on the North West slopes and plains of New South Wales. The word Narrabri means ‘forked waters’, which describes the splintering waterways of the Namoi River, the Narrabri Creek and Horse Arm Creek. The township of Narrabri is the administrative centre of the Shire. Much of the Narrabri Shire population is centralised in the township of Narrabri, Wee Waa and Boggabri, and around the villages of Bellata, Edgeroi, Maules Creek, Baan Baa, Gwabegar and Pilliga. The Narrabri region is known for its fertile soils, abundant natural resources, strong industry and world-leading research.

In November 2020, Narrabri was declared the sixth and final SAP investigation area, enabled by its strong reputation and location within Australia’s highest productive grain region as well as its strong transportation linkages including existing road and rail connections and the future Inland Rail. To facilitate the planning within this precinct DPE has engaged WSP to prepare a series of technical studies regarding Hydrogeology and Water Demand within Narrabri SAP investigation area. An overview of the area is shown in Figure 1.2.

Set against the backdrop of the Nandewar Ranges and on the banks of the Namoi River, the topography of the area varies from river plains through to mountain ranges. The Namoi River meanders through these plains and acts as the lifeblood of the area supporting agriculture, industry and people. The Namoi traverses the township of Narrabri from north west to south east. A number of smaller tributaries of the Namoi are also located within Narrabri including Mulgate Creek, Horsearm Creek and Long Gully. Narrabri has historically experienced flooding from each of these sources on a regular basis.

Narrabri township is located within the Narrabri Shire local government area (LGA), approximately 530 km northwest of Sydney. As of 2021 census, the population of Narrabri township was 6,898 persons with 16% identifying as Aboriginal and/or Torres Strait Island Peoples.

The township lies at the junction of the Newell and Kamilaroi highways and has direct rail connection to the Port of Newcastle via the Walgett branch of the Main North line. Once completed, Narrabri will also have a direct connection to the new Inland Rail route which will connect Melbourne to Brisbane via new and upgraded track.

1.3 Masterplan process

The Narrabri Masterplan is the initial stage in determining the area and land uses for the Precinct and is guided and informed by DPE in partnership with the Department of Regional NSW and Narrabri Shire Council. Throughout master planning process, community, stakeholder and industry consultation will take place, as well as a range of technical studies to help inform the preparation of a draft master plan.

Creation of the Masterplan is developed across a series of key inputs and includes a range of technical disciplines including urban design, architecture, landscape design, engineering, and environmental disciplines. The Masterplan process and its stages are summarised in Figure 1.1.

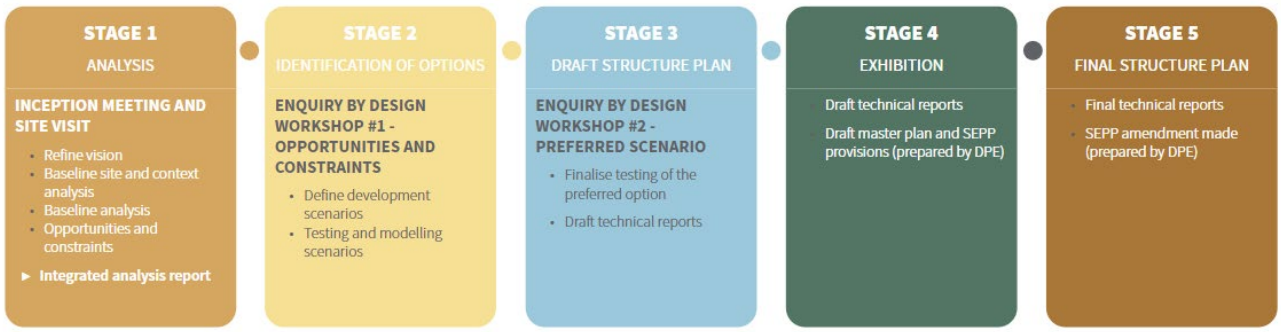


Figure 1.1 Narrabri SAP Masterplan process

The following is a summary of key inputs and activities completed to date that support the findings of this technical report:

- **Stage 1 Analysis:** This stage sets the scene for Narrabri SAP by refining the vision and providing a more detailed understanding the SAP. This stage is supported by overview findings from a site visit, baseline assessment across various technical topics, and identification of key opportunities and constraints.
- **Stage 2 Identification of Options:** Various scenarios of the Narrabri SAP were developed in conjunction with council and inputs from the technical findings from the baseline assessment. A preliminary Enquiry by Design (EbD) workshop was held on 29 and 30 March 2022 to develop a range of initial land use scenarios for further assessment.
- **Stage 3 Draft Structure Plan:** Develops more detailed structure requirements based on the preferred land use scenario based on the range of options assessed in Stage 2. The preferred land use scenario was assessed through a final EbD workshop held between 5 and 8 September 2022 to study the interdisciplinary constraints and key infrastructure requirements. This technical report assesses the land use Structure Plan from the final EbD workshop from a Hydrology and Water Demand perspective. Figure 1.2 is an overview of the Narrabri SAP preferred land use scenario.

Following Stage 3 Draft Structure Plan, further community and stakeholder consultation will occur in the form of an exhibition period which includes display of technical reports from the Draft Structure Plan, Draft Master Plan, and SEPP.

1.4 Report structure

This Hydrology and Water Demand report has been prepared to provide key inputs for the Narrabri SAP Structure Plan.

The remainder of this report is structured as follows:

- **Narrabri SAP overview – Structure Plan**

  Chapter 2 is overview of the Narrabri SAP including key elements of the SAP as well as relationship with the Inland Port, Town Centre, and proposed residential areas. In addition, an indicative summary of land uses, employment, and population are summarised.

- **Local context**

  Chapter 3 provides an overview of local context from a Hydrology and Water Demand perspective summarising key strategic plans, policy, and planning documentation as well as existing conditions of the area.

- **Methodology**

  Chapter 4 includes a description of the process used of undertaking the study, and list of stakeholders involved, and information relied upon as part of the study.

- **Assessment and findings**

  Chapter 5 provides technical inputs and findings for the Structure Plan against the visions and aspirations of the Narrabri SAP from the context of a Hydrology and Water Demand perspective.

- **Recommendations and conclusions**

  Chapter 6 summarises recommendations and conclusions based on findings and inputs for Hydrology and Water Demand within the Narrabri SAP.

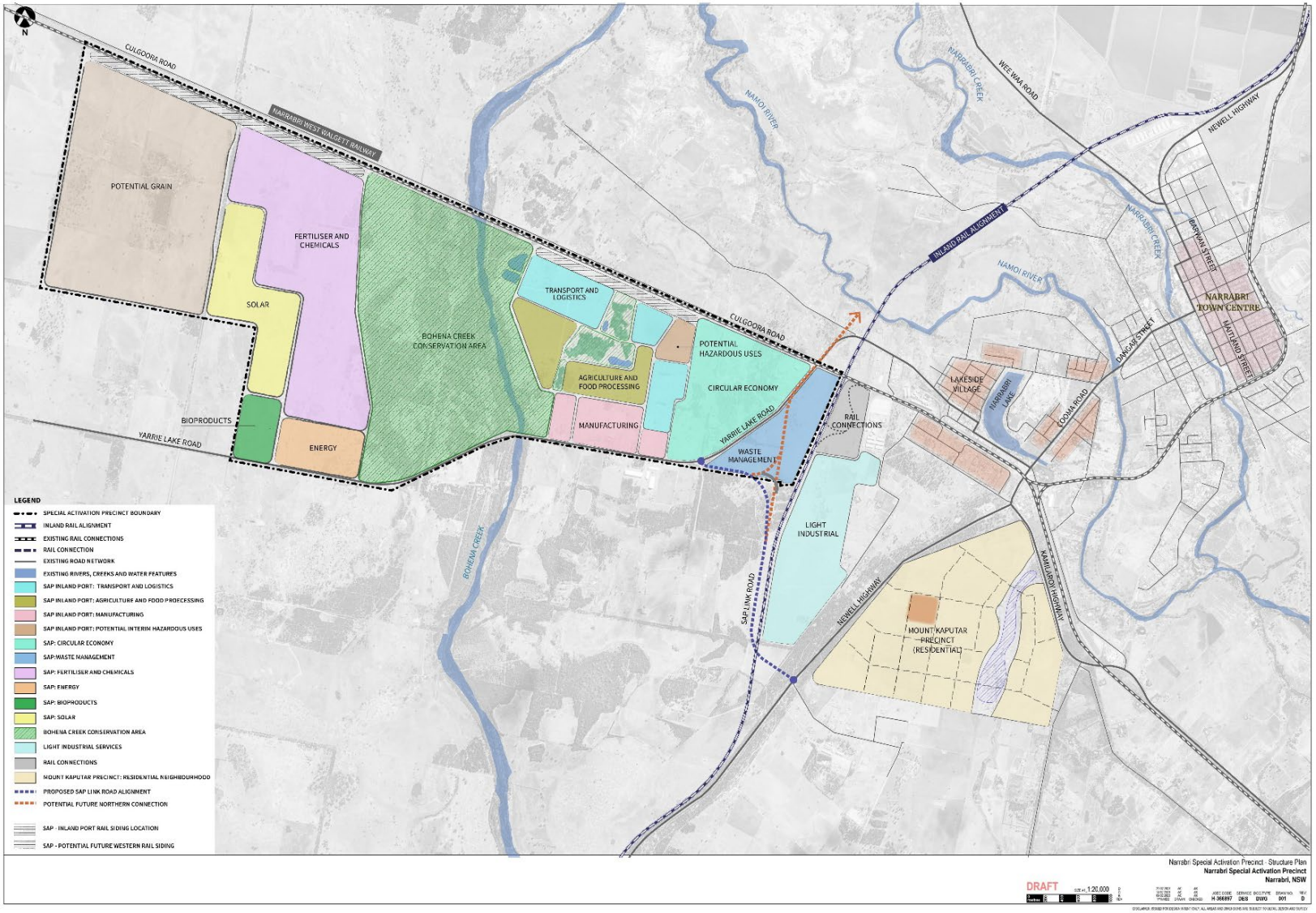


Figure 1.2 Overview of the Narrabri SAP (DPE, April 2023)

2 Narrabri SAP overview – structure plan

2.1 Overview

The Narrabri SAP boundary was developed at the Final EbD covers an area of 2,629.45 ha. It is located to the west of the existing township and incorporates two areas separated by an environmental buffer zone. This boundary was utilised as a basis for all technical studies and was refined during the master planning and technical assessment process as summarised in Section 1.3. Figure 2.1 provides an overview of key elements of the Narrabri SAP.

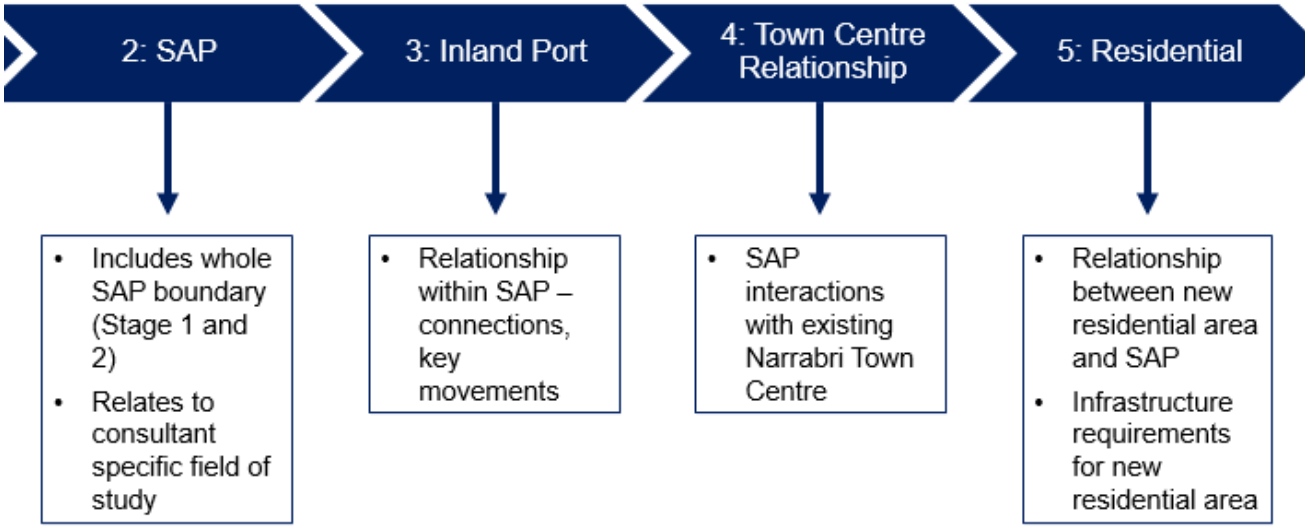


Figure 2.1 Overview of key elements of Narrabri SAP

2.1.1 Visions and aspirations

The vision and principles for the Narrabri SAP is grounded by the *7 Elements of Great Places* which is based on the United Nation's *The New Urban Agenda framework*. The Narrabri SAP Vision and Principles were developed with this framework and summarised in Table 2.1. They were refined during the preliminary EbD to respond to feedback from stakeholders and consultants. This vision will guide the design and development of the precinct and the assessment of the merits of each of the scenarios.

Strengthening our relationship with Country and Water; the Narrabri SAP will retain the Town Centre as the heart of Narrabri, unlock greater economic growth for the region, leveraging from the Inland Rail, the Northern NSW Inland Port and the Narrabri Gas Project.

Table 2.1 SAP vision – 7 Elements of Great Places

Element	Vision
 **Equity**	Strengthen the existing community and businesses giving them the tools and the reason to stay whilst attracting economic and residential growth for Narrabri that will 'give back' to Narrabri. Respect the cultural and lifestyle diversity by providing access to housing, health, education, social and community infrastructure to enhance the liveability and lifestyle of Narrabri.
 **Identity**	Establish a legacy at Narrabri for future generations to be proud of which reflects diversity, protects and respects the site's natural features, heritage and vegetation whilst integrating a cultural lens across the entire SAP in all actions.
 **Greenery**	Use science and local knowledge to define constraints and opportunities enabling the protection of community and environment with a strong focus on safety, flood and bush fire risk, water security and bio values.
 **Urbanity**	Reinforce the Town Centre as the heart of Narrabri, breaking down boundaries, addressing basic social deficits and embracing diversity to achieve a liveable and lovable place that is safe, connected and active.
 **Mobility**	Plan for both regional and local equitable access for future residents, visitors and workers of all ages, abilities, and economic position; aiming to improve health, convenience and social connectedness.
 **Wellness**	Prioritising the community's health, well-being and sense of belonging and setting a new environmental sustainability benchmark for energy intensive development.
 **Resilience**	Grow and retain the local small industry community whilst up-skilling and attracting new industries and enterprises, setting a standard for innovation and circular economy across the board and including energy-intensive industries.

