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NSW GOVERNMENT

Sustainability Report

Narrabri Special Activation Precinct

Final

May 2023

Sustainability Report

Narrabri Special Activation Precinct

Final

Prepared by Umwelt (Australia) Pty Limited
on behalf of HATCH RobertsDay

Project Director:	Paul Douglass
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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

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.

Disclaimer

Document Status

Revision Number	Reviewer Name	Review Date	Approver Name	Approved Date
01	Paul Douglass	03/11/2022	Paul Douglass	03/11/2022
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Executive Summary

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 Umwelt Environment and Social Consultants to prepare a series of technical studies regarding sustainability within the Narrabri SAP investigation area.

As part of the master planning process and to inform this technical study, two Enquiry by Design (EbD) workshops were organised. A preliminary EbD was held on the 29 and 30 March 2022 to develop three initial land use scenarios. Following an interdisciplinary assessment of the three scenarios, a final EbD workshop was held between 5 and 8 September 2022 to study the interdisciplinary constraints of the three scenarios and identify and develop a preferred land use Structure Plan. This report assesses the Land Use Plan from the final EbD workshop from a sustainability perspective.

The purpose of this report is to provide sustainability and circular economy recommendations for inclusion within the proposed Narrabri SAP Structure Plan, Master Plan and Delivery Plan. Specifically, these include:

- Recommendations and opportunities for the Precinct based on the Narrabri SAP Investigation Area Land Use Plan.
- Set clear precinct scale measures to address sustainability and circular economy objectives.
- Recommendations for building design and performance measures that could be incorporated into the Delivery Plan.

This Sustainability Report has been supported by additional investigations and analysis summarised in preceding reports including the Sustainability Analysis Report (**Section 1.7**) and Sustainability Scenarios Report.

The NSW Government has identified Sustainability and Circular Economy principles as a core focus of the SAP program and outlined a number of key objectives associated with the Narrabri SAP:

- **Resilience and Innovation** – The design and delivery[1] of the Precinct will be adaptable to future changes including the impacts of climate change and technology innovations.
- **Optimal Resource Efficiency** – The design and delivery[1] of the Precinct will harness and promote water, energy and waste reduction and efficiencies.
- **Regional Scale Circular Economy Exemplar** – The design and delivery[1] of the Precinct will promote co-location of land uses to optimise strategic benefits and maximise infrastructure capacity and resource flows to support circular economy principles.
- **Guided by best practice frameworks, ratings and accreditations** – The design and delivery[1] of the Precinct will be guided by best practice sustainability frameworks, ratings and accreditations.

[1] Note: "Delivery" refers to the construction and operation of the Precinct.

Across the six sustainability themes for the Narrabri SAP, a range of constraints and opportunities have been identified and were utilised during the master planning process including the design of the Structure Plan. The six sustainability themes are:

- Climate Change Adaptation.
- Energy and Emissions.
- Water Use.
- Circular Economy.
- Transport.
- Built Environment and Construction.

Analysis of the constraints and opportunities within these six themes has then been undertaken in the context of the Narrabri SAP Investigation Area and sub-precincts where relevant. This analysis has resulted in the recommendations outlined in **Section 9.1** as measures and mechanisms to achieve the Sustainability and Circular Economy objectives of the Narrabri SAP.

Key recommendations of the Sustainability Report include:

- Implementing the recommendations of the Climate Change Adaptation Report (Umwelt, 2022).
- Maximising opportunities to reduce energy demand, promote energy efficiency and generate and/or source renewable or decarbonised energy.
- Maximising opportunities to reduce water demand, promote energy efficiency and implement water cycle management.
- Maximising opportunities to implement circular economy principles and opportunities.
- Promoting and providing infrastructure for electric vehicles, active transport and public transport.
- Use of industry best practice rating tools, accreditation and certification for the construction and built environment.

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1.0 Introduction

1.1 Special Activation Precincts

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. RGDC is responsible for the delivery of each precinct. The key components of the Special Activation Precincts are outlined in **Figure 1.1**.

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 Umwelt Environment and Social Consultants to prepare a series of technical studies regarding sustainability within the Narrabri SAP investigation area.

As part of the master planning process and to inform this technical study, two Enquiry by Design (EbD) workshops were organised. A preliminary EbD was held on the 29 and 30 March 2022 to develop three initial land use scenarios. Following an interdisciplinary assessment of the three scenarios, a final EbD workshop was held between 5 and 8 September 2022 to study the interdisciplinary constraints of the three scenarios and identify and develop a preferred land use Structure Plan. This report assesses the Land Use Plan from the final EbD workshop from a sustainability perspective.

Figure 1.1 Key Components of Special Activation Precincts

1.2 Why Narrabri

Narrabri is located 530 km northwest of Sydney on the Kamilaroi Highway and 560 km southwest of Brisbane on the Newell Highway, making Narrabri an ideal mid-way destination for travellers and for freight and logistics. The investigation area for the Narrabri Special Activation Precinct (Precinct) is in the same vicinity as the proposed Northern NSW Inland Port and Narrabri Gas Project, 7 km from the town centre around Yarrie Lake Road, and comprises of approximately 2,668 hectares.

The Precinct will leverage key infrastructure such as the Inland Rail and the Northern NSW Inland Port, giving investors direct access to global supply chains and markets. This includes supporting energy intensive industries and manufacturing linked to the Narrabri Gas Project, allowing the region to diversify economically and enhance its traditional agriculture and manufacturing industries, providing sustained economic growth and a drought resilient economy.

1.3 Governance

Special Activation Precincts are a unique collaboration across NSW Government including:

- The development and delivery of SAPs in NSW including overseeing funding, planning and development of each Precinct is led by the Department of Regional NSW.
- The planning of SAPs including master planning, technical studies and community and stakeholder engagement is led by DPE.
- The delivery of SAPs including development of catalytic enabling infrastructure and investor attraction and support is led by RGDC.
- The Precinct is located entirely within the Narrabri Shire Council (Council) local government area. Council is a key partner in the development of the Precinct.

1.4 Purpose

The purpose of this report is to provide sustainability and circular economy recommendations for inclusion within the proposed Narrabri SAP Structure Plan, Master Plan and Delivery Plan. It is also acknowledged that some recommendations may be out of scope of the direct spheres of influence for the SAP and may require further collaboration with NSW Government agencies, businesses and community.

Specifically, these include:

- Recommendations and opportunities for the Precinct based on the Narrabri SAP Investigation Area Land Use Plan.
- Setting clear precinct scale measures to address sustainability and circular economy objectives.
- Recommendations for building design and performance measures that could be incorporated into the Delivery Plan.

This Sustainability Report has been supported by additional investigations and analysis summarised in preceding reports including Sustainability Analysis Report and Sustainability Scenarios Report.

1.5 Sustainability Objectives

The Brundtland Report 1987 (Our Common Future)[2] introduced the concept of sustainable development which would meet the needs of the current generation without compromising the ability of future generations to meet their needs.

Sustainable development implies integration of risk, technological capacity, social organisation, the state of the environment and the ability of the biosphere to absorb the cumulative effects of human activities.

It is acknowledged that the 'baseline' for sustainability measures is rising as willingness, external drivers and technology coincide. Many organisations are adopting sustainability policies and plans and setting aspirational targets. Additionally Environmental, Social and Governance (ESG) standards are emerging as important corporate considerations and encourages businesses to incorporate sustainable development practices, allowing for overall sustainable development and operation as well as greater investor confidence.

To achieve sustainability objectives, development standards for the Precinct will need to be flexible, responsive and adaptive, so that they continue to accommodate changes to the regional, national and international context of sustainability. The staged approach to the development of the Precinct over its lifespan will enable the development to benefit from ongoing sustainability innovation and technology advances.

There are diverse perspectives on the scope of sustainability. Some practitioners focus on resource utilisation; others on environmental systems; others on environmental and social resilience. For the purposes of master planning of the Narrabri SAP, this sustainability report focuses on six key themes including:

- Climate Change.
- Energy and Emissions.
- Water use.
- Circular economy.
- Transport.
- Built Environment, Industry and Construction.

The NSW Government has identified Sustainability and Circular Economy principles as a core focus of the SAP program and outlined a number of key objectives associated with the Narrabri SAP:

- **Resilience and Innovation** – The design and delivery[1] of the Precinct will be adaptable to future changes including the impacts of climate change and technology innovations.
    - This objective is primarily achieved through measures within Climate Change Adaptation, Transport and Built Environment themes.

[2] Brundtland, G. (1987). Report of the World Commission on Environment and Development: Our Common Future. United Nations General Assembly document A/42/427.

- **Optimal Resource Efficiency** – The design and delivery[1] of the Precinct will harness and promote water, energy and waste efficiencies.
    - This objective is primarily achieved through measures within the Energy and Emissions, Water and Circular Economy theme.
- **Regional Scale Circular Economy Exemplar** – The design and delivery[1] of the Precinct will promote co-location of land uses to optimise strategic benefits and maximise infrastructure capacity to maximise resource flows to support circular economy principles.
    - This objective is primarily achieved through measures within the Circular Economy and Transport themes.
- **Guided by best practice frameworks, ratings and accreditations** -The design and delivery[1] of the Precinct will be guided by best practice sustainability frameworks, ratings and accreditations.
    - This objective is primarily achieved through measures within the Energy and Emissions, Water Use and Built Environment themes.

The analysis and recommendations in this report address these aspects of sustainability noting other elements such as social infrastructure and community needs are covered by other disciplines within the master planning process.

Key stakeholders have identified that the sustainability objectives and recommendations present an opportunity to further attract and retain enterprise and businesses to the SAP. They should be developed as an enabler and should not act as an inhibitor to the overall objectives of the SAP for economic development.

1.6 Limitations

This report is based on a review of relevant available reports and data and conceptual level analysis. It has not been supported by a comprehensive review of all technical reports prepared for the SAP. It does not provide detailed quantitative analysis or technical advice. The available documents do not necessarily cover all aspects of the sustainability status and opportunities of the area. The aim of the report is to identify opportunities for sustainability initiatives to add value to development and delivery of the SAP. The report provides objectives and identifies measures to achieve the stated objectives within the scope and constraints of the SAP.

1.7 Stage 1 – Sustainability Analysis Report Summary

1.7.1 Purpose of the Sustainability Analysis Report

As part of the master planning process for Narrabri SAP, Umwelt were engaged to prepare a Sustainability Analysis Report.

The Report highlighted sustainable development opportunities for the Precinct to build on current leading practice to create a business investment environment that is innovative but supported by robust evidence and analysis and a clear development framework.

The sustainability analysis established the pathway to embed and showcase sustainability principles in every aspect of the development of the Precinct. It provided a baseline to foster discussion of the sustainability context of the site, what could be achieved; and highlighted key issues for further investigation.

1.7.2 Key Findings of Stage 1 – Sustainability Analysis Report

Opportunities

- **Capitalise on the Narrabri SAP's proximity to planned solar farms** to capture the abundant solar energy in the region. The region typically receives 19–20 megajoules per day of daily solar exposure making it one of the highest solar penetrating areas in NSW. The New England North West Regional Plan outlines that the region can be a leader in the renewable energy sector.

- **Establish a manufacturing hub that supports a circular economy:** With advanced manufacturing identified by Regional NSW as an emerging industry for the region, an opportunity exists to support a circular economy within the manufacturing sector underpinned by the principles of designing out waste, enhancing resource efficiency and utilising by-products or waste from nearby industries to create new products. Narrabri SAP can enhance its advanced manufacturing value proposition by capitalising on the low cost, renewable energy available in the region.

- **Given Narrabri's proximity to Moree, synergies can be identified with the nearby Moree SAP** to service the agriculture sector with its needs for technical materials such as metal/plastic equipment, or plastic packaging (as distinct from biological materials such as timber, cotton or food crops) to ensure the impact of each individual SAP is amplified by being part of a network.

- **Set ambitious sustainability rating goals:** All new precinct infrastructure and buildings should conform with the most ambitious level within the IS Rating Scheme, Green Star or other industry rating systems to ensure design minimises whole of life impact of assets, informed by evidence through lifecycle analysis. Examples of design techniques to minimise whole-of-life impact include using low-embodied carbon materials, buildings are flexible to adapt to different users, and building elements are designed for disassembly and reuse at their end of life.

- **Facilitate industrial symbiosis through co-location and collaboration driven through the business concierge:** Potential tenants can be strategically co-located within the SAP to facilitate the sharing of complementary resource flows (such as materials, heat (including industrial heat), or water) where possible. Including symbiotic and circular economy principles into the design of the precinct will help to attract organisations to the SAP.

- **Adopt an Eco-industrial Park management/governance model for the precinct,** potentially through the Regional Development Corporation's business concierge service. This management model could provide the precinct with strong data collection and analysis, strong park leadership to facilitate collaboration among tenants to capitalise on opportunities for industrial synergies, and provide performance monitoring, reporting, and benchmarking.

  Since the baseline report, Regional NSW has indicated that the SAP will not be seeking to become an Eco-industrial Park precinct, however the UNIDO EIP principles should still be embedded where appropriate, supporting not only the SAP's circular economy ambitions but also NSW Governments drive for data driven 'Smart Places'.

- **Leverage the existing recycling presence:** The Narrabri SAP has the opportunity to establish itself as a leader in recycling practices and industries with opportunities to attract solar PV, e-waste and textiles recycling opportunities as well as a range of other materials. This could build upon the presence of the existing plastics recycling operation located in the Narrabri SAP Boundary.

Constraints

- **Water scarce region:** The Northwest New England region is drought prone with future projections indicating a hotter and drier climate. Proposed industries utilising water in an already water scarce region will have to be carefully considered. Currently the Great Artisan Basin (Southern Recharge) seems to be the most practical option for water sourcing.

- **Current shortage in workforce skills and requirements:** The largest urban centre, Coffs Harbour, is located over 400 km away by road limiting the possibility of commuting long distances to the SAP. Local workforce and skills development to meet the future demand of industries will have to be considered. Potential solutions could include:

    - A review of courses offered at Narrabri TAFE and advocating for new courses to fill any relevant skills gaps.

    - Collaborating with Narrabri TAFE to provide education to career pathways, internships or on-the-job training opportunities.

    - Engaging with other education Science, Technology, Engineering and Mathematics (STEM) providers to fill any relevant skills gaps.

    - Opportunities to leverage the skilled workforce of the nearby Moree SAP with specialists in agribusiness, logistics and food processing.

- **Poor proximity to large scale sources of wastes and end-markets for recycled materials:** There is the potential that even with the Inland Rail and the planned Northern NSW Inland Port improving connectivity between Narrabri and larger cities, the cost to transport waste materials to the SAP and recycled products back to end markets may render a recycling hub in Narrabri SAP uncompetitive compared with recycling facilities located closer to points of large-scale waste generation and end markets. To manage this, any recycling facilities should aim to make use of locally available sources of waste, service local industries for example the growing solar industry, target specialised material streams with high-value and low weight, identify local off-take markets for recycled products, or make use of reverse logistics to optimise transport costs.

2.0 Strategic Overview

2.1 Location

The Narrabri township is located within the Narrabri Shire local government area (LGA), 530 km northwest of Sydney. 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. Narrabri will also have a direct connection to the Inland Rail route (once completed) which will connect Melbourne to Brisbane via new and upgraded track.

2.2 Economic & Land Use Context

As of the 2021 census, the population of Narrabri township was 6,898 persons. The existing local industry of Narrabri is dominated by agribusiness, education and healthcare, manufacturing and mining industries but also has increasing opportunities for renewable energy and new technologies which will make the economy one of the most diverse in NSW.

The development of the Narrabri SAP and the accompanied infrastructure investment within the area aims to support the growth of the local labour market, aid in the economic development of the local Shire and surrounding councils.

2.3 Strategic Policy Framework

Sustainability is not a static condition, and the concept of sustainable development has evolved since its introduction and will continue to evolve over time. This report, and its predecessors, have been informed by a diverse range and scales of governance and policy which influence the sustainability framework from global to local and regional approaches and strategies.

More recently, all levels of Australian government and many businesses have recognised that action to move towards sustainable development is not a remote concept, but an urgent priority. This has resulted in agreement about short, medium and long-term goals and targets which direct innovation and investment into new ways of delivering products and services, managing resources, connecting systems and people. These targets and actions are a way of operationalising sustainability and linking it directly to business performance systems.

The sustainability performance of the Narrabri SAP will depend on how government and private sector investors respond to these goals and targets at all levels.

A high-level summary of the key policies influencing the Narrabri SAP is included in **Table 2.1**. A more detailed summary of these key documents can be found in **Appendix A**.

Table 2.1 Summary of Strategic Policy Framework

Jurisdiction	Policy	Description	Influence on SAP
International	**Paris Agreement COP21**	The Paris Agreement is an international agreement within the United Nations Framework on Climate Change (UNFCC) which aims to keep global temperature rise this century within 2 degrees Celsius (°C) of pre-industrial levels and further pursue options to limit the temperature rise to less than 1.5 °C above pre-industrial levels.[3]	Australia committed to reducing their emissions to below 26–28%. This agreement set a benchmark for each state and territory to develop and set their own targets with an emphasis on meeting or exceeding this target.
International	**United Nations Sustainable Development Goals**	The United Nation's Sustainable Development Goals (UN SDGs) are a set of 17 holistically developed goals intended to drive better outcomes in terms of the health, dignity and equality of people; sustainable management of natural resources (linked to earlier definitions and principles of ecologically sustainable development); economic prosperity; peace and cross regional to global partnerships.	The UN SDGs are directly applicable to the Narrabri SAP. **Appendix A** provides a summary of the relevance of each goal to the Narrabri SAP.
National	**Long Term Emissions Reduction Plan**	The plan aims to achieve net zero emissions by 2050 across four areas through a number of priority low emissions technologies. At a high level, the plan identifies a number of stretch goals between 2030 and 2040 to guide and encourage development	A long-term goal for the SAP will include a framework to reduce emissions. Opportunities and constraints on the emissions profile within the Precinct is outlined in **Section 4.4**.
National	***National Waste Policy (2018) National Waste Policy Action Plan (2019)***	*The National Waste Policy* (2018) provides a national framework for waste and resource recovery in Australia and outlines the five key principles for waste management that will enable Australia to transition to a circular economy. *The National Waste Policy Action Plan* (2019) includes targets and actions to implement the Policy. These includes aims to: • Reduce the total waste generated in Australia by 10% per person by 2030. • Achieve an 80% average recovery rate from all waste streams by 2030.	Circular economy and waste management principles are a key focus for the SAP. These are discussed in detail in **Appendix B**.

[3] United Nations (2015) Paris Agreement to the United Nations Framework Convention on Climate Change.

Jurisdiction	Policy	Description	Influence on SAP
National	***Water Management Act (2000)***	*The Water Management Act (2000)* provides for the sustainable and integrated management of the state's water sources for the benefit of present and future generations.	Groundwater resources within the Narrabri SAP investigation area are governed under the Water Management Act 2000. *The Water Management Act* will govern the issue of water access licenses and approvals for water sources relevant to the SAP where water sharing plans have commenced.
National	**Best Practice Management of Water Supply and Sewerage (2007)**	Identifies six criteria for best practice management of town water supply and sewerage. It defines outcomes local water utilities need to achieve to demonstrate the implementation of the guidelines.	It is recommended that Narrabri SAP demonstrate compliance to the guidelines in the event that Narrabri Shire Council wish to increase their water allocations under their local water utility water access licences.
State	**NSW Circular Economy Policy Statement**	NSW Circular Economy Policy Statement seeks to deliver positive economic, social and environmental outcomes.	The SAP could align with circular innovation ambitions defined in the policy statement and leverage industrial symbiosis opportunities to enhance recycling, support reuse and adopt sustainable procurement across the development of the precinct, including circular design of buildings, infrastructure and manufacturing products.
State	**NSW Waste and Sustainable materials strategy 2041**	This Strategy outlines the NSW Government's approach to transitioning to a circular economy over the next 20 years and provides a long-term strategic focus to build resilient services and markets for waste resources.	Circular economy and waste management principles are a key theme for the SAP. These are explored in detail in **Appendix B**.
State	**Future Transport 2056 – NSW Electric and Hybrid Vehicle Plan**	Overarching strategy to broadly lead the transition of a NSW Transport System.	The SAP could support uptake of electric vehicles through development of supporting infrastructure (e.g., charging stations) and make the SAP 'EV Ready'.

Jurisdiction	Policy	Description	Influence on SAP
State	**NSW Electricity Infrastructure Road map**	Framework to plan the transition and modernisation of the NSW electricity system.	The SAP operations would benefit from supporting infrastructure upgrades under the Electricity Infrastructure Investment Safeguard. The SAP would also maximise onsite energy generation wherever practicable (most likely via small-scale Solar PV on rooftops etc.) to reduce reliance on energy imported from the NSW grid.
Regional and Local	**New England North West Regional Plan**	Overarching plan to direct support, major investment and development priorities across the New England North West region.	The plan includes strategies to support the agricultural industry, such as strengthening freight networks with better access to national and international markets and looks to expand the food processing sector by identifying the most suitable areas for agribusiness to benefit on-farm jobs and attract long-term investors. These priorities compliment the objectives of the SAP.
Regional and Local	**Narrabri Growth Management Strategy (NGMS)**	NGMS identified a demand for additional industrial land, in addition to the pre-existing and approved logistics and industrial hubs across the LGA. The NGMS also recognises a demand for green industries that will continue to emerge as the landscape transitions to a net zero economy.	'Green' industries are businesses, facilities, services or technologies that provide sustainable alternatives or solutions to environmental challenges. Examples include bottle recycling plants, waste management and treatment or research and development for clean energy. These sectors will be at the heart of considerable innovation and can gain greater success with local partnerships between industry, government and educational facilitates.
Regional and Local	**Northern Inland Regional Waste Strategy 2017–2021 and Action Plan 2017–2019**	Northern Inland Regional Waste Strategy 2017–2021 and Action Plan 2017–2019 works collaboratively in pursuit of effective waste management and resource recovery across the region with 11 other member councils. The strategy is now outdated however, should an updated regional waste management plan be released during the course of this project, it will be reviewed and integrated.	To align with the level of ambition for the Narrabri SAP in relation to circular economy, it is recommended that the NSW Waste and Sustainable Materials Strategy is more relevant.

2.4 Frameworks and Accreditations

As industry and governments extend their sustainability aspirations and global and national reporting requirements are established through policy, a range of frameworks and accreditations have emerged. It is also likely that further frameworks and accreditations will be developed in the life of the Precinct.

The design, delivery and operation of the Precinct should be guided by best practice sustainability frameworks and accreditations. At a strategic or Precinct level the following were identified during Stage 1 as suitable to provide guiding strategic principles. It is acknowledged that given the constraints and limitations noted throughout this report the NSW Government is seeking to implement a place-based sustainability framework rather than specifically following some of the broader national or international frameworks. Regardless, the principles and goals embedded within these frameworks provide relevant context and guidance for the development of a Narrabri SAP specific framework alongside this report.

Climate Active Carbon Neutral

Climate Active certifies carbon neutrality, and can be awarded to buildings, events, organisations, precincts, products and services. Climate Active provides the framework to verify that Precincts have suitably quantified their footprint, understand the emissions that can be abated and offset the rest.

The standard could be used to verify the precinct or sub-precincts as carbon neutral; however, it is not being pursued at this time. Whilst the SAP is not seeking Climate Active Carbon Neutral verification the objective for the SAP to be guided by best practice frameworks, rating and accreditations should remain a long-term goal of the Precinct. United Nations Industrial Development Organisation Eco-Industrial Parks (UNIDO EIP).

An eco-industrial park is a community of businesses located on a common property in which businesses seek to achieve enhanced environmental, economic and social performance through collaboration in managing environmental and resource issues.

The aim of eco-industrial parks is to promote resource efficiency and circular economy practices and better connect cities and industries. In particular, the promotion of circular economy objectives is a key principle of the UNIDO Eco-Industrial Park Framework.

This framework could be used to guide the Precinct or sub-precincts in achieving enhanced performance. Whilst the SAP is not seeking to be recognised as an Eco-industrial Park precinct, the principles should still be embedded through the design, delivery and operation of the Precinct where appropriate.

Further information regarding rating tools and accreditation specific to the built environment and construction are outlined in **Section 8.1.1**.

3.0 Narrabri SAP Investigation Area

3.1 Location

The investigation area for the Narrabri SAP, developed at the Final EbD covers an area of approximately 3097 ha. It is located to the west of the existing township and incorporates two areas separated by an environmental buffer zone. It also identifies key opportunities in the Town Centre and additional industrial and residential land uses within Narrabri including the Mt Kaputar Precinct.

This investigation area is being utilised as a basis for all technical studies, however, will not necessarily form the final SAP boundary which may change throughout the master planning process. See **Figure 3.1**.

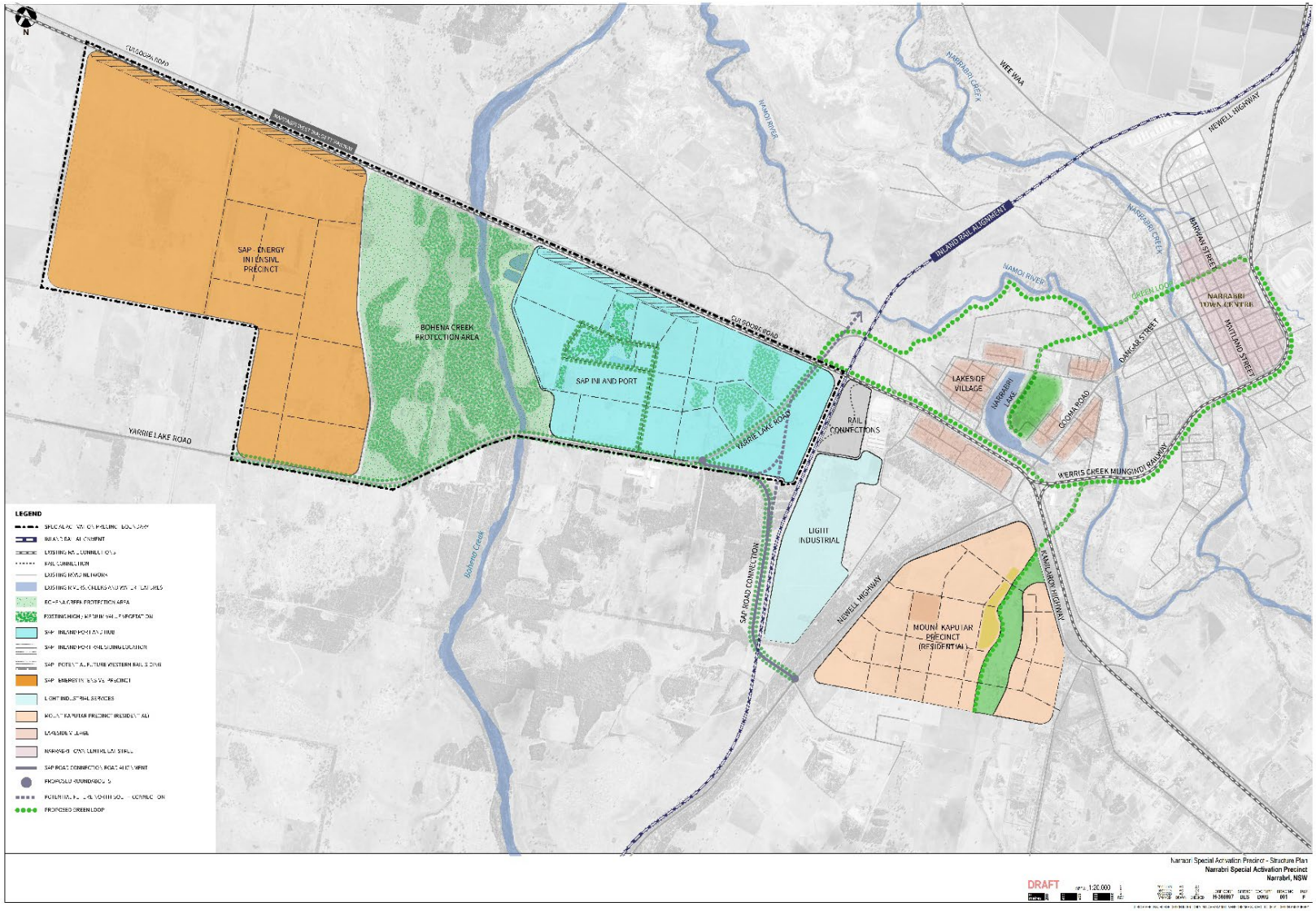

Figure 3.1 Narrabri SAP Structure Plan Investigation Area

Within the investigation area the following key areas are identified and addressed throughout this report as presented in **Figure 3.2**.