2.1.2 Staging

For the delivery of the Narrabri SAP, an indicative staging delivery plan is assumed to commence in 2024 and ongoing toward 2030 and beyond. Staging at this time is assumed across three stages:

— **Stage 1:** east of Bohena Creek with a focus on the transport and logistics land use (e.g. the Inland Port development), associated light industrial industry and assumed development of 600 new residential lots.
— **Stage 2:** remaining development east of Bohena Creek and associated light industrial industry, waste management and circular economy land uses.
— **Stage 3:** west of Bohena Creek focussing on more hazardous heavy industry land development (such as energy, fertiliser and chemical production), bulk grain handling, and assumed development of a further 1,800 new residential lots.

Figure 2.2 provides an overview of the infrastructure delivery for the Narrabri SAP.

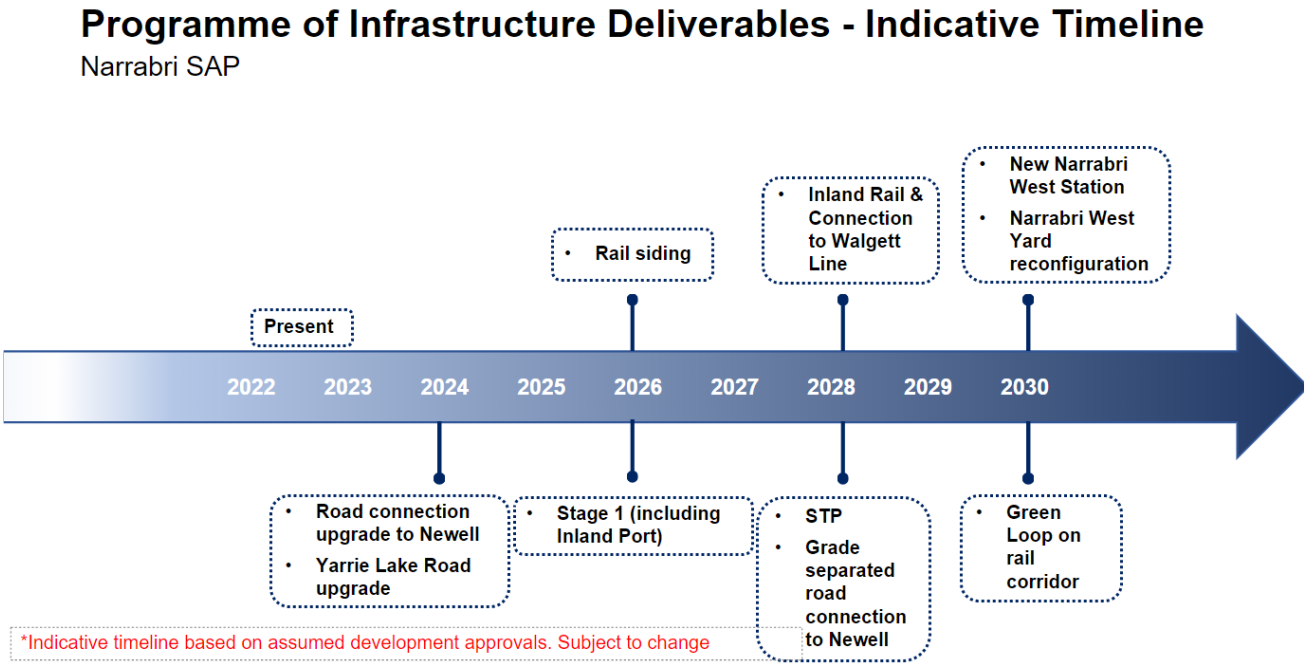


Figure 2.2 Indicative program and staging of infrastructure deliverables (subject to change)[1]

(1) Note: Reference of the 'Green loop' is considered a long-term strategic concept and is not assessed in this report.

2.1.3 Land uses

Land uses and size within the Narrabri SAP and external to the SAP are summarised in Table 2.2 and Figure 2.3 provides an overview of the land uses.

Table 2.2 Overview of land use and sizing within and outside the Narrabri SAP boundary

Land use within the Narrabri SAP boundary	Area (ha)	Land use outside of the Narrabri SAP boundary	Area (ha)
Fertiliser and Chemicals	366.62	Rail connection	44.92
Solar	144.14	Light Industrial (North)	106.75
Grain (Potential)	527.48	Light Industrial (South)	187.30
Western Rail Siding	37.75	Residential (2060 Target)	597.15[3]
Energy	63.31		
Bioproducts	40.79		
Inland Port (Rail siding and additional rail siding reserve)	36.07		
Transport and Logistics	108.20		
Interim Potential Hazardous Uses	19.19		
Waste Management and Recycling	94.32		
Agricultural and Food Processing	90.88		
Manufacturing	72.59		
Circular Economy[1]	181.75		
High Value Vegetation (To be retained)[2]	45.85		
Bohena Creek Conservation Area[2]	626.27		
Others (Rail, Roads, Decoupling Infrastructure)[2]	174.24		
Total	**2629.45**	**Total**	**936.12**

Source: DPE, 17 February 2023

(1) Circular Economy land use is identified land that align with circular economy goals by valuing resources, by getting as much use out of products and materials as possible, and reducing the amount of waste generated.

(2) Non-employment land uses.

(3) The net residential area (excluding flooding area and main indicative connections) = 488.18 ha.

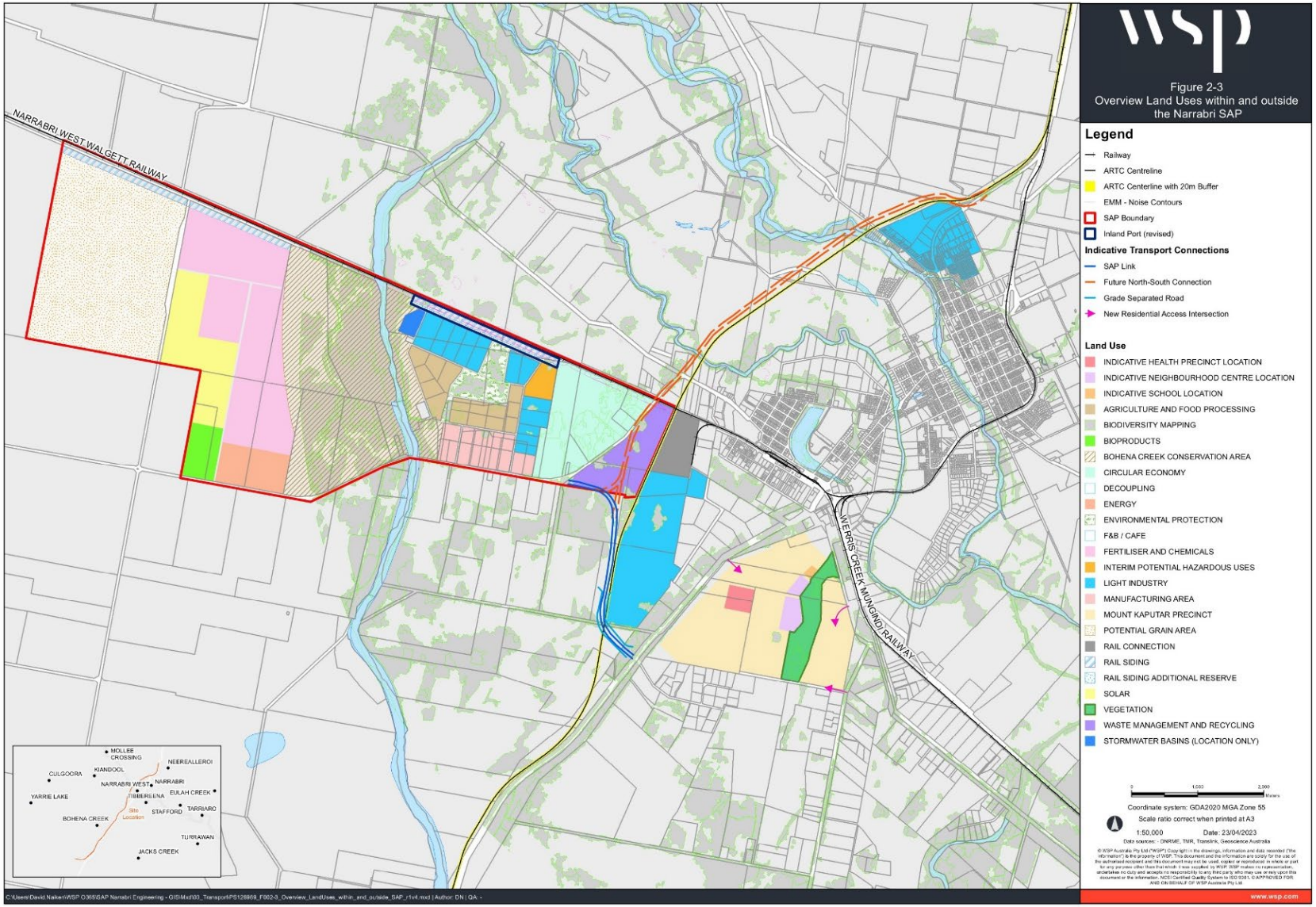


Figure 2.3 Overview land uses within and outside the Narrabri SAP (April 2023)

2.1.4 Employment

An estimate of the number of forecasted jobs created within the SAP is summarised in Table 2.3.

Table 2.3 Estimated employment requirements (FTEs) within the SAP based on high uptake sensitivity[1]

Industry	2027	2032	2042	2062
Fertiliser & Chemicals	260	260	260	260
Energy	10	10	10	10
Bioproducts	0	0	0	50
Transport & Logistics	70	80	90	120
Agricultural & Food Processing	40	220	220	220
Waste Management & Recycling	50	60	110	110
Total	**430**	**630**	**690**	**770**

Source: Narrabri SAP Economic Analysis Updated employment figures following September 2022 Enquiry by Design (EbD) Workshop (Aurecon, 2022-10-10)

(1) Employment numbers correspond to high uptake sensitivity with gas project

Assumptions related to these estimates include:

— It is assumed that the employment in the grain, rail siding, interim potential hazardous uses and circular economy areas would not increase substantially or is included in the estimates for other land uses.

— The employment numbers in Table 2.3 do not include a specific allowance for the land allocated for Manufacturing. DPE has advised that the total employment estimate should be considered the maximum number. For the purposes of this assessment, we have assumed that the manufacturing jobs are included within the Agricultural & Food Processing estimate (as they are adjacent to each other).

— It is assumed that the Transport & Logistics employment forecasts include those associated with the Inland Port and light industrial within the SAP.

— The numbers in Table 2.3 do not include an estimate of the number of jobs potentially created in the identified land external to the SAP (Light Industrial North and South). While the impact of this development is outside the scope of this assessment, we have included a nominal allowance for the purposes of estimating the road network performance for the SAP. Based on the relative proportions of their land areas (3.5 times), it is estimated that the number of jobs in the Light Industrial South area are 245 in 2027, 280 in 2032, 315 in 2042 and 420 in 2062.

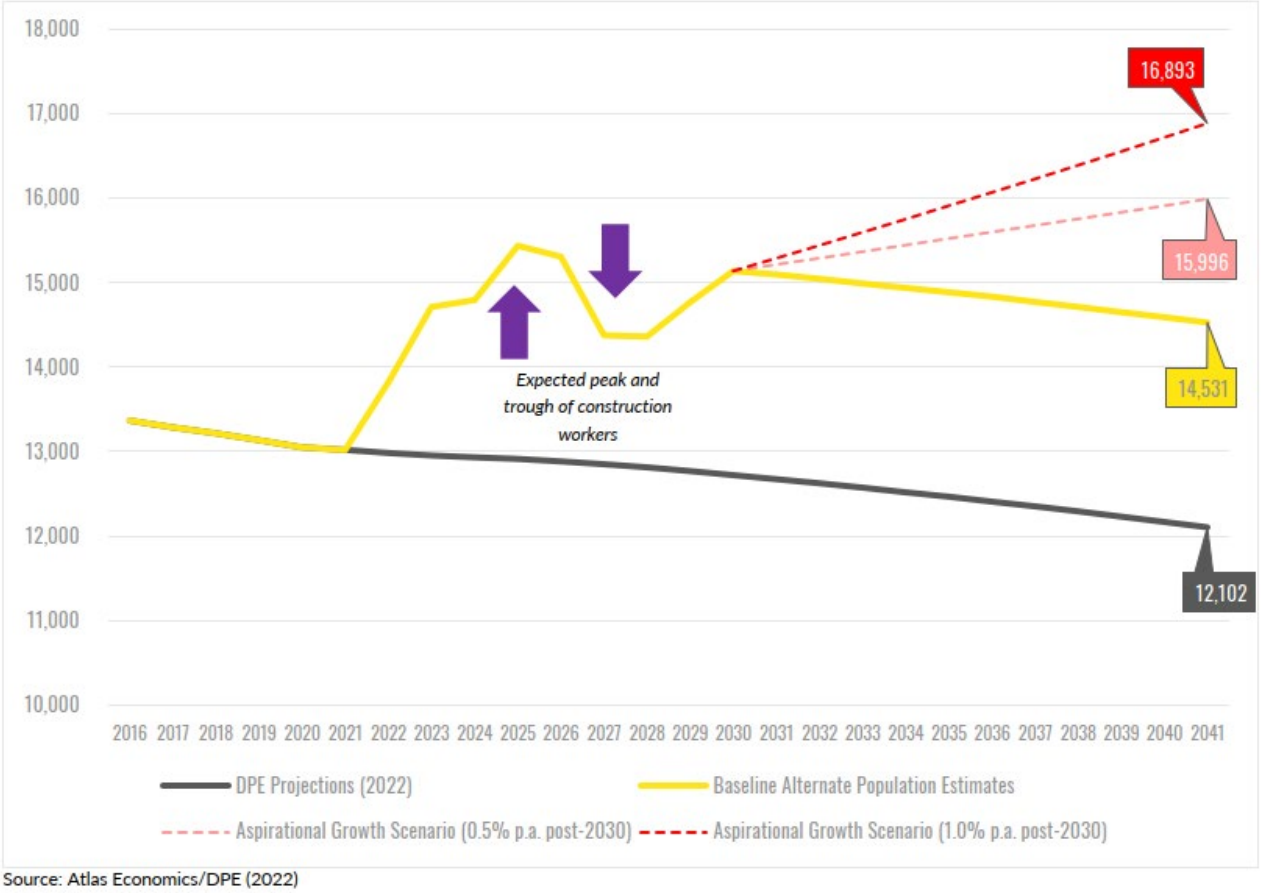
2.1.5 Population

The Narrabri Shire region could reach a resident population between 14,500 and 16,900 residents by 2041 as shown in Figure 2.4. Based on these estimates the potential dwelling need for the Narrabri Shire region would be between 7,000 and 8,000 dwellings by 2041. Accordingly, the population estimate scenarios could require between 1,000 and 2,100 additional dwellings over the coming 20 years to 2041, equating to between about 50 to 110 additional dwellings per annum. These estimates identify a significant uptick in housing supply would be required to meet population growth.

Population estimates indicate that the SAP would increase the potential workforce as well as the population of Narrabri as a whole. The peak increase in workers is expected to occur in 2025/2026.

- 1,003 operational jobs (Source: Narrabri Shire Council, 2021)
- of these 85% would be new jobs (853)
- of the new jobs, 15% would be filled by people already living in Narrabri Shire, while the remaining 85% would be filled by new employees to Narrabri Shire = 725 new workers
- the population increase associated with new operational workers (assuming 2.5 people per household) = 1,812 people.

For the purposes of this assessment, we have assumed that the maximum increase of new residents would be contained within the new residential area, and that it would be maintained, even if there is a decline in the population in current residential areas within Narrabri Town.



Source: Atlas Economics/DPE (2022)

Source: Atlas Economics developed alternate population forecasts for DPE, November 2022

Figure 2.4 Narrabri Shire Population projections (2016–2041)

3 Policy and planning context

3.1 Strategic plans, policy, and planning

A review of Commonwealth and State legislation, policy, and guidelines relevant to water resources management across the Narrabri SAP investigation area has been completed. Table 3.1 provides an overview of relevant plans, policy, and planning which govern the management of water resources and their relevance to the Narrabri SAP.

Table 3.1 Overview of plans and policy

Name	Description
State Legislation	
Water Management Act 2000	The objective of the *Water Management Act 2000* is the sustainable and integrated management of the state's water sources for the benefit of present and future generations and to ensure that no more than minimal harm will be done to the aquifer, or its dependent ecosystems, as a consequence of its being interfered with in the course of the activities. he *Water Management Act 2000* governs the issue of water access licences (WALs) and approvals for water sources (rivers, lakes, estuaries, and groundwater) in NSW. The *Water Management Act 2000* includes the concept of ensuring 'no more than minimal harm' for both the granting of water access licences and the granting of approvals. Groundwater resources within the Narrabri SAP investigation area are governed under the *Water Management Act 2000*. It provides for the sustainable and integrated management of the state's water sources for the benefit of present and future generations.
Water Management (General) Regulation 2018	Specifies procedural, technical and licence requirements, and exemptions under the *Water Management Act 2000*. Defines the function and powers of water supply authorities.
Water Sharing Plans	Water Sharing Plans are the main legislative tool in NSW set rules for sharing water between water users and the environment and bring water users into a single licensing system managed under the *Water Management Act 2000.* Water Sharing Plans include provisions that impose conditions on access licences and water supply work approvals. These conditions specify the circumstances under which water access rights may be used. There are seven Water Sharing Plans of relevance to the Narrabri SAP investigation area: five for groundwater sources and two for surface water, as follows: — NSW Great Artesian Basin Shallow Groundwater Sources 2020 — NSW Great Artesian Basin Groundwater Sources 2020 — NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020 — NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020 — Namoi Alluvial Groundwater Sources 2020 — Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012 — Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016.

Name	Description
Guidelines and Policies	
Water supply works approvals	Water supply work approvals allow you to construct and use a work which takes water from a river, lake, or aquifer. The purpose of water supply work approvals is to ensure that the construction or use of a work does not cause more than minimal harm on water sources and their dependent ecosystems, or to other authorised water users. Responsibilities for granting and managing water licences and approvals are shared between the Natural Resources Access Regulator (NRAR) and WaterNSW.
Best Practice Management of Water Supply and Sewerage (2007)	Identifies six criteria for best practice management of town water supply and sewerage. Defines outcomes local water utilities need to achieve to demonstrate the implementation of the guidelines. Demonstration of compliance to the guidelines is recommended in the event that Narrabri Shire Council wish to increase their water allocations under their local water utility water access licences.
Australian Guidelines for Water Recycling (AGWR): Managing Health and Environmental Risks (2006)	Provide guidance regarding the best practices for water recycling, including stormwater, greywater, and treated sewage. Recommends a health-based performance target for managing pathogen risk, and provides a detailed framework for this process. Considers whole-of-system risks management, matching suitable end-uses, and end-use controls, with appropriate treatment and system operational measures.
NSW Guidelines for Recycled Water Management Systems (2015)	Provides additional guidance for developing a RWMS which complies with the elements in AGWR (the national guidelines) and the applicable legislative requirements in NSW. A RWMS includes a collection of documents, procedures, processes, data, and records that support the proposal and continued use of recycled water. Recommends a health-based performance target for achieving microbial and pathogen quality in recycled water, like the AGWR.
NSW Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises (2008)	The guidelines provide advice related to the use of greywater diversion devices (GDDs) in residential households and to provide advisory information to owner and/or occupiers of sewered residential premises that include grey water treatment systems and manual bucketing of greywater. The intent of the guidelines is to promote knowledge for how to best use these systems versus steps for the implementation.

3.2 Existing conditions

3.2.1 Water sources

This section presents brief descriptions of the water sources that are potentially available to support the water supply for the Narrabri SAP. Information on water source annual extraction volumes, water quality, and aquifer productivity has been summarised.

The two main productive groundwater sources in the vicinity of the SAP development are the Lower Namoi and the Southern Recharge groundwater sources. The NSC currently extract groundwater from the Lower Namoi alluvial groundwater source to supply Narrabri with town water. The Southern Recharge groundwater source is directly beneath the SAP development area, and the NSC has purchased three Water Access Licences for a total of 610 units. Details on NSC water licences are provided in Section 5.3.

3.2.1.1 Namoi Alluvial Groundwater Sources – Lower Namoi

The Lower Namoi Alluvium consists of unconsolidated Cenozoic sediments deposited as an extensive alluvial fan by the Namoi River and its tributaries. It is a major water source in the region used for both town and irrigation water supply. The alluvium extends to approximately 160 km west of Narrabri. The water bearing sands and gravels within the alluvial sediments of the Lower Namoi alluvium are broadly divided into two main aquifer systems: a shallow aquifer system up to approximately 40 m deep, and a deep aquifer system up to 90 m to a maximum of approximately 120 m deep depending on bedrock topography (Kalaitzis et al, 2000).

The highest bore yields are between Narrabri through to Burren Junction which is the ‘go-to’ area and has significant groundwater extraction. The bore yields are lower in the west and far south of the system as the sediments contain more clay and less sand and gravel in these areas.

3.2.1.2 Great Artesian Basin Groundwater Sources

The Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources governs several groundwater sources. Relevant groundwater sources to the Narrabri SAP is the Southern Recharge Groundwater Source. The Southern Recharge Groundwater Source is directly beneath the industrial/employment area of the Narrabri SAP, and is present as the Pilliga Sandstone, which contains significant aquifers. This Pilliga Sandstone is a potential supply target for the SAP development, although the location of the bores and extraction requires an impact assessment and work approval. Production bores may need to be located away from existing users to minimise groundwater level impacts.

3.2.2 Groundwater productivity and quality

3.2.2.1 Annual extraction

Annual extraction volumes provided by WaterNSW for surrounding work approvals and groundwater sources for 2016–2021 is summarised in Table 3.2. The extraction volumes presented represent the annual average volumes reported to WaterNSW by existing users. Extraction is typically largest from the Lower Namoi alluvium, due to good quality groundwater and high extraction rates available. Extracted groundwater is mainly used for irrigation in these areas. The largest concentration of work approvals is in the Lower Namoi groundwater source, on the western side of Narrabri.

Table 3.2 Annual average extraction volumes within 50 km of SAP (ML/yr)

Groundwater source	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	Average usage (ML)
Lower Namoi	33,531	61,198	78,058	61,807	36,392	48,393
Southern Recharge	508	716	917	844	113	515

3.2.2.2 Yields

There is limited publicly available information available on extraction yields from the surrounding groundwater bores. Qualitative information of aquifer yields from the groundwater sources is provided in driller's bore completion reports. Available groundwater airlift yield data from driller's bore completion reports within the vicinity of the SAP area is summarised in Table 3.3.

Table 3.3 Qualitative yield information

Groundwater sources	Drilling yields (L/s)
Lower Namoi	1 – 20
Southern Recharge	1 – 30

3.2.2.3 Groundwater quality

Groundwater quality information for the SAP investigation area includes data from various sources including:

- qualitative salinity (as Total Dissolved Solids [TDS]) information provided in driller's bore completion reports available from WaterNSW website (WaterNSW, 2021)
- WaterNSW monitoring bore GW273314.1.1.

Qualitative salinity

Groundwater quality descriptions for other groundwater sources are limited to qualitative salinity (as TDS) information provided in driller's bore completion reports. Qualitative groundwater quality for each of the groundwater sources is summarised in Table 3.4.

Table 3.4 Qualitative groundwater quality

Groundwater source	Average TDS (mg/L)	Max. TDS (mg/L)
Lower Namoi	467	4,297
Southern Recharge	1,124	5,323

Note: TDS – Total Dissolved Solids (mg/L)

WaterNSW groundwater quality monitoring

There is one WaterNSW monitoring bore, GW273314.1.1, (WaterNSW, 2021) with water quality monitoring occurring since 2015 in the Pilliga Sandstone (Southern Recharge Groundwater Source). Groundwater salinity (as Total Dissolved Solids [TDS]) has increased slightly since 2015 and is now around 220 mg/L (335 µS/cm). The monitoring observations are shown on Figure 3.1.

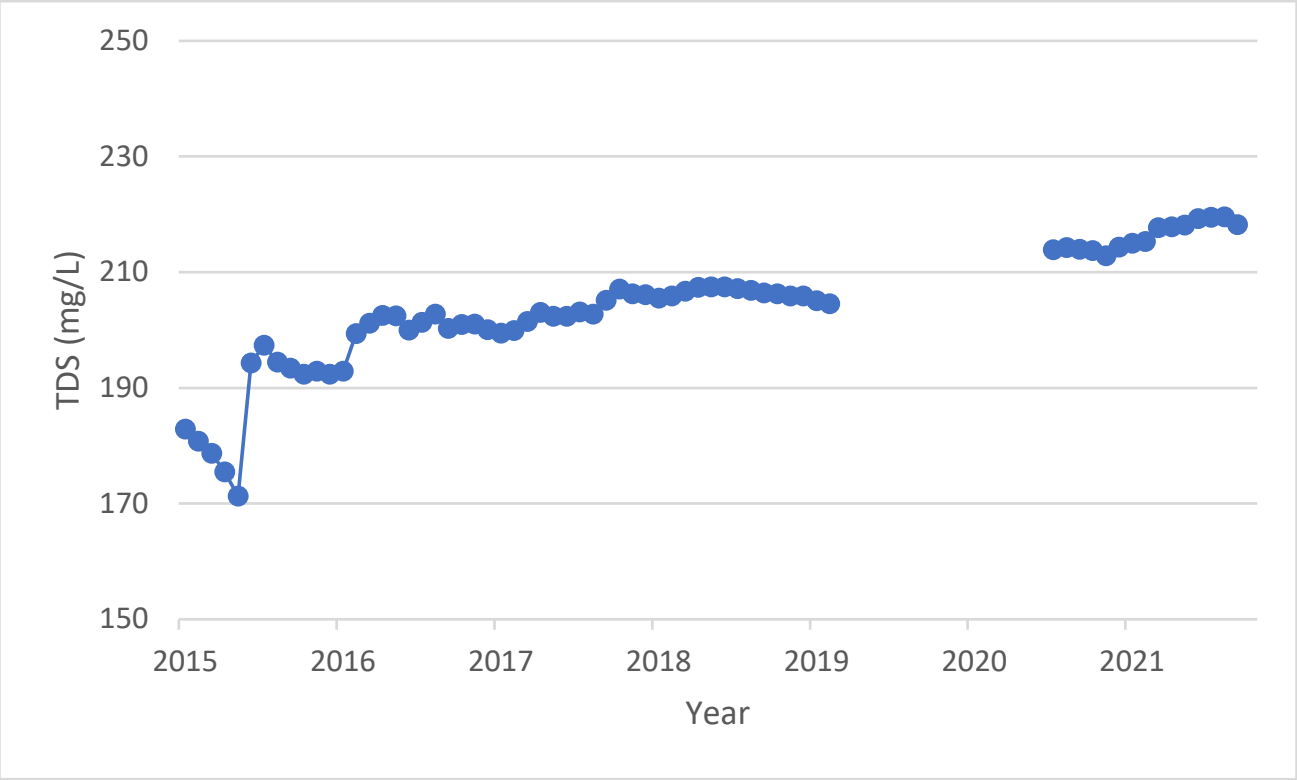


Figure 3.1 GW273314.1.1 groundwater quality

4 Methodology

4.1 Overview of the key stages of work

The hydrogeology and water demand assessment for the Narrabri SAP was completed in a stepwise approach over three stages, with the work in each stage building on the last. A summary of the objectives and outputs of each stage is described below.