Special Activation Precinct including

- Inland Port and Hub:
    - The Inland Port and Hub comprises the proposed Narrabri Inland Port (N2IP) which is anticipated to be delivered as part of the first stage of development and support non-energy (gas) reliant industrial uses and leverage the containerised siding. This would also include land to enable waste management, recycling and circular economy businesses and operations.
- Energy Precinct:
    - The Energy Precinct to the west of Bohena Creek is anticipated to comprise higher hazard, energy intensive uses proximate to the Narrabri Gas Project with the opportunity for a separate siding.
- Investigation Areas:
    - Further discussions are required to determine if bulk grain opportunities are viable in the western portion of the SAP.

Town Centre Framework including

- Developing Narrabri Town Centre's tourism and 'Eat Street' character.
- Enhancing the sport, recreation and social infrastructure of the Lakeside Village.

Mt Kaputar Precinct

- The Mt Kaputar Precinct is proposed to accommodate residential growth of Narrabri to 2060 including capacity for approximately 3000 dwellings, local community infrastructure and convenience retail, and a health and education precinct.

3.2 Existing Land Uses

The following existing land uses, and developments are noted within the SAP Investigation Area:

- Chasarwill Pty Limited Australian Recycled Plastics is a plastics processing facility that processes kerbside plastics, producing PET and HDPE Flake. The capacity of this processing facility is currently sitting at 6,000 tonnes of waste annually with increased investment tipped to see the facility expand to upwards of 9,000 tonnes annually.
- Narrabri Shire Council – Waste Management Centre is the existing municipal waste management facility for Narrabri. It currently cannot accept liquid waste nor shred green waste due to minimal volumes. Narrabri Shire Council are currently expanding the land fill site (January 2022). There is capacity at the existing site to service Narrabri for approximately 30 years through future expansion of cells. The Narrabri Waste Management Facility operates an EPA funded Community Recycling Centre (CRC). The EPA funded CRC is a NSW-wide funded initiative and recycles industrial materials including batteries, oil, paints and other substances.

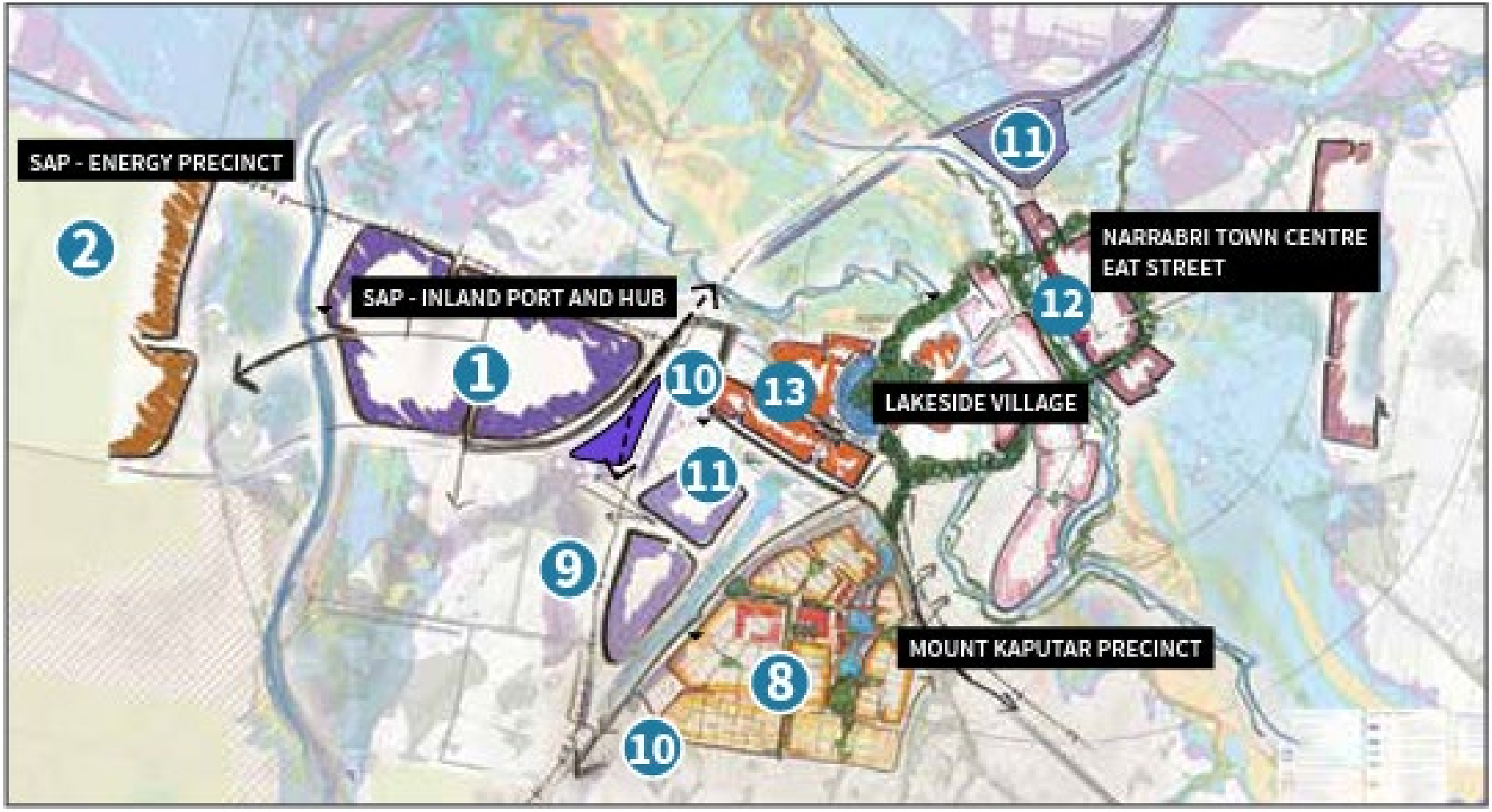

Figure 3.2 Narrabri SAP Key Areas[4]

[4] Note: The image has been provided by Hatch RobertsDay. The number references are not contextually relevant, and this figure can be replaced once updated version is available.

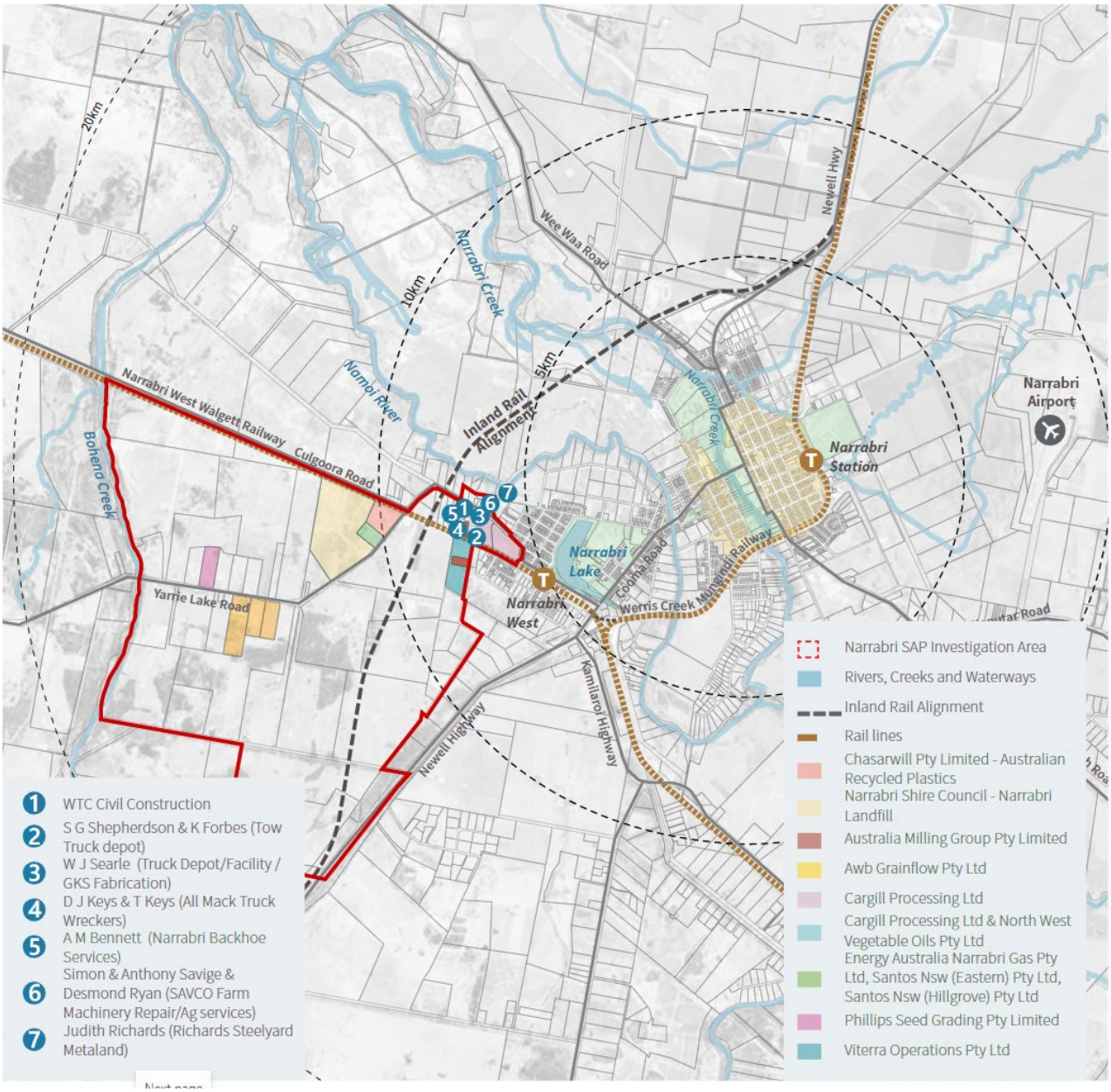

Figure 3.3 Narrabri SAP Existing Land Uses

3.3 Vision

Through the master planning process the following vision has been identified for the Narrabri SAP.

> *Strengthening our relationship and care for the land, waters and biodiversity of Country, the Narrabri SAP will reinforce the Town Centre as a destination and the heart of Narrabri, unlocking greater economic growth for the town and region, leveraging from the Inland Rail, the Northern NSW Inland Port and the Narrabri Gas Project.*

3.4 Design Principles

Through the master planning process, 7 principles have been identified that build on the Narrabri SAP vision as outlined in **Figure 3.4**.

Through the master planning process, a strong focus on designing with country principles was also identified and these have been embedded within the design of the SAP Structure Plan and Town Centre Framework.

Figure 3.4 Narrabri SAP Principles Sub-Precincts and Focus Areas

3.5 Narrabri Inland Port (N2IP)

The N2IP is proposed to be located in the central core of the SAP bounded by Culgoora Road to the north, Yarrie Lake Road to the south and Bohena Creek to the west. **Table 3.1** outlines potential land uses and development opportunities within the Narrabri Inland Port including indicative resource requirements as described in the Economics Report prepared by Nous/Aurecon.

Table 3.1 Narrabri Inland Port Land Uses

Land Use	Land Area	Description of potential development opportunities	Energy Requirements	Water Requirements
Narrabri Inland Port Rail Siding	36.07 ha	The Inland Port will comprise business/s running the terminal operations and businesses specializing in warehousing, transport, vehicle maintenance and other ancillary services.	Minimal	Minimal
Transport and Logistics	108.2 ha	Expansion of existing transport and logistics companies.	Moderate	Minimal
Agriculture and Food Processing	90.88 ha	• AGT Foods expansion. • Grain processing facility. • Feedmill Facility. • Flour Mill. • Plant Protein.	Moderate	Moderate
Manufacturing	72.5 ha	Support development of a range of manufacturing activities. This may include potentially hazardous developments.	Moderate	Moderate
Interim potential hazardous	19.19 ha	Warehouses that store or handle DGs/hazardous chemicals. Manufacturing and/or storage of DGs/hazardous chemicals.	Moderate	Moderate
Circular Economy	169.47 ha	Handling, storage, sorting and processing of waste to support a circular economy.	Likely to target renewable energy	Likely to target low water consumption
Waste Management and Recycling	94.32 ha	• Narrabri Shire Council Waste Management Facility expansion. • Australian Recycled Plastics expansion. • New recycling facilities for other materials. (Glass/Plastics).	Moderate	Moderate

3.6 Energy Hub

The Energy Hub is proposed to be located in the western extent of the SAP bounded by Culgoora Road to the north, Yarrie Lake Road to the south and Bohena Creek to the east. **Table 3.2** outlines potential land uses and development opportunities within the Energy Hub including indicative resource requirements as described in the Economics Report prepared by Nous/Aurecon.