- **Stage 1 – Hydrogeology and water demand baseline assessment:** This stage was designed to provide context, baseline analysis and information regarding hydrogeology and water demand constraints and opportunities to the SAP technical study groups and stakeholders. The baseline assessment included characterising the hydrogeological environment and groundwater sources in the area as well as engagement with Narrabri Shire Council (NSC) was completed at this stage to understand the water supply and demand context of the NSC existing town water supply. This baseline understanding of the existing groundwater environment and availability of NSC town water supplies and system helped to guide the development of opportunities and constraints with respect to providing water to future development within the SAP.
- **Stage 2 – Water demand scenario analysis:** This stage quantitatively assessed the water supply and demand requirements for three development scenarios developed for the Narrabri SAP Master Plan. It included potential water supply options such as the existing Narrabri town water supply, recycled water, stormwater harvesting, and developing new groundwater borefield supply from the Pilliga sandstone (Southern Recharge groundwater source), which is directly beneath the site. Each of the development scenarios was comprised of a varying scale and types of development. The purpose of this stage of the work was to test the types and scale of developments that could be feasibly serviced by means of existing water supplies and the steps required to develop new supplies if needed. In addition, the key opportunities and constraints identified at Stage 1 were further developed based on the specific details of the three scenarios.

  Following stage 2, the final EbD workshop was held with the respective technical study teams and keys stakeholders. This process allowed the final SAP structure plan to be developed.
- **Stage 3 – SAP structure plan water balance report:** A water balance assessment based on the final SAP structure plan has been developed and is the focus of this report.

  This stage consolidates the previous investigations and outcomes of the second EbD workshop. It aims to quantify the water demands for the SAP and identifies the potential water supplies required. The feasible volumes of water that can be provided, and respective treatment methods, are also considered. This report identifies key recommendations for necessary next steps and investigations required to secure water supply for the SAP Structure Plan.

4.2 Stakeholder engagement

Initial understanding of potential water supply was developed during stage 1 and stage 2 and through discussion with key stakeholders including NSC and DPE. The findings of the scenario water demand assessment were tested and challenged by all stakeholders through the EbD workshop.

NSC is currently developing an Integrated Water Cycle Management (IWCM) Strategy, which will consider long-term water supply and demand requirements for the broader NSC service area. As the IWCM strategy is interrelated with the SAP masterplan, the IWCM study team has been engaged with as a stakeholder to this technical study. Key inputs and assumptions, such as the current town water demand, the annual available entitlement from the existing Narrabri town water supply that could be committed for water supply to the SAP, and extraction rates from existing town water supply bores have been discussed and aligned where possible.

4.3 Water balance assessment

The water balance was developed for each stage of the SAP structure plan (see Section 2.1.2 for staging information) and compares the demand estimate vs available supply. The water demand rates from land uses identified in the SAP structure plan and access to water supplies was assessed to develop a water balance for each stage of the SAP. Water quality for the potential land use and from the water supply sources was also considered. The water balance assessment provides the basis for management of existing supply and demand and identifies the need to develop additional water supplies.

4.3.1 Water demand rates

Demand rates for the range of the land uses defined in the Structure Plan were developed from available information. These include:

- direct input from potential businesses via the Economics study market sounding process
- literature and guideline demand rates based on developed area (in particular, the Section 64 Determinations of Equivalent Tenements Guidelines, NSW Water Directorate, 2017)
- review of metered water consumption for similar existing businesses (where available) in Narrabri
- residential demands based on number of allotments, informed by existing consumption, Building Sustainability Index (BASIX) targets and aligned with NSC's IWCM Strategy assumptions.

These rates were tested with the study stakeholder group to refine assumptions and utilise best available information. Water demand rates can vary significantly depending on many site-specific factors including exact types of development, scale of development, specific business needs, technologies applied, climate, water availability and cost of water. As there is uncertainty about the exact nature and scale of development that will occur, and site specific water needs for major developments, an indicative range of demand has been considered (i.e., a maximum and minimum demand estimate). This range can be problematic for water balance assessment and planning purposes; however it is considered a prudent way to assess and communicate water demand information to the broader study team as it highlights these actual uncertainties.

4.3.1.1 Non-residential demand rates

Typical water demands for agricultural and food processing, transport and logistics, light industry and waste management and recycling have been estimated on a per hectare rate, based on typical water demand from these industries and are provided in Table 5.1. Where information was available from similar existing businesses in the Narrabri shire, these demand rates have been used. Indicative total water demands for the energy, bioproducts and fertiliser land-uses, have been provided from the market sounding exercise and economics package.

4.3.1.2 Residential demand rates

Population increases, outlined in Section 2.1.5, will result in an additional 2,100 dwellings during the master planning period. The demand per dwelling has been estimated as a range, as follows:

- minimum demand based on 307 kL/dwelling/yr (3 star efficiency rating in an average year). This is considered an aspirational target (i.e., best case water efficiency) in an average rainfall year, and will require significant measures to encourage water-efficient behaviours compared to the baseline situation
- maximum demand based on 396 kL/dwelling/yr (2 star efficiency rating in a dry year). This is a less ambitious target, and more reflective of a dry year (assuming no water restrictions), however still reflects a modest improvement in water efficiency compared to the baseline situation.

Residential demands typically include a significant proportion of outdoor/garden and evaporative cooler water use, which is highly dependent on climate. Hence, residential demands can be expected to have a summer peak and to be higher during dry years.

4.3.2 Access to water supply

NSC's local water utility access licence (subcategory - none) and associated water supply work approval includes three groundwater extraction bores for the township of Narrabri. The groundwater bores are approved to extract up to 3,500 ML/yr from the Lower Namoi groundwater source. The existing baseline Narrabri town water demand is assumed to be around 2,000 ML/yr.

NSC also has entitlement from the Southern Recharge groundwater source with a total of 610 units (a unit is typically equal to 1 ML). The entitlement is not currently linked to any water supply, and water use approvals and test bores will need to be completed to confirm extraction yields and quality. Any new groundwater extraction would be subject to a hydrogeological impact assessment and granting of water supply work and water use approval. New extraction bores would need to be located away from existing users to minimise groundwater level impacts and comply with rules outlined for new works in the water sharing plans.

The water balance assessment assumes that these existing water supplies will be available for the SAP for use. Details of the water access licence and work approval is provided in Table 4.1.

Table 4.1 Narrabri Shire council water supply work approval and water access licence details

Work approval	Works	Locations	Water access licence	Water Sharing Plan Water source	Entitlement
90WA805845	WNA-B1 (GW030545) ESID 155128	Lot 74 DP754944 (Killarney Street)	WAL12215 90AL805844 Category – *Local Water utility* Subcategory – *None*	Namoi Alluvial groundwater sources 2020 Lower Namoi groundwater source	3,500 ML/yr
	WNA-B2 (GW060129) ESID 16966	Lot 13 DP1060622 (Tibbereena Street)			
	WNA-B3 (GW970882) ESID 145188	Lot 13 DP754944 (Elizabeth Street)			
90CA811353	ESID 24569	Lot 151, DP851561 Lot 152, DP851561	WAL15743 (90AL811352) **Status – Expired**	Great Artesian Basin Water Sharing Plan 2020 Southern Recharge groundwater source	162 units*
N/A	N/A	N/A	WAL15814 (90AL811350)		162 units*
			WAL43773 (90AL837248)		286 units*

Note: * a unit is equal to 1 ML. Total Southern Recharge groundwater source access licences 610 units.

5 Assessment and findings

5.1 Water demand estimates

A water demand estimate based on the land-use category and area of development within the SAP for the 40-year planning horizon was developed using the demand rates and water quality requirements for different types of industries. The water demand assessment is based on the Structure Plan configuration as described in Section 2. The Structure Plan land use area considers the opportunities and constraints identified during the master planning process and final EbD workshop.

Although some businesses will have seasonal operational changes, the types of non-residential demand expected in the SAP would generally occur year-round and regardless of year-to-year climatic variation. Residential demands, which make up a significant portion of the total, will be highest during warm summer months and likely to be higher during dry years. The residential, agriculture and food processing and fertilizer and chemicals are the land uses with the highest estimated demands.

The estimated water demand for Stage 1 of the SAP is approximately 265–400 ML per year, including development of 600 residential lots, increasing to a total demand of approximately 2,310–4,055 ML per year when fully developed (Stage 3) including residential growth of a further 1,800 lots. The minimum end of the water demand range is higher than the existing Narrabri town water consumption, that has an existing baseline annual demand of around 2,000 ML/yr. This increase represents an approximate doubling of total water demand for Narrabri.

The estimated water demand breakdown per land use is summarised for each land use category in Table 5.1 and shown on Figure 5.1. The range of water demands for each land use type (i.e., a maximum and minimum demand estimate) is due to the indicative water demand rates adopted (refer to Section 4.3.1).

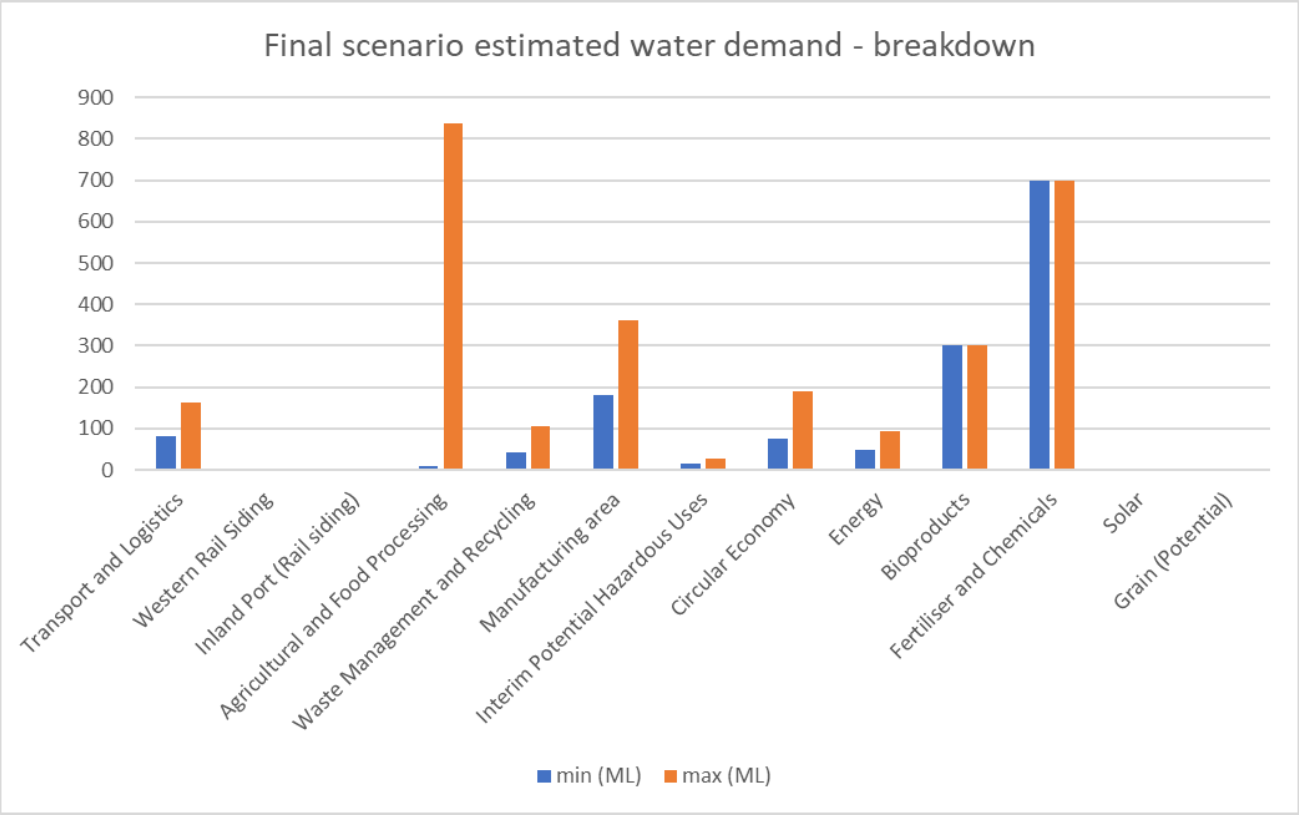


Figure 5.1 Range of annual water demand for the Narrabri SAP

5.2 Water quality

Each land use has specific water quality requirements and may be able to utilise water from different sources which have a different quality level. Two key aspects of water quality have been considered, which help to differentiate the potential water quality demands. These are:

- **Potable vs. non-potable.** Potable water is suitable for human consumption and domestic uses and must meet the minimum requirements of the Australian Drinking Water Guidelines (ADWG), such as the existing Narrabri town water supply.
- **High salinity vs. low salinity.** Salinity has been considered relative to the existing Narrabri town water supply, which has Total Dissolved Solids (TDS) of approximately 650 mg/L. 'Low salinity' water is of a level similar to or lower than this existing town water supply. It is assumed that any water provided as 'potable' quality will also be 'low salinity', for aesthetic and community acceptance reasons.

Explicit quality requirements are not possible to develop without further study and more specific development details. The water quality requirements adopted for each land use are detailed in Table 5.1. Water demand breakdown for water quality and per stage is shown on Figure 5.2, and includes the water demand for new land uses outside of the SAP (e.g. residential growth). Figure 5.3 shows a breakdown of water demand and quality per SAP land use for each stage.

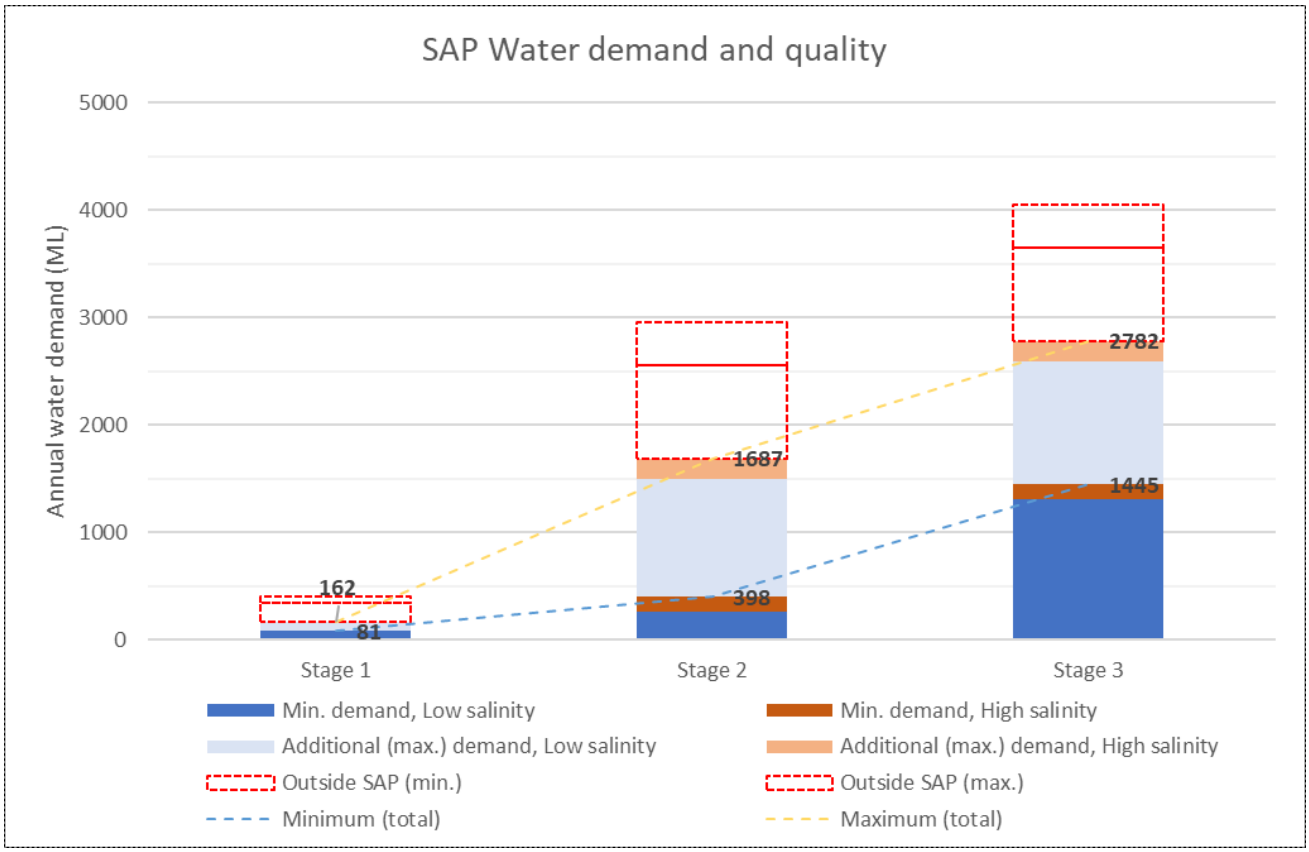


Figure 5.2 Staged water demand for the Narrabri SAP (including outside SAP demand)

Table 5.1 Summary of SAP development types and estimated annual water demands

Land use	Gross area (ha)/ Stage developed	Adopted area (% and ha)	Demand rate (ML/ha)	Annual demand (ML)	Water quality requirements	Comments/assumptions
Transport and Logistics	108 ha/Stage 1	0.2 / 16 ha	5 – 10	81.15 – 162.3	Low salinity As per Light Industrial (Table 5.2)	Freight handling and storage businesses expected, with large yards and limited density of buildings and offices. As per the Light Industrial land use assumptions (see below).
Western Rail Siding	TBC ha/Stage 1	N/A	N/A	N/A	N/A	Assumed no water demand for this land use.
Inland Port (Rail siding)	TBC ha/Stage 1	N/A	N/A	N/A	N/A	Assumed no water demand for this land use.
Agricultural and Food Processing	90 ha/Stage 2	0.2 / 14 ha	N/A	2 – 836	— Potable water will be required for food processing/drinking/kitchen use as a minimum. — Potential for non-potable and/or high salinity water to be used for washing, dust suppression, some processing uses and toilet flushing. — Some water intensive processing facilities may require very low salinity water or have other specific quality requirements. In these cases, additional treatment may be provided by the customer on-site	— Market sounding indicates potential for the expansion of existing agricultural facilities which currently include grain handling and bulk processing and have relatively low water demands. — New businesses could include water intensive processing plants such as grain and pulse food processing (moderate 30–70 ML/ha p.a.1), cotton ginning and manufacturing such as cotton spinning, food canning and packaging. — Only a limited number of these major facilities/water intensive business are expected. — Minimum/maximum demand taken as 2 ha/10 ha of water intensive facilities (30–70 ML/ha1) with the remainder of the area developed as per the Light Industrial land use assumptions (as below). — Low demand volume assumed from existing Viterra silos and grain processing metered use, that is around 10 ML/yr and 13 ML in a dry year. This is about 0.5 ML/ha based on the area the business covers.
Waste Management and Recycling	94 ha/Stage 2	0.2 / 14 ha	3 – 7.5	42 – 106	High salinity	— Landfill and other waste management facilities generally have very low water demands, however may have site specific process and operational requirements.
Manufacturing area	72 ha/Stage 2	0.5 / 36 ha	5 – 10	181 – 362	Low salinity As per Agriculture and Food Processing (see above)	— New land use arising from EbD workshop, such as local light industrial and rural industry services. — Manufacturing facilities potentially have a higher density of employees and processes compared to general light industrial areas, hence a higher developed area of 50% has been adopted.
Interim Potential Hazardous Uses	19 ha/Stage 2	0.2 / 3 ha	5 – 10	14 – 28	High salinity As per Agriculture and Food Processing (see above)	— New land use arising from EbD workshop. Limited details available about potential businesses. As per the Light Industrial land use assumptions (see above).
Circular Economy	169 ha/Stage 2	0.2 / 25 ha	3 – 7.5	76 – 190	High salinity As per Waste Management (see above)	As per the Waste Management land use assumptions (see above).
Energy	63 ha/Stage 3	0.2 / 9 ha	5 – 10	47.4 – 94.9	Low salinity As per Light Industrial (Table 5.2)	— Gas fired power station in this area is proposed to use closed cycle technology and have minimal water demands. — Battery storage facilities identified as a potential business in market sounding. — Minimum/maximum demand taken as per the Light Industrial land use assumptions, to account for site facilities and potential enabling businesses to support major energy facilities.

Land use	Gross area (ha)/ Stage developed	Adopted area (% and ha)	Demand rate (ML/ha)	Annual demand (ML)	Water quality requirements	Comments/assumptions
Bioproducts	40 ha/Stage 3	N/A	N/A	300 ML	Low salinity As per Agriculture and Food Processing (see above)	— Estimated volume based on input from potential business during market sounding exercise.
Fertiliser and Chemicals	366 ha/Stage 3	N/A	N/A	700 ML	Low salinity As per Agriculture and Food Processing (see above)	— Estimated volume based on input from potential business during market sounding exercise.
Solar	144 ha/Stage 3	N/A	N/A	N/A	N/A	— Zero water demand assumed.
Grain (Potential)	TBC ha/Stage 3	N/A	N/A	N/A	N/A	— Zero water demand assumed.

(1) Typical annual water demand rates estimated based on Section 64 Determinations of Equivalent Tenements Guidelines, NSW Water Directorate, 2017. Note built up hectares refers to the building floor area. This figure provides an order of magnitude indication only (and may be highly site specific).

(2) Stage 1 residential lots are dependent on delivery of a new STP which has an approximate five year roll out timeframe

Table 5.2 Summary of development types outside of the SAP area and estimated annual water demands

Land use	Gross area (ha)/ Stage developed	Adopted area (% and ha)	Demand rate (ML/ha)	Annual demand (ML)	Water quality requirements	Comments/assumptions
Rail Connection	45 ha/Stage 1	N/A	N/A	N/A	N/A	— Zero water demand assumed.
Light Industrial (North)	107 ha/Stage 2	0.2 / 16 ha	5 – 10	80 – 160	— Potable water will be required for drinking/kitchen use as a minimum. — Potential for non-potable and/or high salinity water to be used for washdown, dust suppression and toilet flushing.	— 15% of area assumed to be developed with buildings/built up facilities. This is similar to the typical density of existing Narrabri light industrial areas.
Light Industrial (South)	187 ha/Stage 2	0.2 / 28 ha	5 – 10	140 – 281		
Residential	600 lots ha/Stage 1	N/A	N/A	184 – 237	— Potable water will be required for drinking and most domestic uses. — Non-potable, low salinity water could be used for garden irrigation, toilet flushing.	— Demand based on 2,100 total dwellings as per structure plan. — Minimum demand adopts 307 kL/dwelling/yr (3 star efficiency house in an average year). Maximum adopts 396 kL/dwelling/yr (2 start efficiency house in a dry year) for the full 2,100 lots developed.
Residential	1,500 lots ha/Stage 2	N/A	N/A	460 – 594		

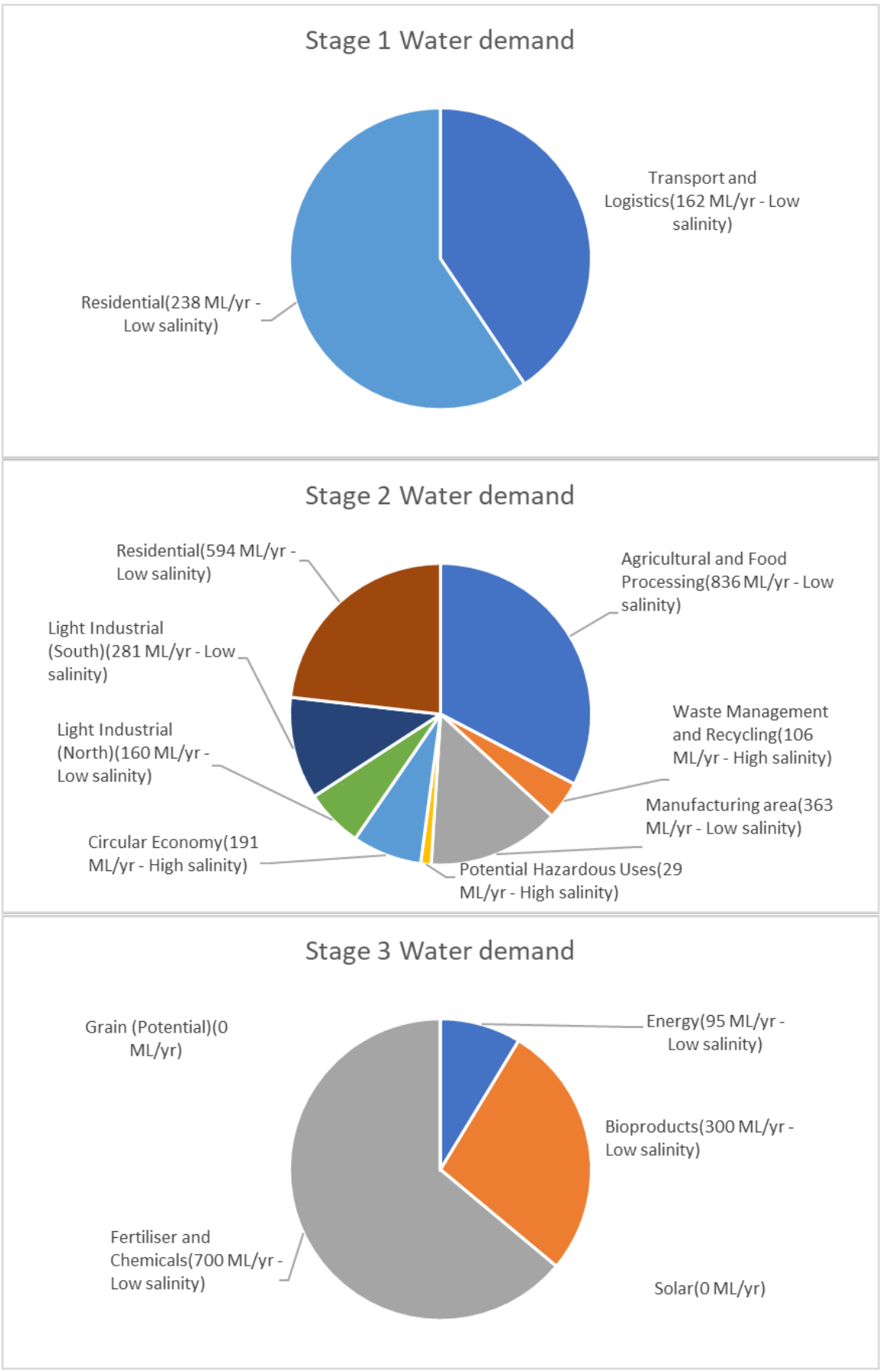


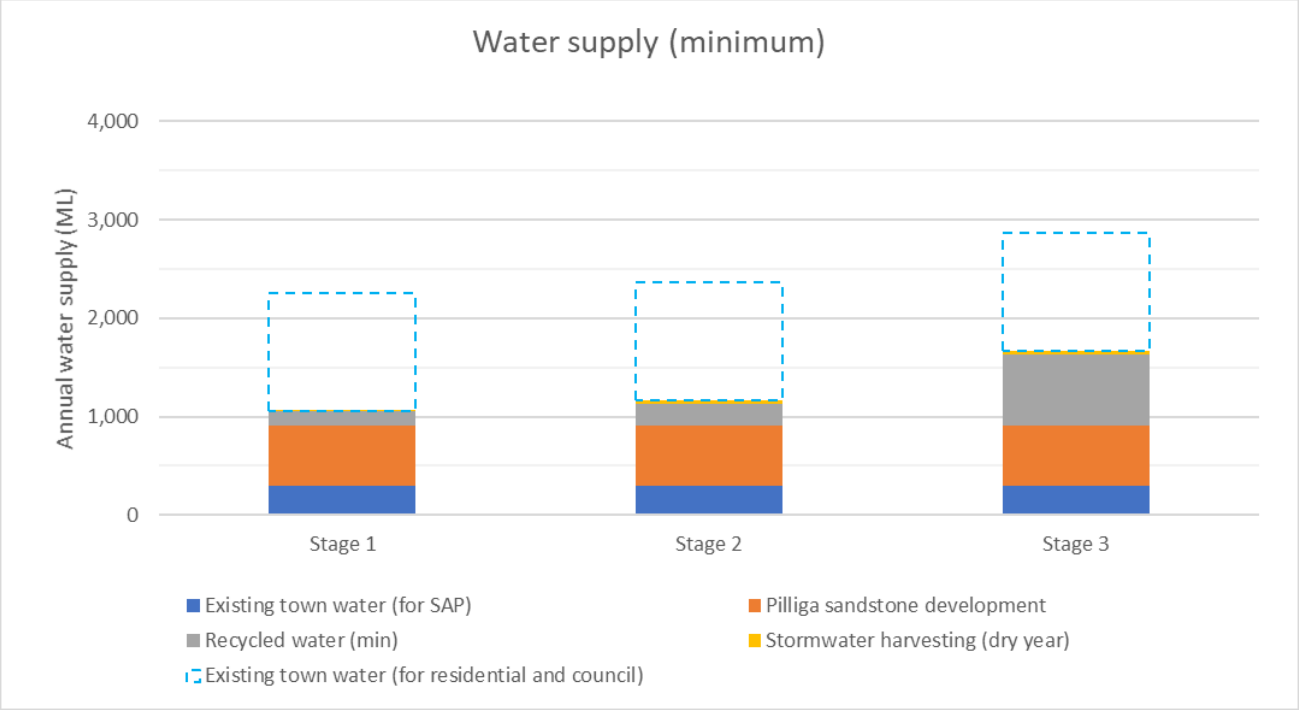
Figure 5.3 Annual water demand rates and water quality for each stage

5.3 Water supply assessment

The SAP water supply assessment is based on a review of available water sources in the surrounding Narrabri area. The water supply sources, and the likely water quality (in terms of salinity) used for the assessment were:

- existing town water supply groundwater extraction from the Lower Namoi alluvium
- new groundwater extraction from the Pilliga sandstone (Southern Recharge groundwater source)
- recycled water from the STP
- stormwater harvesting from roof areas within the SAP.