Table 3.2 Energy Hub Land Uses

Land Use	Area	Description of potential development opportunities	Energy Requirements	Water Requirements
Fertiliser and Chemicals	366.62 ha	Ammonia-derivative production including fertiliser and explosives. Could also include: • Sodium bicarbonate producer. • Industrial CO2 plant. • Methanol production facility.	Natural gas from NGP (~28 PJ p.a.). Grid electricity (60 MW p.a.).	Highest water use is for steam-methane reformation process which is used to convert natural gas feedstock into hydrogen for use in the ammonia (~700 ML p.a.).
Energy	63.1 ha	A Gas fired power station or Battery Energy Storage System (BESS) operating as a peaking generator.	Natural gas from NGP (~5 PJ p.a.).	Minimal assuming an open cycle plant is developed. Recommended given water demand constraints.
Solar Energy	144.41 ha	Large Scale Solar Farm (ground mounted arrays). 144.14 ha land scale solar farm is expected to enable the construction of a 48 MW Solar Farm which would be able to power approximately 15,000 homes in NSW.	N/A.	N/A.
Bioproducts	40.79 ha	Bioenergy and biofuels production from agricultural waste and biomass. Bioplastics production.	Electricity – likely to target renewable energy sources (~20 MW).	300 ML p.a. assuming bioethanol production.

3.7 Narrabri Town Centre Framework

Alongside the development of the Special Activation Precinct, consideration has been given to establishing a Town Centre Framework: A Vision for Growth.

The Town Centre Framework will reinforce and market the unique character areas within Narrabri to attract and retain families, youth and develop a skilled workforce. The framework focusses on two key areas:

- Narrabri Town Centre Eat Street – Promoting an active front door and eat street onto Narrabri Creek enabled by a calmer street network.
- Lakeside Village – leveraging the emerging sport and recreation identify and further enhancing the social infrastructure provision and place opportunities at the Station.

The Narrabri Town Centre framework sits outside of the SAP but is complimentary to the objectives of the SAP and enabled by the below elements of the Precinct:

- proximity to jobs associated with the Precinct
- co-location of the proposed arterial road and Inland Rail.

The objectives of this Sustainability Report could also apply to the implementation of the town centre framework and whilst not the focus of this report some broad recommendations have been made where relevant.

3.8 Mount Kaputar Precinct

The Mount Kaputar Precinct (Mt Kaputar Precinct) is located south of the Town Centre bounded by the Newell highway to the west and Kamilaroi Highways to the east to future proof Narrabri's growth through a vision for a complete community that is a complimentary and genuine extension of Narrabri.

The Mt Kaputar Precinct will deliver the community needs and housing demand for Narrabri up to 2060 including:

- supporting approximately 3,000 dwellings with a focus on diversity of lot size, building type, price point and desired demographic
- schools in houses or offices as a short-term solution
- community and local retail at the centre of the community co-located with the amenity of an enhanced wetland
- connectivity to Narrabri Town Centre via active travel along the Green Loop and bus services
- a flood free area for vulnerable uses such as a hospital and aged care
- opportunities for business and industry as a buffer to Newell and Kamilaroi Highways
- indoor recreation centres with the ability to function as an evacuation hub.

As a result of the job creation and economic growth from the SAP, the resident population of Narrabri is expected to increase and thus increase the demand for housing supply. The Mt Kaputar Precinct is proposed to meet this demand and as such is closely aligned and complimentary to the SAP. The Mt Kaputar Precinct is in close proximity to the jobs created by the SAP and key transport connections including Narrabri West Station and the proposed arterial road. Its close alignment to the proposed arterial road and inland rail will minimise land sterilisation/optimise developable land.

The objectives of this Sustainability Report also apply to the Mt Kaputar Precinct and whilst not the focus of this report, some broad recommendations have been made where relevant.

4.0 Constraints and Opportunities

Across the six sustainability themes for the Narrabri SAP, a range of constraints and opportunities have been identified and were utilised during the master planning process including the design of the Land Use Plan.

Analysis of these constraints and opportunities has then been undertaken in the context of the Narrabri SAP Land Use Plan. Further analysis should be undertaken following completion of the Structure Plan and in preparation of the Master Plan to refine the recommendations.

This analysis has resulted in the recommendations outlined in **Section 9.1** as actions and mechanisms to achieve the Sustainability and Circular Economy objectives of the Narrabri SAP.

4.1 Climate Change Adaptation

Climate change projection data has been informed by the NSW and ACT Regional Climate Modelling (NARCliM) Project Version 1.0 and AdaptNSW climate change projection snapshots.

Narrabri is located within the central west area New England North West (NENW) boundary. Data projections presented below reference projected changes in climate when compared to the baseline period of 2000.

At a high level the NENW region is projected to experience:

- increase in average and extreme temperature events
- increase in number of hot days (above 35°C)
- increase in rainfall during autumn
- increase in bushfire risk and intensity
- decrease in rainfall during winter
- decrease in number of cold nights (below 2°C).

Preliminary climate change risks have been reported in Climate Change Adaptation Considerations (Umwelt, February 2022). A preliminary climate change risk assessment was undertaken prior to the identification of specific precinct development options and design. To support the development of the SAP and inform the Enquiry by Design workshops adaptation considerations were identified to guide the designing out of a number of risks identified in the preliminary climate change risk assessment. These adaptation considerations included:

- Investigate options to maximise onsite renewable energy generation.
- Consider location of critical infrastructure in low hazard areas (i.e., underground cabling in fire prone areas or asset elevation for roads in flood prone areas).
- Ensure water demand calculations consider the impacts of climate change on water demand (i.e., more dry years and high-water demand during warmer weather).

- Ensure flood modelling considers the impacts of climate change to flood regimes/levels (i.e., this includes a 30% increase in rainfall activity into 1% AEP flooding modelling outputs.
- Investigate areas for ecological corridors and refuges.
- Consider increased demands for emergency services.

The Climate Change Adaptation Report was finalised following the EbD. It found that the Land Use Plan and supporting Technical Reports have incorporated and considered the majority of the climate change risks and adaptation findings to varying degrees. Some risks and adaptation findings remain outstanding and are likely to be addressed during the finalisation of the Structure Plan and the supporting technical reports or through the subsequent preparation of the Master Plan and Delivery Plan. Further detail can be found in the Climate Change Risk and Adaptation Report (Umwelt, 2022).

To support the sustainability objective of a resilient Precinct the adaptation considerations presented in the Climate Change Adaptation Plan should be implemented including undertaking and maintaining a Precinct specific Climate Change Risk Assessment and embedding these requirements into operational management requirements for tenants and operators.

4.2 Energy and Emissions

To reduce the impacts of climate change, keep global temperature rises below 2°C and meet respective international commitments, significant decarbonisation of the energy system towards net zero is required. As outlined in **Section 2.0**, Local, State and Federal governments have made strong commitments to this journey to net zero.

The Narrabri SAP has a role to play in this decarbonisation and journey to net zero. Through the master planning process, implementation (delivery - design and construction) and operations, the SAP has opportunities to strategically plan the Precinct to reduce energy and emissions.

The limitations outlined later in this section indicate offsets are unlikely to be a suitable mechanism to achieve net zero emissions at a Precinct scale.

In the first instance this is achieved through the master planning process which prioritises land uses and co-location opportunities to meet the objectives of a low energy Precinct. Further to this, these objectives can be achieved by maximising energy efficiency to reduce energy demand and the use and generation of renewables and decarbonised energy to ultimately reduce emissions.

Given the 40-year timeline, it is also acknowledged that the Precinct will need to be agile and responsive to market fluctuations, climate change and future technology advancements which may identify additional opportunities and constraints associated with energy and emissions.

Tenants and businesses will need to consider the net zero policy context when designing their facilities and some land uses may need to be reconsidered or the type of process or operations used by that land use altered. An example of how this could apply in practice would be for energy intensive land uses to be required to provide a decarbonisation or transition plan that demonstrates a staged approach to reducing emissions and progressing towards net zero.

Operations within the SAP are forecast to generate Scope 1, 2 and 3 greenhouse gas emissions:

- Scope 1 greenhouse emissions are emissions released to the atmosphere as a direct result of an activity, or series of activities. They are often referred to as direct emissions. Examples of direct emissions includes the burning of diesel fuel or combustion of natural gas.
- Scope 2 greenhouse gas emissions are emissions released to the atmosphere from the indirect consumption of combustion energy. They are often referred to as indirect emissions. Examples of indirect emissions include the use of electricity powered by coal or gas located offsite.
- Scope 3 greenhouse gas emissions are indirect emissions other than scope 2 emissions which are generated in the wider economy. They occur as a consequence of activities of a facility but not from sources not owned by the facility or business. *N.B Scope 3 greenhouse gas emissions are outside the scope of this report.*

Traditionally, the primary inputs into the energy system are sourced from the burning of fossil fuels for heat and/or electricity generation and so to reduce emissions end users must consume energy more efficiently, remove use of fossil fuel energy sources and actively seek or install renewable energy sources.

The development of the SAP investigation area has assumed that the proposed Santos Narrabri Gas Project will proceed and will be a driving force for additional economic growth in the region. It is acknowledged that some of the proposed land use opportunities are identified based on local access to gas and that by co-locating adjacent to the Gas Project it enables energy transportation efficiencies. It is also acknowledged that the use of natural gas as an energy source has limited decarbonisation opportunities but within the context of the Narrabri SAP can still play a role in the transition to net zero by facilitating other outcomes towards net zero.

Furthermore, it is noted that infrastructure and assets for the sole purpose of the storage, transport and use of gas have the potential to become stranded assets as the decarbonisation journey continues and the need and use of gas diminishes.

The following land uses within the Energy Hub are identified as likely to be reliant on a direct piped supply of natural gas from the Santos Narrabri Gas Project for operation.

Gas Fired Power Plant

The opportunity for a Gas Fired Power Plant which would export to the national grid has been included in the SAP Land Use Plan. It is recognised that while the gas fired power plant does not align with long term decarbonisation goals, it does play a role in the governments plan to transition to net zero. For example, it will require transmission upgrades to increase the capacity of the local and regional electricity network. This will in turn activate opportunities for additional renewable energy projects across the Precinct and the broader region which are currently constrained by grid capacity. This includes the proposed solar farm included within the land area for the Energy Hub.

As such, the opportunity to increase the network capacity presented by the gas fired power plant can facilitate and contribute to decarbonisation through new and/or expanded renewable energy projects in the region and thus could be supported as part of a staged approach to achieving sustainability objectives. Longer term, the use of gas as an energy source does not support the sustainability objectives of the Precinct.

Note: The gas demands of this land use have not been confirmed and as such are not included in the demand figures or calculator. This can be updated following confirmation of the demands.

Fertilisers and Chemicals

The opportunity for fertiliser and chemical processing within the SAP has also been identified, in part due to proximity and access to a local supply of natural gas (a required input for the production process). This land use would be dependent on the Narrabri Gas Project, which is not yet guaranteed.

It is recognised that this is an energy intensive land use that is limited in its current pathways to decarbonisation and as such does not align with the longer-term goals to achieve net zero without the purchase of high cost offsets.

Note: The process gas demands of this land use have not been confirmed and as such are not included in the demand figures or calculator. This can be updated following confirmation of the demands.

For the purposes of this report, it is assumed that the remainder of land uses within the Precinct will use electricity from the grid as the main source of energy.

4.2.1 Limitations

Based on the current proposed Land Use Plan, the scale of energy and emissions reduction is limited by the:

- high energy intensity of some of the proposed land uses
- use of natural gas as an energy source and process input
- compliance with regulatory changes as part of the decarbonisation journey
- small land area allocated for non-rooftop renewable energy on-site.

Further consideration should be given to justification for the inclusion of energy intensive land uses with limited ability to decarbonise in the future as they conflict with the sustainability objectives of the Precinct. Alternatively, prioritisation could be given to land uses with low energy intensity or a detailed program to achieve decarbonisation over the life of the Precinct.

Offsets are the final and least desirable mechanism available to decarbonise and progress towards net zero emissions. These are discussed further at **Section 4.7** including limitations at the Precinct scale. These limitations mean offsets are unlikely to be sourced to achieve net zero emissions at a Precinct scale.

Recognising the above constraints, it is unlikely that the Narrabri SAP would achieve net zero emissions at a Precinct scale in the short term however, components of and sub-precincts within the Narrabri SAP have great potential to make significant contributions to the journey to net zero.

Progressing towards net zero should remain a long-term target for the Precinct given the 40-year timeline, the uncertainty on proposed land uses being realised and the advancement of technology and innovation during this time.

4.3 Energy Demand Profile

Understanding the energy demand profile for the Precinct is a key component in achieving a reduction of energy and emissions. The energy demands associated with key land uses have been identified by Aurecon/Nous in development of the Economics Report (as presented in **Table 3.1** and **Table 3.2**). The Utilities Report prepared by WSP has refined these assumptions and correlates with the work undertaken by Umwelt to develop the Energy and Carbon calculators as outlined in **Section 4.5.2.1**.

Umwelt have identified the following business as usual demand profile utilising the Energy and Carbon Calculators (Umwelt, 2022).

Sub-Precinct	Electricity Demand (MWh/year)	Gas Demand (GJ/year)	Emissions (CO2-e/year)
Inland Port	2,368,406	7,274	1,910,258
Energy Hub	477,814	484	385,334
Total	2,846,220	7758	1,147,769

Note: these calculations do not include the gas demands associated with the manufacture of ammonia due to uncertainty on the quantity of ammonium nitrate production or the gas fired power plant due to uncertainty on the MW capacity. Using the values for gas demand within the Nous/Aurecon report the gas demands for the Energy Hub increase in the order of 33 GJ/year.

This energy demand profile is indicative of a likely land use outcome for the Precinct, however, will need to be continually reviewed and updated as the Precinct develops, and key stages are implemented. To ensure this can be achieved, the Precinct will need to have a robust system for the monitoring and collection of energy data. The Energy and Carbon Calculators developed by Umwelt for this report could be adapted for this purpose.

4.4 Emissions Reduction Framework

The Precinct should actively seek to reduce the business-as-usual energy demand and thus reduce the associated emissions profile. A decarbonisation hierarchy, as outlined in **Figure 4.1** is recommended to form the basis of a framework to reduce energy and emissions associated with the SAP Land Use Plan. A key step generally within decarbonisation hierarchy's is to remove the use of fossil fuels as an energy source and electrify, which is not included within this framework due to the inclusion of gas. This can be used as a preliminary guide for the development of a place-based sustainability framework for the Precinct.

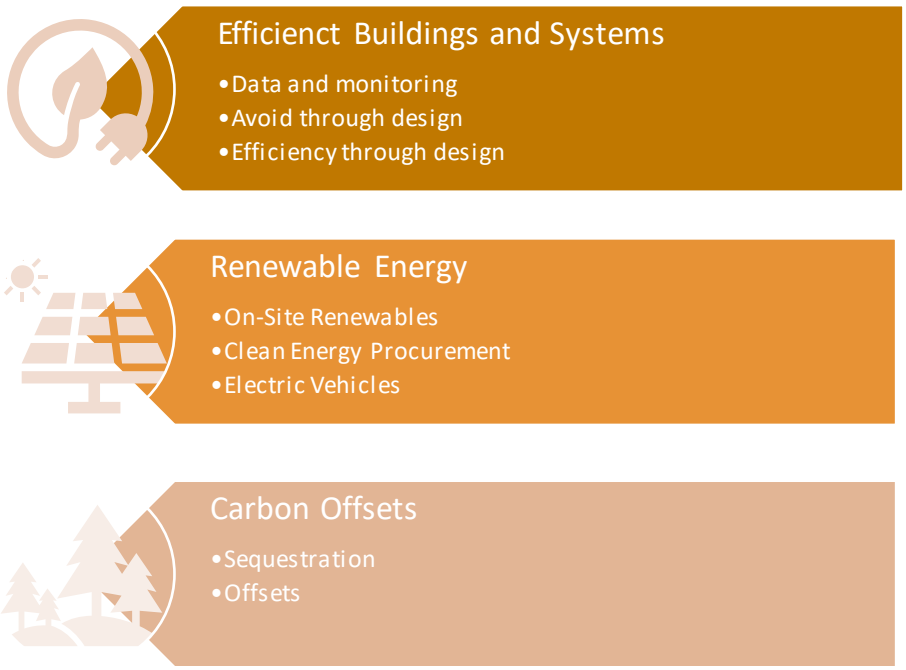

Figure 4.1 Emissions Reduction Framework – Decarbonisation Hierarchy

4.5 Energy Efficient Buildings and Systems

Energy efficiency is a key pillar of the framework and requires good data (the collection and monitoring of energy use) and should be applied to all life cycles of a building or system (design and delivery).

A number of energy efficiency opportunities have been identified through the Sustainability Analysis Report (Umwelt, 2022). Efficiency measures can be simple initiatives such as efficient fixtures and fittings within buildings, through to more innovative technology solutions to achieve more significant energy savings. Efficiency measures can also be embedded into the design process to maximise long term sustainable outcomes. Energy efficiency opportunities include:

- passive shading
- building orientation and design
- urban greening
- Water Sensitive Urban Design (WSUD)
- use of on-site generated renewable energy
- maximising natural light
- reuse of building components at end of life through modularity and design for disassembly.

4.5.1 Avoidance and Efficiency Through Design

Industry partnerships such as Green Building Council of Australia (GBCA), who administer Green Star, and National Australian Built Environment Rating System (NABERS) rating schemes provide best practice benchmarks across a number of key sustainability attributes for the built environment, improving energy efficiency across design, construction and operation. These energy efficiency tools are further detailed within **Section 8.0**. It is noted that these provide direction but industry and building class specific direction may also be required.

For all areas within the SAP, Town Centre and Mt Kaputar Precinct landowners and tenants should be encouraged to consider energy efficiency in the design, construction and operation phases of the building and/or systems.

4.5.2 Data and Monitoring

Collecting, recording and monitoring energy and emissions data during operational phase is a key requirement to identify opportunities for reduction and efficiency as well as to track improvements and progress towards objectives. The Precinct should adopt a Precinct-scale approach to the collection and monitoring of data and this can also be used for reporting and certification in the future (as required).

The ISO14001 EMS framework is recommended as a mechanism to achieve this while also addressing a range of other environmental and sustainability driven performance indicators. The ISO14001 EMS framework establishes audit procedures that provide for the planning and conduct of an audit of an EMS to determine conformance with EMS audit criteria. The Precinct should be managed via an overarching ISO14001 EMS Framework with landowners and tenants encouraged or required to also adopt this framework.

4.5.2.1 Energy and Carbon Calculator

An energy consumption and carbon emissions calculator has been developed for the SAP based on estimated energy usage intensities for each of the anticipated land uses. The calculator accounts for both electricity and gas usage within the SAP to determine overall energy demands and allows for the implementation of rooftop solar and electrification of gas for each land use. Carbon emissions are estimated in the calculator using standard emission factors for electricity and natural gas. It should be noted that the energy calculator does not account for fuel usages associated with vehicles and mobile plant/equipment (e.g., fleet vehicles, forklifts, front end loaders, freight trucks and locomotives) within and around the SAP.

Carbon emission and energy consumption calculations have been combined into one calculator to ensure predicted emissions estimates are consistent with predicted energy usage. The purpose of the energy and carbon calculator is to:

- Estimate energy demands at a precinct and sub-precinct level as well as provide energy usage estimates for different industry types/land uses within the SAP.
- To assist in identification of the industry type/land use mix within sub-precincts that will achieve optimum sustainability outcomes.
- To inform infrastructure requirements across the precinct.

- To estimate the greenhouse gas emissions associated with the SAP based on estimated electricity and gas usage. All emission factors have been sourced from the National Greenhouse Accounts Factors 2020 and Australia's National Inventory Report 2018 (May 2020).
- To provide an insight into "business as usual" (BAU) energy demands and greenhouse gas emissions and the reductions that can be achieved with the implementation of rooftop solar where this measure can be identified and are applicable.

Energy intensity factors and utilisation factors for specific industry type/land uses used in the energy and carbon calculator are based on information provided by WSP and factors developed for the calculations completed for the Narrabri SAP energy and carbon calculator (Umwelt, 2021).

A schematic showing the general structure and outputs of the energy and carbon calculator is provided in **Appendix C**. A copy of the Energy and Carbon calculator is provided in **Appendix D**.

4.5.2.2 Energy and Carbon Calculator Findings

The Energy and Carbon Calculators report BAU energy demands and associated emissions and enable a range of scenarios to be tested across the Precinct and sub-precincts. In this manner they provide inputs for both the design and delivery of the Precinct and could form part of the ongoing management of the Precinct.

Example Scenario – Rooftop Solar

For example, the reduction in demands and emissions associated with the application of rooftop solar within the Precinct are outlined for the Inland Port in **Table 4.1**. Based on the assumptions applied to the energy and carbon calculator and the indicative land uses it is estimated that energy demands can be reduced by 5% through the implementation of rooftop solar within the Precinct. Further information is provided in **Appendix D**.

Table 4.1 Energy and Emissions – Inland Port – Business as Usual and Optimised

Sub-Precinct	Business as Usual Electricity Demand (MWh/year)	Business as Usual Gas Demand (GJ/year)	Business as Usual Emissions (TCO2-e/year)	Optimised Electricity Demand (MWh/year)	Optimised Gas Demand (GJ/year)	Optimised Emissions (TCO2-e/year)	Reduction in Energy Demand through Optimisation
Inland Port	2,368,406	7,274	1,910,258	2,245,289	N/A	1,810,976	~5%

4.6 Renewable Energy

Renewable energy opportunities within the SAP investigation area were identified and refined during the EbD including generation for on-site use or export to the grid.

A number of renewable energy generation opportunities were reviewed and assessed during the master planning process. All of these opportunities are recommended for inclusion in the Master Plan to support decarbonisation of the Precinct and to contribute to wider State and Federal commitments. All renewable energy opportunities should also consider incorporating battery storage to maximise onsite use.

Inland Port and Hub

- Rooftop Solar (Onsite use).
- Biogas connected to Landfill (Export to Grid or Onsite use).
- Medium Sized Solar on rehabilitated land associated with the Council Landfill site.
- Electric Vehicle Charging Station.

Energy Hub

- Large scale Solar Farms (Export to Grid or Onsite use).
- An opportunity has been identified for a large-scale Solar Farm and Battery Energy Storage System to utilise land that forms the buffer to the proposed high hazard uses such as the fertiliser and chemical plant. The land area provided is approximately 144 ha which assuming some constraints is expected to enable the construction of a 48 MW solar farm. The final expected additional average load demand from the SAP is approximately 260 MW (WSP 2022). The solar farm would account for only 18% of the prospective future load. Further consideration should be given to extending the land area for solar energy generation within the SAP or in close proximity.

Town Centre and Mt Kaputar

- Rooftop Solar (Residential and Commercial).
- Solar powered infrastructure such as street lighting.
- Energy efficient fittings and fixtures.
- LED lighting.

For all areas within the SAP, Town Centre and Mt Kaputar Precinct Council, landowners and tenants should be encouraged to include onsite renewable energy generation such as those identified above alongside battery storage to maximise demand reduction and onsite use.

Solar Farms Outside the SAP

WSP's Renewable Energy Report also identifies multiple options for siting of solar farms outside the SAP. Of these, most are large enough to provide a peak of-day offset equivalent to the final land use plan demand estimate. The remainder could be scaled to suit the demand requirements. The location of three of the sites are suitable for associating with the SAP to enable distribution of the renewable energy primarily into the SAP (WSP 2022).

4.6.1 Reducing Gas Emissions

As part of the decarbonisation strategy efforts should be made to reduce reliance on natural gas. It is noted that the utilisation of gas for processing will continue to have functionality in several industrial and manufacturing land uses in the short term.

The Energy and Emissions Calculator (**Appendix D**) can illustrate the potential reduction in demand and emissions associated with electrification of gas usage. Alternatively, longer term opportunities for decarbonisation of this energy include emerging technology such as green hydrogen.

Green Hydrogen is an energy resource that can be manufactured from 100% renewable resources which can also reduce life-cycle emissions of the product to zero and is a suitable replacement for a number of applications natural gas is used for. It is also projected to reach commercial maturity during the lifecycle of the SAP.

Successful green hydrogen generation within the SAP requires pairing with large scale renewable energy generation and access to significant volumes of water. Given the constraints on large scale renewable energy (**Section 4.6**) and access to water (**Section 5.0**) currently the potential for hydrogen to form a part of the Narrabri SAP in the short term is low. However, with technology advancements and further investigation this may be viable in the longer term for the Precinct and should continue to be explored.

For all areas within the SAP, Town Centre and Mt Kaputar Precinct landowners and tenants should be encouraged to use electricity over gas and where gas is required investigate decarbonisation options.

4.6.2 Energy Procurement

Where onsite renewable or decarbonised energy cannot fully sustain operations within the SAP, renewable energy can be sourced from outside the SAP.

This could be achieved by:

- promoting and encouraging tenants to source their energy from renewable sources
- requiring a percentage (%) of energy to be sourced from renewable sources
- entering into a Power Purchase Agreement (PPA) at a precinct or sub-precinct level.

Sourcing additional offsite electricity at a precinct level, could create a competitive advantage over other direct market consumers and entice new business within the SAP. Uptake of a PPA has the potential to drive and further influence sustainable development in NSW, particularly in areas of Regional NSW where Renewable Energy Zones or Hubs are being rolled out. Potential also exists for the PPA to be linked to the proposed large scale solar farm proposed in the Land Use Plan.

For all areas within the SAP, Town Centre and Mt Kaputar Precinct landowners and tenants should be encouraged to purchase renewable energy through their energy supplier or via a Power Purchase Agreement dependent on the scale of energy use.

4.7 Carbon Offsets

Carbon offsets are able to be purchased to offset unavoidable emissions. During Stage 1 of the project carbon offsets were investigated as relevant to Narrabri SAP. Climate Active Carbon Neutral Standard was identified as an opportunity for the Narrabri SAP (as outlined in **Section 2.4**). To be certified under a carbon neutral scheme, such as Climate Active, specific offset units would be required to be purchased. Each offset credit surrendered offsets one tonne of carbon dioxide (equivalent).

Offset units that are eligible for generation or purchase under the Climate Active Carbon Neutral Standard include Australia Carbon Credit Units (ACCUs). An offset strategy based around ACCUs has the potential to drive sustainable development in NSW. ACCU methodologies are also likely to align with existing SAP land use and industries.

Greenhouse gas emissions generated across the SAP could be offset by a number of different stakeholders including organisations, local council and the NSW Government who may be operating within the SAP. A decentralised approach could encourage stakeholders to offset individual emissions on their own accord. Government stakeholders could assist the adoption of this approach, through development of education programs, incentive schemes and compliance programs for those operating within the SAP.

Alternatively, a centralised approach could be developed to offset emissions on behalf of the entire SAP whereby RGDC would manage an offset program on behalf of SAP stakeholders. This may include the purchase of land, development of offset projects or purchase and surrender of offset units on behalf of SAP stakeholders. A hybrid model may also be suitable whereby a decentralised approach is taken for well-resourced business or organisations with existing programs, and a centralised service to cover market failures and other stakeholders.

The role of carbon offsets within a place-based sustainability framework should be considered further during development of said framework.

4.8 Energy Management Measures

Table 4.2 provides a summary of the recommended energy management measures. Further detail regarding these measures is provided within the recommendations in **Section 9.1**.

Table 4.2 Summary of Energy Management Measures

Measure	Site-Specific	Precinct Wide
Consider the emissions reduction framework in development of a place-based sustainability framework		X
Collect and Monitor energy and emissions data i.e. energy and carbon calculator	X	X
Adopt a precinct wide ISO14001 EMS which integrates the place-based sustainability framework		X
Encourage tenants to implement a ISO14001 EMS which integrates the place-based sustainability framework	X	X
Require minimum efficiency standards in design and delivery		X
Prioritisation of low energy intensity land uses		X
Require decarbonisation plans for energy intensive land uses	X	
Include on-site renewable energy generation (large scale)		X
Include on-site renewable energy generation (site scale – i.e. rooftop solar)	X	X
Encourage coupling of battery storage with renewable energy generation	X	X
Prioritisation of electric energy use within developments	X	X
Continue to review the opportunities related to Green Hydrogen		X
Procurement of renewable energy	X	X
Consider the role of carbon offsets in development of a place-based sustainability framework		X

5.0 Water

Water is recognised as a constrained resource in many parts of regional NSW including in Narrabri. As such, water use needs to be sustainably planned and managed to ensure it remains a resource available to development within the Precinct without compromising the needs of other water users.