A summary of the annual water supply volumes available for the SAP and residential growth is provided in Table 5.5 and shown on Figure 5.4. Access to the Lower Namoi alluvium and Southern Recharge groundwater sources in terms of water access licences is outlined in Table 4.1.



Note: Extraction from Southern Recharge groundwater source requires test bores and a water supply work approval

Figure 5.4 Narrabri SAP water supply sources (minimum range)

5.3.1 Narrabri Shire council town water supply (Lower Namoi alluvium)

The Narrabri town water supply is sourced from three, large diameter, high yielding town water supply bores installed in the Lower Namoi alluvium. NSC is also investigating the installation of two additional bore sites for improved redundancy and demand response in the system.

Based on current planning and commitments, NSC has advised that 300 ML from its existing local utility water access licence is available to supply future demand within the SAP. This water would be sourced from a currently unused entitlement from WAL12215. The existing system has a baseline extraction of around 2,000 ML/yr and can extract up to around 10 ML/month (3,500 ML/yr), meaning the full entitlement could be extracted if required with existing infrastructure. Details of historical extraction are provided in Appendix A.

The remaining 1,200 ML available on WAL12215 is reserved for future residential growth and council use and development outside of the SAP.

Water quality from this source is potable and has low salinity. Basic treatment including disinfection is required for the potable supply (i.e., as per existing NSC town water). The average groundwater salinity (as TDS) from the town water supply bores is around 650 mg/L. This level of salinity is suitable for potable water supply.

The Australian Drinking Water Guidelines indicate that in major Australia cities, TDS ranges from below 100 mg/L to more than 750 mg/L, while regional supplies and remote communities can have values up to or exceeding 1000 mg/L. High TDS is an aesthetic/taste issue rather than related to drinking water safety. It is possible that certain types of industrial processing and manufacturing customers in the SAP may require additional on-site treatment to reduce salinity to suit their needs.

5.3.2 New groundwater extraction – Pilliga sandstone (Southern Recharge groundwater source)

The NSC currently has an entitlement of 610 units from the Southern Recharge groundwater source (Table 4.1) however this is not developed. Test bores are needed to confirm extraction yields, water quality, and inform the hydrogeological impact assessment for granting of a water supply work and water use approval. The entitlement is not currently linked to any active water supply and water use approval.

Groundwater quality within the regional Pilliga Sandstone aquifer close to the SAP area is measured in WaterNSW monitoring bore, GW273314.1.1, installed in the Pilliga sandstone, and has a salinity (as TDS) of around 220 mg/L. Further data available from a study completed by the CSIRO (Raiber et al 2022), indicates potentially good quality potable water, based on the measured pH, TDS and hardness (Ca and Mg) from areas south to south-west of the SAP. Groundwater quality south to south-east of the SAP is less promising, based on a pH below ADWG guidelines (6.5–8.5) and very low hardness, indicating a potentially corrosive water source.

5.3.3 Existing Narrabri STP (or new STP) recycled water

Additional SAP water demand will result in some corresponding increase in wastewater generation, which will in turn provide additional opportunity for recycled water supply. The proportion of demand assumed to be returned to sewer and potentially available as recycled water, for each land-use type, is summarised in Table 5.3.

The existing NSC STP is currently fully utilised, and a new STP would be required to use these volumes of recycled water as a water supply for the SAP. This project has been identified and discussed futher in the Infrstructure Study Report, which recommends investigations are undertaken to select a suitable site and confirm the feasibility and requirements for this project. Developing and implementing this project is likely to require a range of additional studies and approvals over a significant period time. However this project is critical to realising the vision for sustainability of the SAP, securing adequate water supply and as part of NSC's strategic asset managment.

Water quality from this source is assumed to be non-potable, and low salinity. Advanced wastewater treatment will be required to enable reuse with the exact level of treatment (and end-use controls) depending on the proposed end-uses and risk assessment.

For the purposes of this assessment, the total supply available by reusing all additional recycled water generated by the SAP ranges between **149–225 ML/yr** in stage 1 and **723–964 ML/yr** when the SAP is fully developed. This assumes that the current wastewater volume to the Narrabri STP is fully used by the existing Federation Farms re-use scheme and is not available for the SAP.

Table 5.3 Assumed proportion of SAP and external development water demand returned to sewer (i.e., potentially available as additional recycled water source)

Land use	Proportion of water demand assumed returned to sewer[1]
Transport and logistics	75%
Light industrial	25%
Manufacturing	25%
Bioproducts	25%
Fertiliser and chemicals	25%
Residential	75%

(1) Of the volume returned to sewer, the final recycled water volumes assume a further 25% losses within the STP

5.3.4 Recycled stormwater

Stormwater harvesting and re-use could be either via private on-site systems (i.e., rainwater tanks) or a centralised scheme managed by NSC or another appropriate authority, or some combination of both. Stormwater modelling completed as part of the Flooding and Water Cycle Management Study Package has estimated the total annual volume of runoff generated from roof areas within the SAP. The roof areas make up just 4% of the total area of the SAP investigation area. Future land uses will need to consider using rainwater tanks and other storage solutions that are specific of the water requirements. Despite the quantities being small, rainwater tanks should be considered essential as part of any new development because they can supply water that requires little to no treatment for use in buildings and across vegetated areas.

Rainfall runoff volumes captured for use are summarised in Table 5.4. A dry year volume has been adopted for the purpose of the water balance assessment and it is assumed that 10% of the annual runoff would be able to be stored and used.

Although runoff from hardstand areas could also potentially be harvested, it will introduce additional contamination risks and require either advanced treatment and/or only be suitable for a much more limited range of end-uses. Hence, it is assumed that only roof water would be harvested. Water quality from this source is assumed to be non-potable but low salinity. Passive treatment (via tanks and filtration) is expected to be required for reuse but could include more advanced treatment dependent on end-use requirements.

The estimated volume is for the non-residential areas only, as the adopted residential water demands (aligning with BASIX requirements) assume that each house has its own rainwater tank for private collection and use of rainwater.

Table 5.4 Estimated rainwater quantities per land use

Land uses	Area for roof (ha)	Dry year annual rainwater quantities (ML/yr)	Rainwater captured and stored for use (ML/yr)
Transport and Logistics	5.41	20	2
Interim Potential Hazardous uses	2.87	11	1
Waste Management and recycling	0.04	0	0
Agricultural and Food Processing	13.6	50	5
Manufacturing	10.89	40	4
Circular Economy	25.42	94	9
Light Industrial North	16.01	59	6
Light Industrial South	28.09	104	10

It is important to note that the actual volume available:

- will vary significantly year to year (i.e., significantly lower in a dry year)
- will be limited by the volume available for storage.

5.3.5 Narrabri Gas Project

Produced water associated with the Narrabri Gas Project has not been considered as a water source for the SAP development scenario testing; due to:

- the distance from the SAP. The two proposed treatment facilities are located approximately 17 km and 27 km south of the SAP development area, respectively
- this not being a permanent source of water, associated with the initial development and assessed 25-year operation period of the project.

5.3.6 SAP water supply summary

For the purposes of this assessment the water supply volumes presented in Table 5.5 have been used.

Table 5.5 Summary of estimated annual water supply

Water supply	Volume (minimum)	Volume (maximum)	Comment
Existing town water supply	300 ML for the SAP available from existing entitlement		Baseline extraction around 2,000 ML/yr and approved to extract up to 3,500 ML/yr (WAL2215 [refer to Section 4.3.2]). Infrastructure capable of extracting 10,000 $m^{3/}$day (3,650 ML/yr) (see Figure A.1). 300 ML/yr for the SAP is based on NSC advice. 1,200 ML for future residential growth and council use and development *outside* of the SAP (refer Figure 5.4).
Pilliga sandstone (Southern Recharge groundwater source)	610 (ML) units		Entitlement linked to three WALs (refer to Section 4.3.2). Will need to be developed and tested (see next steps in Section 6).
Recycled water from the STP	Stage 1: 149 ML	225 ML	Volumes for each stage are cumulative. Volume is addition to the demand from Federation farm assumes the supply to the farm is maintained. Assumes new STP built to realise recycled water volumes (refer Section 5.3.3).
	Stage 2: 225 ML	376 ML	
	Stage 3: 723 ML	964 ML	
Stormwater harvesting from roof areas within the SAP (dry year)	Stage 1: 2 ML		Rainfall runoff based on rainfall in a dry year. Storage will be incorporated into building design.
	Stage 2: 37 ML		
	Stage 3: 38 ML		
Narrabri gas project	0 ML		Not considered due to the distance from the SAP and not a permanent source of water.
Total: Stage 1	**1,061 ML**	**1,137 ML**	**Excludes 1,200 ML of available entitlement for future residential growth and council use.**
Total: Stage 2	**1,172 ML**	**1,323 ML**	
Total: Stage 3	**1,671 ML**	**1,912 ML**	

5.4 Water balance results

The water balance was developed for each stage of the SAP structure plan (see Section 2.1.2 for staging information) and compares the demand estimate vs available supply. The water demand assumptions are outlined in Section 5.1 and water supply assumptions outlined in Section 5.2. The findings have identified periods of sufficient water in the early stages of the SAP, and periods of deficit water available for the SAP when fully developed.

The additional supply volume potentially available from stormwater and recycled water is closely linked to the land uses (and thus demand) of the SAP. This water supply increases over time (i.e., due to increase roof area and return to sewer volume) as the SAP is fully developed.

The water balance findings for the land uses within the SAP structure plan area, excluding residential growth, and light industrial land outside of the SAP boundary is shown on Figure 5.5 and summarised in Table 5.6. The findings include the minimum and maximum range of the estimated demand.

The water balance for the land uses outside of the SAP area, including residential growth and light industrial land are provided in Table 5.7. These findings include the minimum and maximum range of the estimated demand. The residential growth of 2,100 dwellings over the 40 year master planning period has a total demand of 832 ML/yr (using the higher rate of 396 kL/dwelling/day). This new residential water demand can be met with the 1,200 ML/yr from the existing local water utility licence (WAL12215). Appendix B provides detailed information regarding the demand and water balance calculations.

5.4.1 SAP structure plan land uses

The key findings of the water balance assessment for land uses within the SAP are (i.e. excluding residential development and other new land uses outside of the SAP boundary):

- **Stage 1** – SAP water demands can be met by using the 300 ML/yr available from the existing NSC town water supply. There is not a requirement to develop and access the full entitlement from the Pilliga sandstone (Southern Recharge groundwater source).
- **Stage 2** – SAP water supply can meet the minimum water demand development (i.e., lower water intensive industries) using the 300 ML/yr available from the existing NSC town water supply, recycled water from the TSP, and capture and use of stormwater. There is a supply gap of around 364 ML/yr to meet the demands of the more water intensive industries (maximum water demand assessment). This supply gap includes the assumption that the Pilliga sandstone (Southern Recharge groundwater source) is developed and access to the full entitlement is approved. Any approval and use of less than 610 ML/yr from the Pilliga sandstone will increase the supply gap. This water supply is currently not developed, and any new groundwater extraction would be subject to a hydrogeological impact assessment and granting of water supply work and water use approval. The next steps are outlined in Section 6.
- **Stage 3** – SAP water supply can meet the minimum water demand development (i.e., lower water intensive industries) using the 300 ML/yr available from the existing NSC town water supply, recycled water from the TSP, and capture and use of stormwater, and development of the Pilliga Sandstone. Up to 382 ML/yr of groundwater is required from the Pilliga Sandstone and is within existing NSC entitlement. There is a remaining supply gap of around 870 ML/yr to meet the demands of the more water intensive industries (maximum water demand assessment) and includes the development of the Pilliga Sandstone and access to the full entitlement is approved.

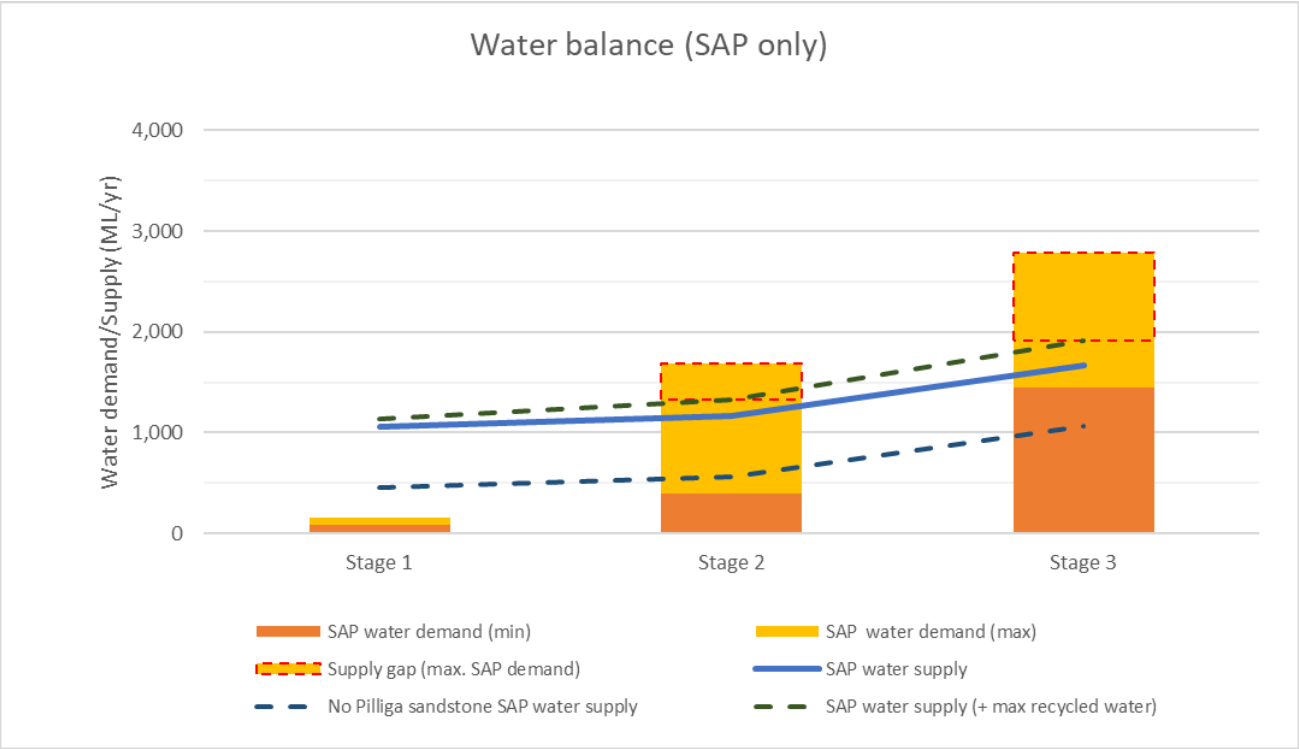


Figure 5.5 Water balance for the SAP (excluding land uses outside of SAP and additional residential development)

5.5 Relationships/interdependencies to other disciplines

The SAP structure plan water balance assessment indicates additional water supplies will be required to be developed over time, to meet the demands of the SAP. The nature and location of the mix of new supply sources (i.e., new groundwater supply, potable vs. non-potable, alternative/recycled water) will have significant implications for the:

- utilities infrastructure (water and wastewater) – to service the SAP development
- stormwater and environmental management – relating to harvesting, storage, treatment and re-use of stormwater vs: environmental discharges
- environment, town planning, stakeholder/community – in particular for the proposed new STP, required to service the SAP development and external residential development.

Table 5.6 Structure plan water balance summary

Supply source/demand type	Minimum (ML/yr)	Maximum (ML/yr)	Minimum (ML/yr)	Maximum (ML/yr)	Minimum (ML/yr)	Maximum (ML/yr)
	Stage 1		Stage 2		Stage 3	
NSC Potable Town Water (Lower Namoi) for the SAP Structure Plan[1]	300		300		300	
Pilliga sandstone (Southern Recharge groundwater source)[1]	610		610		610	
Recycled stormwater from SAP (assumed able to be harvested, stored and recycled)[4]	2		37		38	
Additional recycled water available due to SAP Development (i.e. from Narrabri STP)[2, 3]	149	225	225	376	723	964
Supply total	**1,061**	**1,137 ML**	**1,172 ML**	**1,323 ML**	**1,671 ML**	**1,912 ML**
Transport and Logistics	81	162	81	162	81	162
Western Rail Siding	N/A	N/A	N/A	N/A	N/A	N/A
Inland Port (Rail siding)	N/A	N/A	N/A	N/A	N/A	N/A
Agricultural and Food Processing	–	–	2	836	2	836
Waste Management and Recycling	–	–	42	106	42	106
Manufacturing area	–	–	181	363	181	363
Interim Potential Hazardous Uses	–	–	14	29	14	29
Circular Economy	–	–	76	191	76	191
Energy	–	–	–	–	47	95
Bioproducts	–	–	–	–	300	300
Fertiliser and Chemicals	–	–	–	–	700	700

Supply source/demand type	Minimum (ML/yr)	Maximum (ML/yr)	Minimum (ML/yr)	Maximum (ML/yr)	Minimum (ML/yr)	Maximum (ML/yr)
	Stage 1		Stage 2		Stage 3	
Solar	–	–	–	–	N/A	N/A
Grain (Potential)	–	–	–	–	N/A	N/A
Demand total	**81**	**162**	**396**	**1687**	**1443**	**2782**
Balance (surplus[+]/deficit[-])	**980**	**975**	**776**	**-364**	**228**	**-870**
Balance with no Pilliga sandstone development (surplus[+]/deficit[-])	**370**	**365**	**166**	**-974**	**-382**	**-1,480**

(1) Available supply for groundwater sources quantified as existing entitlement only.

(2) Refer to Section 5.3 for assumptions regarding the percentage of water demand that is returned to sewer and therefore contributes to the potential recycled water supply volume.

(3) The recycled water volume is assumed to be entirely from the Narrabri STP (either new or existing).

(4) Volume of recycled stormwater quantified is based on preliminary working assumptions from rainfall-runoff from roof areas only. Further investigation into the storage volumes is required to refine this figure.

(5) Excludes 1,200 ML of available entitlement for future residential growth and council use.

Table 5.7 Water balance for new land uses outside of SAP area

Supply source/demand type	Minimum (ML/yr)	Maximum (ML/yr)	Minimum (ML/yr)	Maximum (ML/yr)	Minimum (ML/yr)	Maximum (ML/yr)
	Stage 1		Stage 2		Stage 3	
NSC Potable Town Water (Lower Namoi) for the SAP Structure Plan[1]	1,200		1,200		1,200	
Supply total	**1,200**		**1,200**		**1,200**	
Rail Connection	-	-	-	-	-	-
Light Industrial (North)	-	-	80	160	80	160
Light Industrial (South)	-	-	140	281	140	281
Residential (stage 1 – 600 lots, stage 3 – 2041 target – 2,100 lots)	184	238	184	238	461	594
Demand total	**184**	**238**	**405**	**679**	**681**	**1,035**
Balance (surplus[+]/deficit[-])	**1016**	**962**	**796**	**521**	**519**	**165**

6 Recommendations and conclusions

6.1 Overview

These recommendations have been made to progress the water supply and demand assessment for the Narrabri SAP. An indicative timeline of water investigations and connections, in line with the infrastructure deliverables is shown on Figure 6.1.

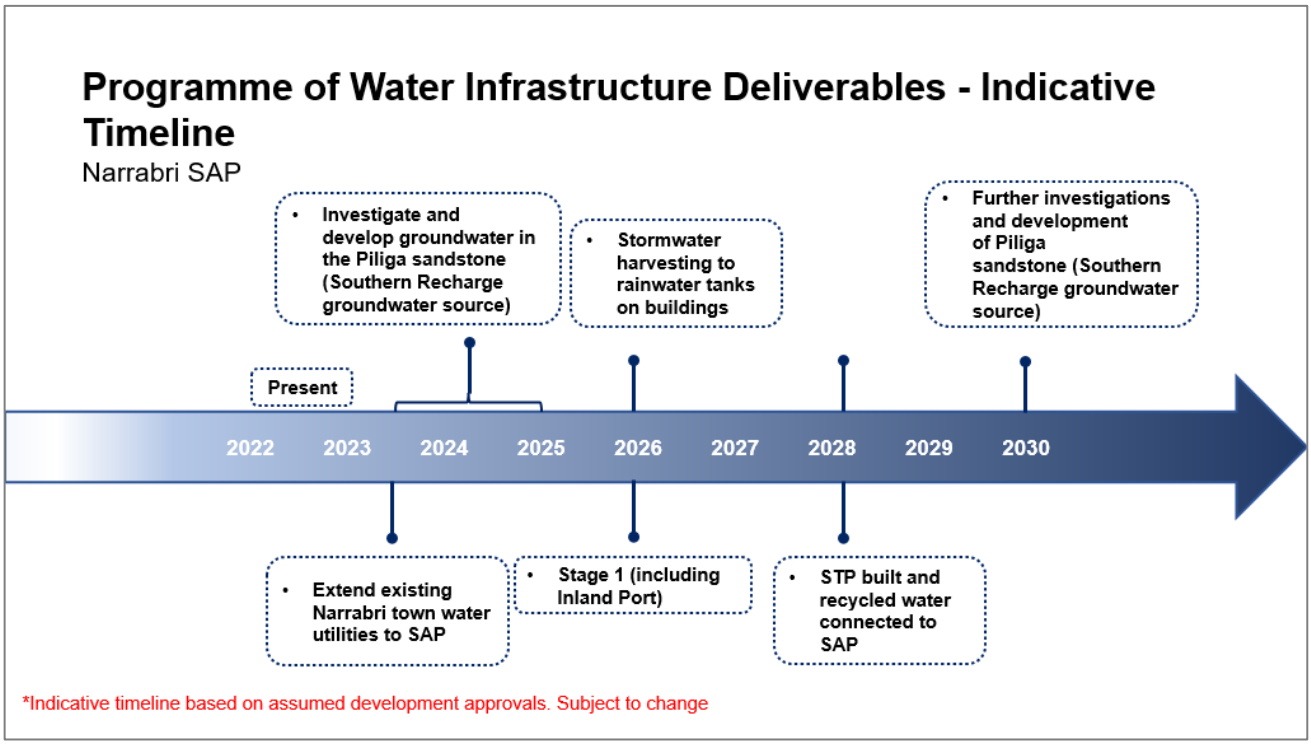


Figure 6.1 Water supply development

The sections below outline recommendations to manage water supply and demand for the SAP.

6.2 Maximise use of existing water supplies

The use of existing water supplies provides an economically sustainable method of servicing the SAP area as there is a baseline amount of infrastructure in place. It is therefore recommended that the SAP maximise the use of existing water supplies prior to investing in new supplies and enabling infrastructure. The same logic, to maximise existing water supplies, also applies to future systems once they are established. While this report identifies several options for additional water supplies, their implementation must be considered holistically. That is, consideration must be given to what types of developments would use varying sources to determine the ones that warrant investment. Investigation of stormwater capture and recycled water sources uptake is particularly important in this regard.

6.3 Integrate findings into the IWCM plan

To allow for flexibility in planning water systems using varying water sources, it is recommended that the findings of the Structure Plan water balance assessment are incorporated into the NSC Integrated Water Cycle Management Plan.

6.4 SAP water demand action and response plan

A water demand trigger, action, response plan for water uses within the SAP should be developed. This will enable the new water supplies to be planned and delivered in time, and based on actual demand triggers, when required, as the SAP land uses are built.

6.5 Stormwater capture, storage and use into SAP land uses

A recycled stormwater supply for the SAP would require capture/storage/treatment and reticulation infrastructure. There are several challenges and some limitations associated with treating stormwater flows which requires more detailed investigations.

Treated stormwater would ideally be used for non-potable uses such as irrigation or industrial processes. There are some challenges with defining the raw water quality, level of treatment required, and risk management (like that of recycled wastewater) which would require site-specific investigation to confirm feasibility.

Additional modelling will be required to investigate this opportunity including the effectiveness of storage, variability of flows due to climate and consideration of pre-development vs post-development flows to waterways. Investigation of the feasibility of different storage options is also required including private tanks, constructed wetlands and Managed Aquifer Recharge (MAR).

6.6 New groundwater extraction from the Pilliga sandstone

Additional water supply will need to be connected to the SAP for stage 2 and 3 to be developed. New groundwater supply would most likely be developed in the Pilliga sandstone (Southern Recharge groundwater source). The Pilliga sandstone is a regional aquifer system and directly beneath the SAP area from a depth of around 15–20 m. The NSC currently has an entitlement of 610 units from the Southern Recharge groundwater source (Table 4.1). The supply would be developed as either a dedicated borefield and pipeline to supply the SAP or several single extraction bores to supply each land development separately.

Development of new groundwater supply bores will require the following measures:

- investigation of groundwater drilling and pump testing to determine potential sustainable yields and water quality from the Pilliga sandstone beneath the SAP
- additional groundwater entitlements will be required to meet to maximum water demands. These groundwater entitlements will need to be purchased on the open market from an existing water access licence holder or by the competitive controlled allocation process
- a water supply works approval to extract groundwater is required and is subject to a hydrogeological impact assessment to assess potential impacts on surrounding groundwater users.

6.7 Recycled wastewater

To utilise recycled water generated within the SAP, a new local STP is proposed, which also forms part of the recommendations for the Infrastructure Study Report. Treatment infrastructure will be dictated by the water quality requirements for the specific SAP end-uses. Tertiary treatment including filtration and disinfection is expected to be required, beyond the existing treatment level at Narrabri STP to enable the current agricultural end-use (i.e., agricultural irrigation). This water supply is a reliable and climate independent water source.

The proposed STP would have additional benefits of minimising infrastructure upgrades and network extensions to convey this volume to and from the existing Narrabri STP (and additional capacity upgrades at the existing STP). In addition this project should also be aligned with NSC's asset management strategy for the existing STP, which is understood to be ageing and operating at capacity, to maximise overall benefits and efficiency of investments.

This infrastructure has significant approvals and regulatory requirements/measures which also need to be considered. In some cases, these aspects can be a significant barrier to the feasibility and implementation of these systems. Hence, site selection and feasibility investigations are required immediately.

6.8 Conclusion

This report summarises the water balance assessment completed as part of the Hydrogeology and Water Demand study package. This report consolidates the potential water supplies and demands for SAP land uses previous investigations and outcomes of the structure plan and EbD workshop. It aims to quantify the water demands for the SAP and identifies the potential water sources required to meet demand. The feasible volumes of water that can be provided by each source, and respective treatment have been considered.

A water balance method, in terms of water supply and demands, has been used to quantify the excess or shortfall in available water supply to meet the estimated demands of the SAP structure plan.

The criteria for the available water supply from existing sources have, generally, previously been defined in Stage 1 – Baseline Analysis. Since Stage 1, NSC has advised that the volume of existing town water entitlement which is available to support the SAP is 300 ML/yr.

Where available, existing metered use data of water demands from businesses within the Narrabri Shire have been used to estimate water demands for SAP land uses. Where no data on similar land uses was available, estimates based on literature or standard industry best practice have been used.