Given the 40-year timeline it is also acknowledged that the Precinct will need to be agile and responsive to market fluctuations, climate change and future technology advancements which may identify additional opportunities and constraints associated with water use and optimisation.

The main sources for drinking and process water in the region include the Namoi River and a range of groundwater sources. Increases in water demand in a number of areas across the Namoi region has resulted in a decline in groundwater levels, particularly in times of drought and other prolonged periods without rain. The diversification of industry, such as via the SAP may provide opportunities to reduce requirements for water and dependence on water supplies, providing a level of resilience to the local economy during periods of prolonged dryness.

The draft Namoi Regional Water Strategy proposes to build on State-wide reforms being introduced including non-urban water metering and improvements to compliance with water sharing rules.

The goal for sustainable water management across the Precinct is to develop a precinct wide, coordinated approach to flooding, drainage and water cycle management which also preserves, enhances and protects the natural environment. Water is a significant feature of the landscape surrounding Narrabri with Namoi River, Narrabri Creek and Bohena Creek within the general locality of the Narrabri SAP.

5.1 Water Demand

Water inputs across the Narrabri SAP can be broadly categorised into the following groups (see **Table 5.1**).

Table 5.1 Water Inputs

Category	Description
Potable	Potable water will be supplied via mains water supply. Sourced from either surface or groundwater sources.
Rainwater	Water captured across roofing structures. This includes both buildings and enclosed/roofed carparks. Assumes sufficient volume of water tanks available to capture rainwater
Stormwater	Stormwater measures will capture run-off from across the Precinct. Impervious lots, such as roads, car parks and pedestrian access areas will be the primary sources of stormwater runoff across the Precinct.
Groundwater	Groundwater from bores or other mains water sources for various non-potable applications across SAP likely to be from the GAB Southern Recharge Groundwater Source.
Wastewater	Water that has been used and would otherwise be disposed e.g. greywater (water from sinks, basins and some industrial processes) and blackwater (water from sewage).

WSP have completed a Water Demand analysis for the Precinct based on the land-use category and area of development within the SAP for the 40-year planning horizon. The water demand estimate was developed using the demand rates and water quality requirements for different types of industries. The estimated demand for Stage 1 (comprising Inland Port and Mt Kaputar) of the SAP is approximately 265–400 ML per year, including development of 600 residential lots, increasing to a total demand of approximately 2,400–4,200 ML per year when fully developed (Energy Hub) including residential growth of a further 1,800 lots (WSP, 2022).

As a result of this analysis a significant water shortfall for the land uses currently identified within the Precinct is identified. The minimum end of the estimated water demand is higher than the existing Narrabri town water consumption, that has a current average annual demand of around 2,000 ML/yr (WSP 2022). This places further emphasis on the need to reduce water demand and efficiently use water through a sustainable water management framework.

During the EbD workshop, this was a key theme for consideration, and it was acknowledged that tenants will need to consider this constraint when designing their facilities. Additionally, some land uses may need to be reconsidered or the type of process or operations used by that land use specified. An example of how this could apply in practice to avoid high water uses identifying a preference for the open cycle gas fired power plant as it uses minimal water comparted to the closed cycle system. Further consideration on individual land uses should be undertaken to align the Precinct with the local water constraints and sustainability objectives.

5.2 Water Cycle Management

A water cycle management approach is proposed centred on the categories of Alternative Supply and Reuse, Water Sensitive Urban Design and Water Efficiency with the detailed components shown in **Figure 5.1**. Implementation of alternative water supplies, supported by water sensitive urban design principles and best practice efficiency measures will be a key strategy to ensure adequate water resources are available to preserve, enhance and protect the environment and support the proposed land uses within the Precinct. This can be used as a preliminary guide for the development of a place-based sustainability framework for the Precinct.

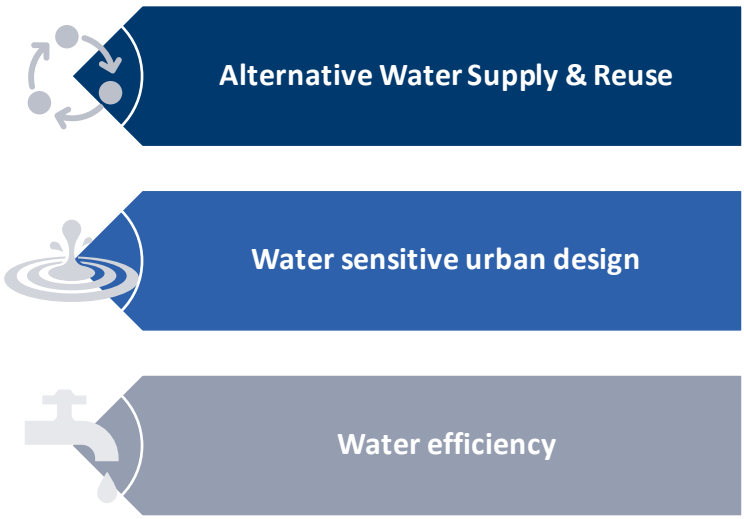

Figure 5.1 Water Management Components

Collecting, recording and monitoring water usage data is a key requirement to identify opportunities for reduction and efficiency as well as to track improvements and progress towards objectives. The Precinct should adopt a collaborative approach to the collection and monitoring of data, and this could also be used for reporting and certification in the future.

The ISO14001 EMS framework is recommended as a mechanism to achieve this while also addressing a range of other environmental and sustainability driven performance indicators. The Precinct should be managed via an overarching ISO14001 EMS Framework integrated with the place-based sustainability framework with landowners and tenants encouraged or required to also adopt this framework.

5.3 Alternative Water Supply and Reuse

Given the water supply gap and to minimise demand on potable water supplies, access to alternative water supplies for non-potable water uses will be required. A number of alternative supply and reuse opportunities were reviewed and assessed during the master planning process. It is recommended these are included in the Master Plan to support sustainable water supply for the Precinct and to contribute to wider State and Federal commitments. This includes:

- Rainwater capture:
    - Rainwater capture from roofing should be maximised across the Precinct particularly in areas with higher water demands. This could include rainwater storage tanks located across the Precinct for non-potable uses. The minimum storage capacity of rainwater tanks should be determined during the development stage and met within the design and operation of individual developments.
- Wastewater treatment:
    - WSP's Utilities Infrastructure Technical Report for the Precinct presents opportunities for the establishment of a new Sewer Treatment Plant (STP) with potential upgrades for the existing reticulation system.

If a new STP is progressed in close vicinity of the SAP, following treatment, water could be used across a number of applications in the Precinct including but not limited to toilet flushing and irrigation purposes. Further investigation at the time of construction of each sub-precinct would be required to assess the functionality and potential constraints of these measures.

For all areas within the SAP, Town Centre and Mt Kaputar Precinct, landowners and tenants should be encouraged to consider alternative water sources in the design, construction and operation phases of the building and/or operational processes.

5.4 Water Sensitive Urban Design

Water sensitive urban design (WSUD) is a term used to describe the integration of water cycle management into planning, design and construction of the built environment and includes replication of natural processes into the treatment of water in a constructed environment.[5]

[5] Water sensitive urban design guideline (nsw.gov.au).

It is understood that water sensitive urban design principles are supported by the Flooding and Surface Water Cycle Management Report prepared by WSP and the Landscape Plan prepared by Moir. They are also well aligned to the sustainability objectives of the Precinct.

It is understood that the SAP will maximise opportunities to instil WSUD principles and recommendations have been made regarding integrated stormwater management corridors (WSP, 2022) and blue green grids and infrastructure including wetlands (Moir, 2022).

The Precinct should adopt water sensitive urban design principles in the design and delivery of the Precinct including the recommendations in other technical reports for the use of integrated stormwater management corridors, green and blue infrastructure including wetlands.

5.5 Water Efficiency

Water efficiency measures can be simple initiatives such as training and awareness programs, collection and monitoring of usage data, use of efficient fixtures and fittings within buildings through to more innovative technology solutions. Efficiency measures can also be embedded into the design process to maximise long term sustainable outcomes.

Industry partnerships such as GBCA and NABERS rating schemes provide best practice benchmarks across a number of key sustainability attributes for the built environment, improving water efficiency across design, construction and operation. These tools are further detailed within **Section 8.0**.

For all areas within the SAP, Town Centre and Mt Kaputar Precinct landowners and tenants should be encouraged to consider water efficiency in the design, construction and operation phases of the building and/or operational processes. This will ensure existing sources extend as far as possible and any future sources are used sustainably.

5.6 Water Calculator

A water consumption calculator has been developed for the SAP based on estimated water usage intensities for each of the anticipated land uses. The calculator estimates overall SAP water demands and allows for the substitution of potable water demands with harvested stormwater, groundwater and recycled water from NSC for each land use.

The purpose of the water calculator is to:

- estimate water demands at a precinct and sub-precinct level as well as provide water usage estimates for different industry types/land uses within the SAP
- to assist in identification of the industry type/land use mix within sub-precincts that will achieve optimum sustainability outcomes
- to inform infrastructure requirements across the precinct
- to provide an insight into “business as usual” (BAU) water demands and the reduction in potable water demands that can be achieved with the implementation of stormwater harvesting and the use of groundwater and/or recycled water from NSC.

Water intensity factors and utilisation factors for specific industry type/land uses used in the water calculator are based on information provided by the WSP and factors used in the water calculator developed for other SAPs.

A schematic showing the general structure and outputs of the water calculator is provided in **Appendix E**. A copy of the Energy and Carbon calculator is provided in **Appendix F**.

5.7 Water Management Measures

Table 5.2 provides a summary of the recommended energy management measures. Further detail regarding these measures is provided within the recommendations in **Section 9.1**.

Table 5.2 Summary of Water Management Measures

Measure	Site-Specific	Precinct Wide
Consider the water management cycle in the development of a place-based sustainability framework		X
Collect and monitor water use data i.e., water calculator	X	X
Adopt a precinct wide ISO14001 EMS which integrates the place-based sustainability framework		X
Encourage tenants to implement a ISO14001 EMS which integrates the place-based sustainability framework	X	X
Capture rainwater for potable and non-potable use	X	X
Include a decentralised wastewater treatment facility in the Precinct		X
Prioritisation of the use of alternative water supply and reuse options within developments	X	X
Utilise an Integrated Stormwater Management Corridors approach		X
Maximise green and blue infrastructure within the Precinct and retain water in the catchment		X
Require minimum efficiency standards in design and delivery		X

6.0 Circular Economy

Edge Environment has prepared a Circular Economy Report for the Narrabri SAP which is contained within **Appendix B** and summarised here.

Resource efficiency and sustainability are key ambitions for the Narrabri SAP. Circular economy will be applicable to most if not all industries with regards to the construction of the various new assets and infrastructure in the SAP.

Circular economy provides a framework to use and manage materials required to meet the needs of society in such a way that decouples economic growth from the depletion of finite resources, retains materials at their highest value in closed-loop systems, uses renewable energy sources, and adds value to ecological and social systems. To achieve this, the circular economy framework provides the following three guiding principles: [6]

- eliminate waste and pollution
- keep materials in use
- regenerate natural systems.

To meet the circularity ambitions of the Narrabri SAP, these principles should be applied across the SAP's lifecycle, interfacing at all scales from nano to macro. Lifecycle thinking at the design stage is particularly important as it can pre-determine much of the impact realised later in the lifecycle.

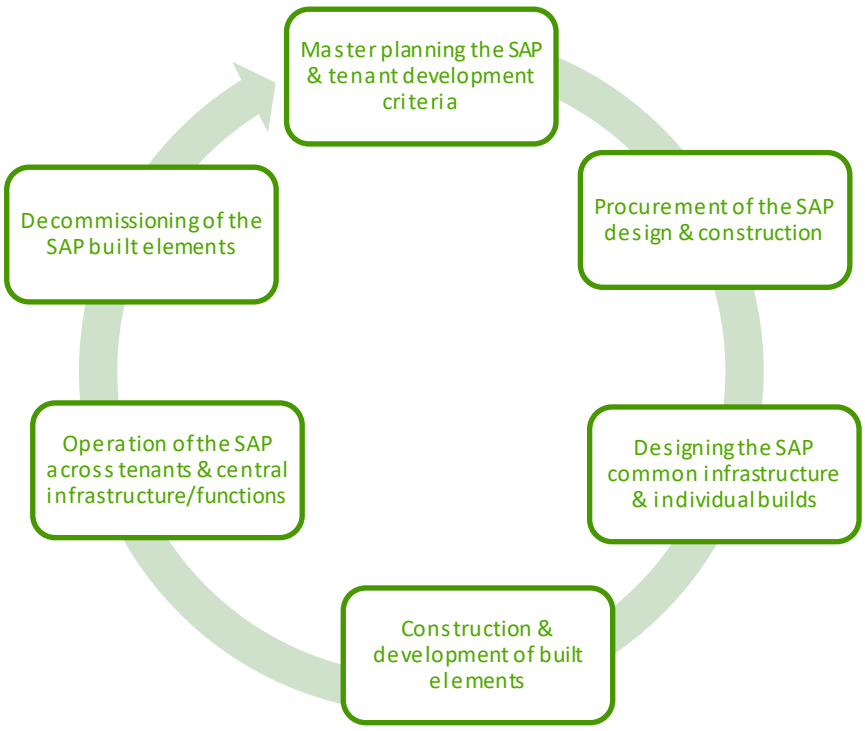

Figure 6.1 Lifecycle of Narrabri SAP

[6] Ellen Macarthur Foundation, What is circular economy?

In the context of the Narrabri SAP, circular economy can be applied in a variety of ways across the SAP's lifecycle and at multiple scales (shown in **Figure 6.2**).

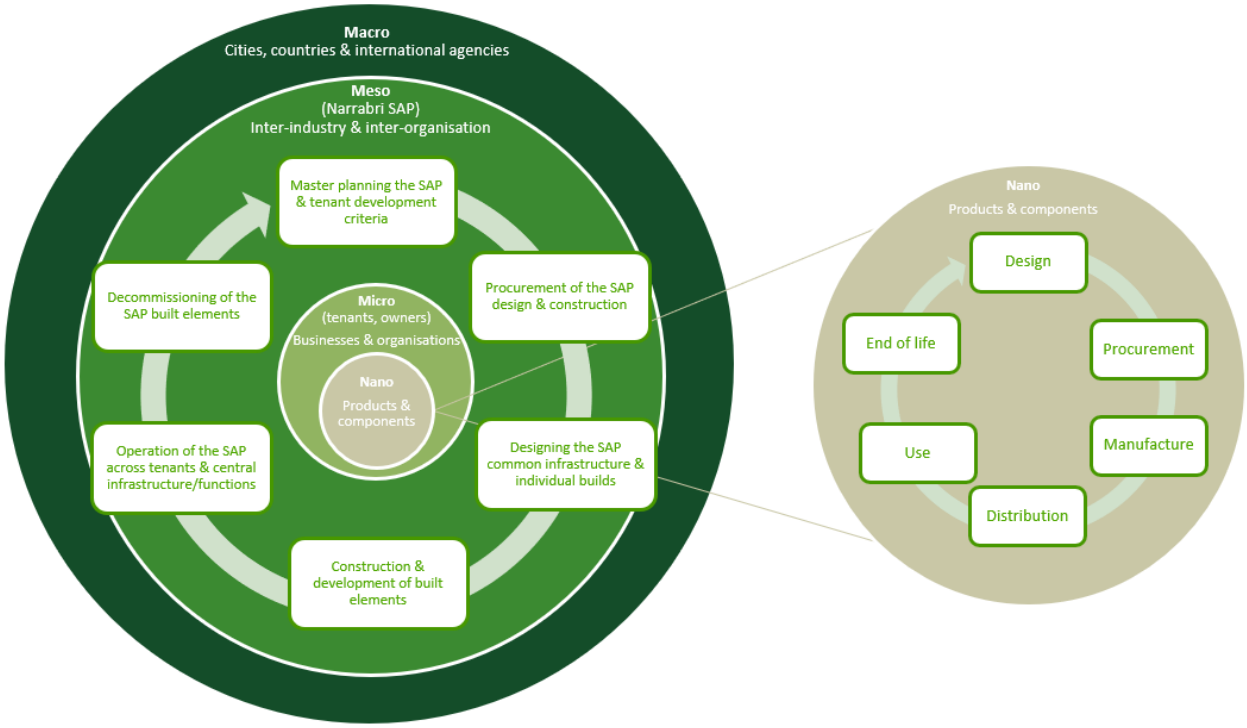

Figure 6.2 Scope and Scale of Circular Economy in the SAP

6.1 Circular Principles

Embedding circular principles and frameworks within the SAP design and operations is key to achieving circularity, reducing whole of life impact, and best practice resource management to maintain highest value. There are several frameworks that can be leveraged across the SAP from the design of buildings through to waste management, including:

- Prioritising the reuse of materials and maintaining the highest order value is an important consideration within the circular economy and should be applied upstream and downstream across the value chain. The R-ladder circular strategies (**Figure 6.3**) provide a valuable framework for assigning and understanding the comparative value of resource management activities.[7]

[7] PBL Netherlands Environmental Assessment Agency (2019), Outline of the Circular Economy.

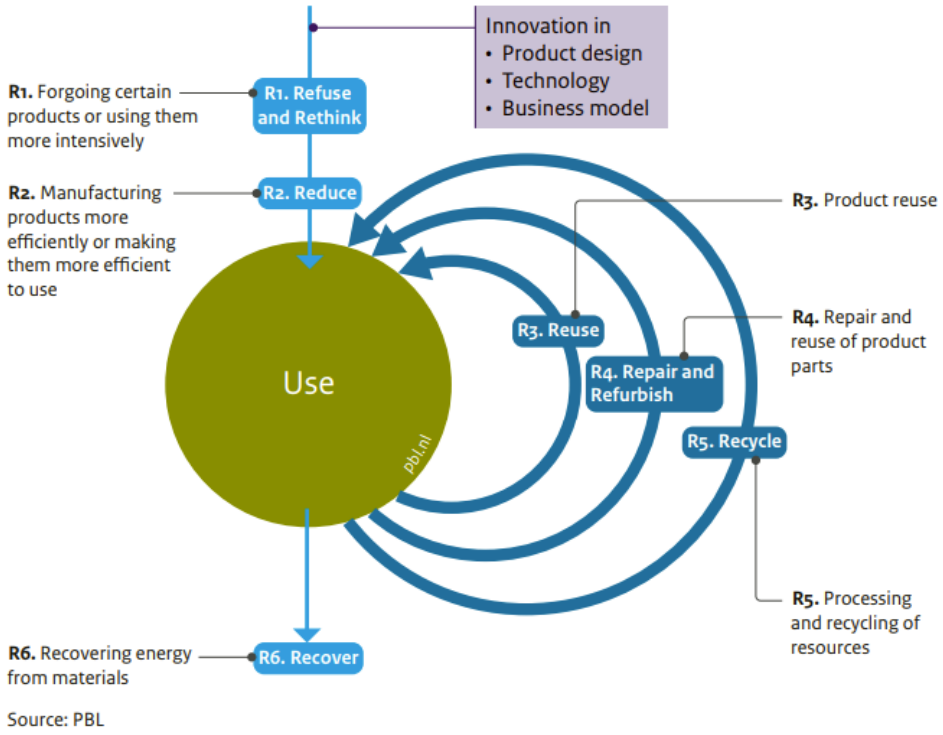

Figure 6.3 R-Ladder Circular Strategies

Circular design principles provide a framework for designing buildings, products, or processes for a circular economy based on lifecycle thinking – designing not only for the user but for the whole system within which the design exists. Key principles include designing for multiple uses at the highest value (such as reuse, sharing, remanufacturing and refurbishment as preference to recycling); moving from products to services; product life extension; safe and circular material choices; dematerialisation to minimise resource requirements while delivering utility (e.g., digitisation); and modularity and design for disassembly. [8]

These principles and frameworks should inform the development of a place-based sustainability framework for the Precinct with a focus on localised circulation and industrial symbiosis, and also the development of a Precinct wide ISO14001 EMS.

6.2 Industrial Synergies

Industrial symbiosis is of keen interest for the SAP and represents one type of industrial synergy that supports resource efficiency and circular economy outcomes. The four key industrial synergy opportunities for the Narrabri SAP include (highlighted in the UNIDO Eco-Industrial Park framework)[9]:

- Supply synergies and co-location of suppliers and clients in the value chain.
- Sharing utility infrastructure, such as water, energy, and materials management infrastructure.

[8] Ellen Macarthur Foundation, Circular design.
[9] United Nations Industrial Development Organization, 2017, Implementation Handbook for Eco-Industrial Parks.

- Sharing services, such as waste collection, maintenance, or staff training.
- Exchange of by-products (solid, liquid or gas) between businesses or facilities, harnessing opportunities to optimise industrial processes and use underutilised resources. This is often referred to as industrial symbiosis.

These principles should inform the development of a place-based sustainability framework for the Precinct and also the development of a Precinct wide ISO14001 EMS.

6.3 Activating Circular Economy Through the Business Concierge

Many enabling functions for circular economy adoption across the precinct could be delivered through the Business Concierge. A number of key functions that should be delivered for the SAP require specialist capability and appropriate resourcing. Drawing on RGDC's team of circular economy specialists, a regionally focused full-time resource responsible for activating circular economy at the operational stage across Narrabri and Moree should be considered. Furthermore, KPIs should be put in place for the dedicated resource / Business Concierge to activate circular economy across the SAP's lifecycle and at different scales. These KPI's should focus on driving action through an outcomes-based approach and be incorporated into the objectives set through the ISO14001 Environmental Management System adopted for the SAP.

6.4 Circular Economy Opportunities for Key Land Uses

The following three SAP land uses will be critical in enabling the identification and activation of resource synergies, and the physical circulation of materials that support a circular SAP and broader region:

- Circular Economy Hub.
- Transport and Logistics.
- Waste Management and Recycling.

The below section outlines the enabling role of these three land uses, and potential activities that could take place within to support a circular economy.

More generally, the activities that take place in other SAP land uses can align to a circular economy, for example through efficient use of resources and utilities, maximising electrification in operations and sourcing renewable energy, prioritising use of recirculated water (as outlined in previous sections of this report), producing low embodied carbon products or products that are critical for a low carbon economy, such as in the renewable energy sector. Two examples of such activities have been put forward in this section for the Manufacturing, and Agriculture and Food Processing land uses in the SAP. Future investigation may highlight significant alternative opportunities for harnessing during the delivery phase for the SAP.

Specific opportunities for the land uses within the Energy Hub have not been discussed as they relate more directly to energy and emissions opportunities and constraints explored in **Section 4.2**, however the general principles discussed above apply, and the enabling functions delivered through the Circular Economy Hub (discussed in **Section 6.4.1**) will support circularity across both the Inland Port Hub and the Energy Hub.

In the event that the Santos Narrabri Gas development progresses, investigations should be made to identify synergies with the SAP. Some examples include:

- processing by-products, such as salt waste, for beneficial reuse
- remanufacturing or disassembly of end-of-life operational equipment
- treatment of waste water[10] for reuse in agribusiness and industry.[11]

However, any industrial synergies achieved with the SAP would be vastly offset by the negative impact of the development itself.

6.4.1 Circular Economy Hub

A 169.47 ha area has been designated in the final structure plan as a 'Circular Economy Hub'. While circular economy principles should be embedded across all land use areas, the area designated for the Circular Economy Hub could be used for innovation or enabling activities for circular economy to thrive across the precinct, or for circular economy aligned tenancies that either are not captured by the other land uses or are additional to the developed tenancies in the other land uses. This could include:

- Collaboration and networking space – servicing the SAP and the wider business community in Narrabri and surrounds.
- Business concierge office – provision for a physical presence to host strategic appointments or activities. There is potential for this to be shared with Moree SAP business concierge, and/or to house educational displays or collateral (most critically these resources should be available online but could be brought to life by physical artefacts from the SAP).
- Reusable materials storage – physical storage facilities that can be used to house used products or materials in anticipation for their reuse. A key challenge in reusing products and materials is misaligned programs, where the right quality of material in the right quantity becomes available at the wrong time, or sufficient scale of materials for reuse has to be aggregated over time. Having storage space available can help to overcome this challenge.
- Innovation and research – provision for a physical space that could be developed in the future for R&D focused on circular products and services aligned with key industries in the SAP. For example, research on manufacturing recycled fabrics from textiles waste that could be processed in the precinct.
- A space dedicated for the sharing and repair economy servicing both businesses within and outside the SAP and the broader community, such as repair cafes and tool libraries. The sharing economy promotes reduced material consumption and increased material efficiency, provides incentives to extend the life of products, centralises control of products at their end of life to achieve higher order waste management outcomes, and in many cases supports upskilling labour and the community in product repair and maintenance.
- Education activities more broadly – focused on critical skills for SAP industries, including dedicated sustainability and circular economy modules so that these priorities become embedded across the workforce and decision makers over time.

[10] Veolia (2019) Waste not want not: From coal seam gas by-product to clean water source.
[11] Mehreen and Underschultz (2016) Coexistence Opportunities for Coal Seam Gas and Agribusiness, Journal of Industrial Ecology.

6.4.2 Transport and Logistics

The Inland Port will provide an important enabling function to drive circular economy in the SAP through its influence on accessibility to markets and driving down the cost of transporting materials within circular supply chains across Australia. The regional location of the SAP presents challenges for transport and logistics which can potentially be overcome through the increased efficiency possible with the Inland Rail. The cost of shipping will drastically be reduced (up to 39% reduction in cost compared to road freight and associated emissions reductions)[12] and unlock geographical markets that were previously closed to Narrabri. This is particularly relevant for businesses moving materials into and out of the SAP, especially within the waste management and recycling, agriculture and food processing, and manufacturing land uses. In addition, investment in intermodal facilities will maximise efficiencies and could shift agricultural freight from bulk to smaller volumes by packaging in containers which would provide access to a greater range of export destinations.[13]

6.4.3 Waste Management and Recycling

Given the small population and business community around Narrabri (even with the additional activity from the SAP), aggregating sufficient tonnages of wastes is a key consideration and constraint for any waste processing facility looking to locate in the SAP. The Inland Rail and Transport and Logistics Hub in the SAP will be a key enabler to access sources of wastes from population centres in NSW, QLD, and Vic, and reducing the cost of transporting wastes to the SAP. To negotiate the constraint, waste processing businesses in the SAP could explore small-scale material processing technologies to suit specialised local waste streams, focus on high-value and low-weight wastes, optimise transport economics through reverse logistics, and seek complementarity between the nearby Moree SAP to ensure the impact of each individual SAP is amplified by being part of a network.

Nonetheless, waste processing activities are critical to enabling materials to recirculate in a circular economy and the area has already proven the commercial viability of a plastics recycling facility, Australian Recycled Plastics, through using reverse logistics to import 50 tonnes of plastic packaging waste per week from outside the region, reprocessing into plastic flake for remanufacturing.[14] Further, expanding Australia's domestic recycling infrastructure capacity is also a current focus of policy, backed by several funding programs from federal and state government, such as the $190 million Recycling Modernisation Fund from the Australian Government.[15] The below waste processing activities have been identified as potential opportunities for the SAP due to their synergies with current or planned local industries, or strategic alignment with government's current waste priorities. More detailed investigation in the future may highlight other opportunities that are aligned to a circular economy and attractive for the SAP.