The key findings of the water balance assessment were:

- **Stage 1** – SAP water demands can be met by using the existing NSC town water supply. There is not a requirement to development and access to the full entitlement from the Pilliga sandstone (Southern Recharge groundwater source).
- **Stage 2** – SAP water demands can be met by using the existing NSC town water supply, recycled water from the TSP, and capture and use of stormwater, to meet the minimum water demand (i.e., lower water intensive industries). There is a supply gap of around 364 ML/yr to meet the demands of the more water intensive industries (maximum water demand assessment).
- **Stage 3** – SAP water supply can meet the minimum water demand development (i.e., lower water intensive industries) using the existing NSC town water supply, recycled water from the TSP, and capture and use of stormwater, and with the development and access to the full entitlement from the Pilliga sandstone (Southern Recharge groundwater source).

As a result of the water balance assessment, the early stages of the SAP development can be met by connecting to the existing NSC town water supply. Additional water supplies will need to be developed to meet the full water demand for the Structure Plan over the next 40 years. Monitoring of actual demand realised, and potential responses is required to manage existing supplies and the timeline for development of additional water supply to support the SAP. Refer to Section 6 for recommendations. There are various options available regarding the potential mix of new supplies. Water quality of new sources (and the ability of development to utilise non-potable water) is an important consideration as only a limited additional volume from potable water sources has been identified for use within the SAP.

Demand for the expected development outside of the SAP (residential and light industry) can be met using the separate 1,200 ML/yr volume allocation which NSC have reserved for this purpose.

Appendix A

Detailed methodology

A1 Narrabri town water demand

A1.1 Narrabri town water demand

The Narrabri town water supply is sourced from three, large diameter, high yielding town water supply bores installed in the Lower Namoi alluvium. Figure A.1 show the existing daily extraction from three groundwater bores that make up the Narrabri town water supply scheme. The average daily production of 4,000–5,000 kL/day (black line) equates to an annual demand of around 1,500–2,000 ML/yr. Figure A.1 shows that groundwater extraction is seasonal with most groundwater extracted during the summer period (red line). The extraction rates from the three town water supply bores demonstrates that the existing infrastructure could extract the 3,500 ML/yr entitlement by maintaining a 10,000 kL/day extraction rate (shown by the red line in January 2020).

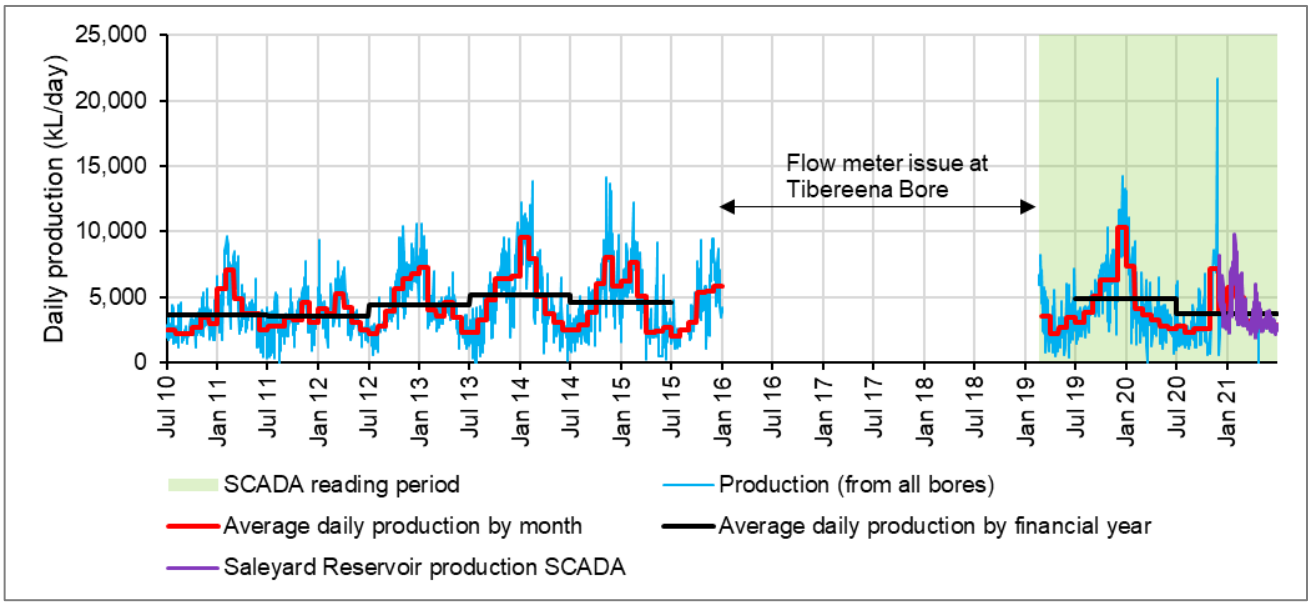


Figure A.1 Narrabri town water supply historical extraction (*Source: Narrabri IWCM*)

A1.2 Water quality

A1.2.1 Recycled wastewater quality and treatment

Table A.1 provides an indication of the types of uses of recycled water which are possible for varying levels of treatment, as well as the performance criteria required at the treatment plant to validate the use of the recycled water stream for each. These uses and the plant performance objectives are informed by the federal and state water reuse guidelines. Table A.1 is provided as a guide only. Treatment performance and on-site preventative measures should be evaluated on a case-by-case basis. For compliance with these guidelines, a number of steps would be undertaken including a site based recycled water risk assessment to verify the allowable uses and manage risks.

Table A.1 Recycled water uses and performance criteria

Treatment process[2]	Typical/allowable uses[1]	Typical usage restrictions/ application requirements[1]	Typical water quality objective[1]
Secondary Treatment w/ Lagoon Detention & Chlorination	Municipal uses (ovals, golf courses, etc.)	— No access after irrigation — Min 25–30 m buffer to public — Sprinkler spray drift control	— BOD <20 mg/L — SS <30 mg/L — E.coli <100 to <1000 cfu/100 mL (depending on treatment and usage restrictions)
	Landscape irrigation (trees, shrubs, public gardens)	— Microspray — Drip irrigation — No public access	— BOD <20 mg/L — SS <30 mg/L — E.coli <1000 cfu/100 mL
	Commercial food crops, for crops with limited or no ground contact or skins removed before consumption	— No access and use of drip or subsurface irrigation — No access during irrigation, 25–30 m buffers for spray irrigation — Spray drift control such as low-throw sprinklers)	— BOD <20 mg/L — SS <30 mg/L — E.coli <100 cfu/100 mL
	Non-food crops (trees, turf, woodlots, flowers)		— E.coli <10,000 cfu/ 100 mL
	Commercial food crops, cooked/processed before consumption (potatoes, beetroot), raised crops (i.e. apples, apricots, grapes)		— BOD <20 mg/L — SS <30 mg/L — E.coli <100 cfu/100 mL
MBR (with chlorine and UV disinfection)	Same uses as above	— See above	— See above
	Commercial food crops consumed raw or unprocessed	— Holding period between crop harvesting and sale	— TBC case by case — Turbidity and/or disinfection criteria — E.coli <1 per 100 ml
	Dual reticulation, toilet flushing, washing machines	— Increased controls on backflow prevention and cross connections (i.e. policy, plumbing audits)	— TBC case by case — Turbidity and/or disinfection criteria — E.coli <1 per 100 ml

(1) Typical criteria from Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (2006), and as referenced in NSW Guidelines for Recycled Water Management Systems (2015)

(2) Treatment process provided as examples of typical and more advanced sewage treatment approaches. Multiple combinations of sewage treatment processes are possible, with differing levels of disinfection performance. Note that treatment processes must be well designed, operated and maintained to ensure they achieve their disinfection objectives.

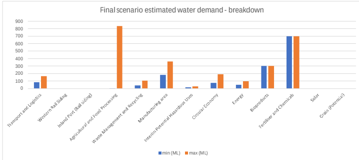
Appendix B

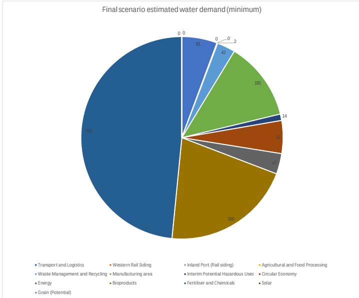
Structure plan water balance assessment

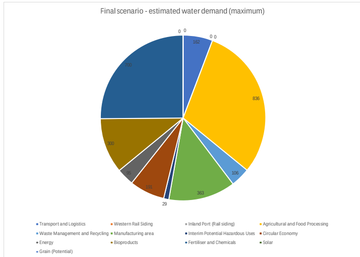
NARRABRI SAP FINAL SCENARIO - Water demand estimate (based on final land budget)

21/02/2023

	Land Use	Stage	Gross Ha defind in Land Budget	Assumed % of gross area applied to demand rate	Area demand rate applied to	Water demand rate (annual) min (ML/ha)	Water demand rate (annual) max (ML/ha)	Water demand (annual) min (ML)	Water demand (annual) max (ML)	Range	Water quality	Assumptions/comments
SAP Development	Transport and Logistics	1	108	15%	16	5	10	81	162	81	Low salinity	Market sounding indicates potential expansion of existing transport and logistics companies. These land uses typically have low potable water demand associated with site offices and facilities (5-10ML/ha p.a., refer Note 1), and a low density of buildings. Potential exists for additional water demand for specific processing or washdown facilities (if any). 15% of aread developed aligns with existing North Narrabri industrial area, refer Note 2.
SAP Development	Western Rail Siding	1	TBC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumed no water demand for this land use
SAP Development	Inland Port (Rail siding)	1	TBC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumed no water demand for this land use
SAP Development	Agricultural and Food Processing	2	91	15%	14	N/A	N/A	2	836	834	Low salinity	Market sounding indicates potential for the expansion of existing agricultural facilities which currently include grain handling and bulk processing, and have relatively low water demands. These businesses could include water intensive processing plants such as grain and pulse food processing (moderate 30-70ML/ha p.a.[1]), cotton ginning and manufacturing such as cotton spinning, food canning and packaging. Realistially, only a limited number of these major facilities / water intensive business are expected. Minimum/maximum demand taken as 2 ha / 10 ha of water intesive facilities (30-70 ML/ha[1]) with the remainder of the area developed as per the Light Indiustrial land use assumptions (as below). —Low demand volume assumed from existing Viterra silos and grain processing metered use, that is around 10 ML/yr and 13 ML in a dry
SAP Development	Waste Management and Recycling	2	94	15%	14	3	7.5	42	106	64	High salinity	Market sounding indicates potential for the expansion of plastic recycling facilities or new recycling facilities for other materials like aluminium. Waste to energy plant investment opportunities are available also (which may have substantial additional water demands). 15% of area developed aligns with existing North Narrabri industrial area, refer Note 2.
SAP Development	Manufacturing area	2	73	50%	36	5	10	181	363	181	Low salinity	Assumed as per light industrial, except assumed 50% of net area is developed rather than 15% (in absence of further information)
SAP Development	Interim Potential Hazardous Uses	2	19	15%	3	5	10	14	29	14	High salinity	Assumed as per light industrial land use
SAP Development	Circular Economy	2	169	15%	25	3	7.5	76	191	114	High salinity	Assumed as per Waste Management and Recycling land use
SAP Development	Energy	3	63	15%	9	5	10	47	95	47	Low salinity	Market sounding indicates potential for gas fired power generation (potentially high water demands) using natural gas from the NGP, as well as Battery Energy Storage System (BESS - minor water demands). Total demand figure from Market sounding responses of 1400ML adopted as best available information, this falls within expected range of demand for this land use
SAP Development	Bioproducts	3	41	N/A	N/A	N/A	N/A	300	300	300	Low salinity	Potential business involved in bioenergy and biofuels production from agricultural waste and biomass, as well as bioplastic production. Total demand figure from market sounding responses of 300ML adopted as best available information, this falls within expected range of demand for this land use
SAP Development	Fertiliser and Chemicals	3	367	N/A	N/A	N/A	N/A	700	700	700	Low salinity	Market sounding indicates potential for ammonia-derivative production (including fertiliser and explosives, using NGP natural gas as a feedstock). Opportunities also include sodium bicarbonate production using brine from NGP or methanol production. Total demand figure from market sounding responses of 700ML adopted as best available information, this falls within expected range of demand for this land use
SAP Development	Solar	3	144	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumed no water demand for this land use
SAP Development	Grain (Potential)	3	TBC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumed no water demand for this land use
Outside of SAP	Rail Connection	1	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumed no water demand for this land use
Outside of SAP	Light Industrial (North)	2	106.75	15%	16.01	5	10	80	160	80	Low salinity	These land uses typically have low potable water demand associated with site offices and facilities (5-10ML/ha p.a.). 15% of aread developed aligns with existing North Narrabri industrial area, refer Note 2.
Outside of SAP	Light Industrial (South)	2	187.30	15%	28.10	5	10	140	281	140	Low salinity	These land uses typically have low potable water demand associated with site offices and facilities (5-10ML/ha p.a.). 15% of aread developed aligns with existing North Narrabri inindustrial area, refer Note 2.
Outside of SAP	Residential	1	600 lots	N/A	N/A	N/A	N/A	184	238	53	Low salinity	Assumed 600 Lots initial development. Minimum adopts 307 kL/dwelling/a demand (3 star efficiency house in an average year). Maximum adopts 396 kL/dwelling/a (2 start efficiency house in a dry year). Per dwelling demand rates adopted from NSC's IWCM strategy issues paper
Outside of SAP	Residential	2	1800 lots	N/A	N/A	N/A	N/A	461	594	134	Low salinity	1500 lots remaining development to reach ultimate figure of 2100 lots as per Access Ecomonics study. Demand rates as above.
TOTAL			1169.51		118.10		55.00	2,310	4,055			







Note - highlighted cells are for input into the Water Balance Spreadsheet

Note 1 - Typical annual water demand rates estimated based on Section 64 Determination of Equivalent Tenement Guidelines, NSW Water Directorate 2017. Note these figures are based on 'built up hectares' which is linked to the building floor area and density of development. This is expected to overestimate demand rates when applied to very large 'precinct-scale' development areas, hence has been further adjusted using the '% of net area applied' factor. This method provides an order of magnitude indication of demand only (and may be highly site specific for any given development)

Note 2 - 15% of area developed aligns with existing North Narrabri industrial area (i.e. building footprint area as a % of net area) and is considered realistic for a regional context

#VALUE! residential dwellings based on above assumptions

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