[12] Inland Rail to save $170 million annually in transport costs - CSIRO.
[13] New-England-North-West---Final-regional-plan-2017-09.pdf (nsw.gov.au).
[14] Narrabri Shire (2020), *Growth Management Strategy*, Narrabri Shire, accessed 4 May 2022.
[15] Department of Agriculture, Water and the Environment (DAWE) (2022), *Investments in Recycling Infrastructure*, DAWE, accessed 4 May 2022.

Solar PV Recycling

With the North West New England region poised for a big increase in the amount of solar panels installed[9] the SAP could leverage the opportunity to establish itself as a leader in solar PV remanufacturing and recycling to service the broader Australian market, and the local market boom that would be anticipated in 25–30 years' time when the imminent increase in solar panels come to their end of life. Australia currently has few solar PV recycling facilities, with Lotus Energy in Melbourne one of the first to claim full recovery of materials.[16] An investigation could look into the feasibility of transporting decommissioned solar panels at scale via the Inland Rail to feed a solar PV recycling facility in the SAP. This would also need to consider the location of collection hubs.

Textiles Recycling

An estimated 780,000 tonnes of textiles waste (or 31 kg per capita) are generated in Australia each year, with only around 7 percent being recycled.[17] There is an estimated 23 tonnes per annum of separated textiles and carpet waste currently generated in the Northern Inland Regional Waste area and processed outside the region.[18] Currently there is a lack of avenues to recirculate textiles other than for reuse, and limited on-shore processing capacity end-of-life textiles.[19] Textiles have been added to the Minister's Priority List[20] and therefore significant additional processing capacity may be required to manage this waste stream. While there is limited local generation of waste textiles, Narrabri could be a strategic location to capture and process volumes from NSW, QLD, and Vic, transported on the Inland Rail at scale. With existing local expertise in cotton production, the region could become leaders in circular textiles through expanding activities across the value chain, and R&D on production of recycled fabrics or other beneficial reuses further into the future. For example, piloting technology developed in Australia to chemically breakdown cotton and polyester textile waste for reuse in fabric or as a soil ameliorator.

Tyres Recycling

The Northern Inland Regional Waste 2021 Material Flow Analysis identified 247 tonnes of tyre and rubber waste generated in the region and processed outside the region.[21] Given the agriculture and mining presence around Narrabri, it is expected there is additional tyre waste not captured in these figures. Australia's waste export ban and allocated funding is driving an increase in onshore processing of waste plastics, paper, glass, and tyres.[22] There is existing momentum with Narrabri Shire Council to attract investment for tyre recycling to the region, and the SAP could be a potential location for such a facility.

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16 Australia's first solar panel recycling plant swings into action | RenewEconomy.
17 Blue Environment (2020), National Waste Report, Department of Agriculture, Water, and the Environment. Accessed 26 October 2022.
18 Northern Inland Regional Waste 2021 Material Flow Analysis, prepared by John Cavanagh and funded by the NSW EPA.
19 Blue Environment (2020), National Waste Report, Department of Agriculture, Water, and the Environment. Accessed 26 October 2022.
20 Department of Industry, Science, Energy and Resources (DISER) (2022), *Australian Government response: Inquiry into Australia's Waste Management and Recycling Industries*, DISER, accessed 4 May 2022.
21 Northern Inland Regional Waste 2021 Material Flow Analysis, prepared by John Cavanagh and funded by the NSW EPA.
22 Australian Government (2019), *National Waste Policy Action Plan 2019*, accessed 4 May 2022.

There are multiple circular treatments for end-of-life tyres including re-treading, shredding, and pyrolysis.[23] Re-treading provides the most circular solution as it allows tyres to be reused, offers the same quality as a new tyre, and uses one-third of the oil required to manufacture a new tyre.[24] However, the current dominant outcome in Australia is recycling through shredding and application of tyre-derived-product (TDP) in infrastructure can realise significant avoided emissions.[25] For example, the use of TDP sees a 10–21% improvement in GHG emissions compared to the traditional material for crumb rubber, up to 96% improvement for pyrolysis formed TDP, and 13–16% for rubber granule applications.

Plastics Recycling

Two million tonnes of plastic waste are generated in NSW and QLD alone per year, with only 18% being recovered.[26] To support a circular economy for plastics in Australia, a range of recycling technologies were considered for suitability for the SAP. Chemical recycling was short-listed due to its broad acceptance of plastic waste feedstocks including low-value streams that otherwise have a high risk of ending up in landfill, and the technology's production of a range of output products, diversifying income streams.

The primary target feedstocks considered were agricultural and industrial plastics, to provide complementarity with the existing Australian Recycled Plastics PET recycling facility in Narrabri SAP, and the planned Brightmark 200,000 tonnes per annum pyrolysis facility in Parkes SAP which will target mixed container plastics from municipal kerbside collections. Residual plastics from Australian Recycled Plastics' operations could potentially provide a minimal feedstock stream, which although negligible in terms of scale, would provide an opportunity for industrial symbiosis between the two facilities, and leverage the benefits of being co-located.

In the medium term, the outputs of a chemical plastics recycling facility in Narrabri would need to be upgraded at refineries, none of which are local.[27] However, future synergies across the plastics value chain could be explored should there be sufficient demand for example for packaging from the expanding industries, supported by the Narrabri, Moree, and Parkes SAPs. With the National Packaging Targets adopted by retailers and food manufacturers, a business case may develop for a more local refinery (e.g., in Parkes SAP) which would further strengthen supply chain synergies and the economic feasibility of a chemical plastics processing facility in Narrabri SAP.

An academic study into the economic feasibility of pyrolysis on waste plastics in Australia found that 15,000 tonnes per annum facilities can achieve a 54% return on investment, with this figure increasing for larger facilities due to economies of scale.[28] However, a cost-benefit analysis conducted on a 25,000 tonnes per annum facility for Narrabri SAP has demonstrated a negative net present value, under the modelling assumptions provided in the accompanying cost-benefit analysis report.

Any additional investigations test the willingness of the market to pay gate fees for processing their plastic wastes. In particular, the agricultural plastics product stewardship scheme may change the market dynamics around this feedstock stream. Should a zero-waste target be introduced to the Narrabri SAP, then tenants generating plastic wastes will likely be willing to pay for local waste processing as a preference to incurring transport fees to process wastes outside the region.

[23] Edge (2022), *Greenhouse gas emissions analysis of waste tyre recovery*, TSA, p.31.
[24] Edge (2022), *Greenhouse gas emissions analysis of waste tyre recovery*, TSA, p.25.
[25] Edge (2022), *Greenhouse gas emissions analysis of waste tyre recovery*, TSA, p.5.
[26] Envisage works (2021), Australian Plastic Flow and Fates Study 2019-20.
[27] Advanced Recycling Feasibility Study, 2021, Geelong-Altona Industrial Corridor, The opportunity for a local circular economy for plastic.
[28] Ghodrat et al. (2019), Economic feasibility of energy recovery from waste plastic using pyrolysis technology: an Australian perspective, International Journal of Environmental Science and Technology, 16:3721–3734.

Council's Existing Landfill

The Narrabri landfill facility falls within the waste management and recycling land use area. It is understood that Council is currently developing a waste management strategy which should aim to ensure maximum waste diversion prior to waste reaching the landfill, to retain value from materials and extend the life of the landfill.

Organics

Narrabri Shire Council's organic waste is currently processed in Moree into products for beneficial reuse, further supporting the Moree area as being the biological reprocessing hub. It is also understood that water effluent from the local wastewater treatment plant has an established outlet on a private farm near Narrabri. These factors combine to make the development of a large-scale organic waste processing facility unviable due to insufficient feedstocks locally in the near-term. Future investigations could consider processing of small-scale organic wastes that may become available through businesses in the SAP's, such as through modular small-scale processing units leverage black soldier flies to valorise food waste into insect protein and fertiliser.

6.4.4 Agriculture and Food Processing

The Agriculture and Food Processing land use could support a circular economy through several ways, such as using waste feedstocks in production, producing low embodied carbon products, and running zero waste and renewable energy powered operations. One example that may be suited to local industries is manufacturing plant-based meat alternative products. There is strong growing demand for plant-based meat alternatives both domestically and internationally.[29] Narrabri is well positioned to support the growing demand for these products through the local production of key relevant agricultural commodities,[30] connection with rail transportation and appropriate zoned land for the development of production and storage facilities. An investment in plant-based meat alternatives would place Narrabri at the forefront of the global transformation of the food system, aligning with circular economy principles through providing low-embodied carbon sources of protein, with the potential to support regenerative agriculture practices through partnerships with local farmers. It is noted that similar opportunities are explored in other SAPs including Moree and opportunities for synergy should be explored.

Narrabri produces wheat and chickpeas, two major inputs for plant-based meat alternatives production. Creating more demand for these commodities would support the continued agricultural tradition in the area, and reduce international supply chain, price volatility and commodity quality risk that Australian manufacturers of finished products are currently exposed to. Lupin is also grown in the area and is an example of another crop where expanded production could be explored should a plant-based meat production facility arise. Some products may be better suited to local production than others, for example textured vegetable protein which is shelf-stable/doesn't require cold chain distribution.

A cost-benefit analysis was conducted on a small-scale and large-scale plant-based meat manufacturing facility for the SAP which demonstrated a negative net present value for the small-scale facility, and a positive net present value for the large-scale facility. The establishment of a large-scale facility could also generate an additional 50–170 ongoing jobs for the region as well as additional jobs during the construction phase.

[29] Good Food Institute, 2021, Plant-based meat: Anticipating 2030 production requirements.
[30] Australian Bureau of Statistics, Value of Agricultural Commodities by Local Government Area – 2020–21.

6.4.5 Manufacturing

Depending on the activities that emerge in the Manufacturing land use, there could be opportunities for example for industrial symbiosis such as for residual heat, the production of products designed to be reused at their end-of-life, the use of by-products or waste to create new products, or the production of products that support a low-carbon economy. One example is a focus on the critical minerals economy which presents an opportunity for Narrabri SAP to participate in enabling global and domestic industries needed for the future including advanced manufacturing, battery manufacturing, defence, aerospace, ag-tech, renewable energy, and automation.

New South Wales has a diverse range of rare and untapped critical minimal deposits with Narrabri in close proximity to gold, copper, scandium, rare earth elements, and platinum group elements[31]. The NSW Government has acknowledged this opportunity by implementing the *Critical Materials and High-Tech Metals Strategy*[32] to support the growth of this emerging sector in regional areas by investing in exploration, mining, processing, downstream industries, and recycling.

The current state focus on critical minerals in Dubbo and Parkes SAP could lead to potential expansion to Narrabri in the long-term horizon for the SAP. The hub could include value-added processing located close to existing, approved and potential mining developments, as well as e-product recycling from domestic or imported markets.

6.5 Circular Economy Opportunities for the Town and Residential area

Circular economy principles can be applied within the town and residential areas to preserve value in the form of energy, labour and materials. Beyond the recommendations for circularity in the built environment in **Section 8.1.2** and the recommendations provided for energy and water, there is also an opportunity to embed circularity through strategies, systems and initiatives such as:

- **Setting the ambition and action plan for a zero-waste town** for example through adequate resource management infrastructure; facilitating business-to-business connections for material reuse; engaging with retailers; and community engagement and education to prompt a mindset and lifestyle shift that values resources.
- **Establishing a thriving secondhand market.** For residents, the provision and consumption of second-hand goods can be enhanced through platforms such as the Charitable Recyclers network, Gumtree, eBay, or Facebook Marketplace. There is also opportunity to leverage recommended features of the SAP's Circular Economy Hub such as the reusable materials storage and sharing economy services that facilitate reuse of materials for businesses and residents.
- **Renewable energy used** to power homes and businesses.
- **Council-led shared services** for example, council could provide financial or in-kind support for a tool library or facilitate the availability of Product as a Service transport models for bikes and scooters.

Further details of circular economy opportunities within the SAP are summarised in **Appendix B**.

[31] NSW Government (2021), *Critical Materials and High-Tech Metals Strategy*, NSW Government, accessed 5 May 2022.
[32] NSW Government (2021), *Critical Materials and High-Tech Metals Strategy*, NSW Government, accessed 5 May 2022.

6.6 Circular Economy Measures

Outcomes-based circular economy performance measures; such as zero waste, 100% electricity from renewable energy, or 100% recirculation of consumed water; should be developed and incorporated into the precinct's targets set and assessed through the ISO14001 Environment Management System process, providing accountability for continuous improvement and embedding ongoing monitoring and evaluation. Relevant frameworks, such as the 'R Ladder' for circular strategies,[33] should be considered to drive more ambitious and impactful targets. For example, targeting greater reuse of would be preferential to greater recycling. These measures should provide tangible goals to assess circular economy performance across lifecycle stages of the SAP, enable ongoing resource monitoring to identify and track improvements over time, and put in place strategic support and plans to activate partnerships and strengthen circular economy ambition for the SAP and its tenants overtime. The SAP will benefit from adopting the standardised approach to circular economy performance measurement being developed for other SAPs.

[33] Pbl Netherlands Environmental Assessment Agency (2019) Outline of the Circular Economy.

7.0 Transport

Implementing sustainable transport options within the SAP is crucial for reducing carbon emissions, however, are also integral in supporting the community in terms of providing alternative transport options such as improved public transport and active transport services.

The Transport connections and Transport and Logistics land uses within the SAP provides a significant connection point not only for locally strategic areas such as Narrabri, Armidale and Tamworth and other areas within the Namoi region but also provides linkages to national and international transport networks through the proposed Inland Rail development. The development of these land uses within the SAP would be supported by the *NSW 2056 Future Transport Strategy* and *NSW Future Transport Technology Roadmap* to ensure a more technologically advanced, resilience and low emissions transport network is developed.

Given the 40-year timeline it is also acknowledged that the Precinct will need to be agile and responsive to market fluctuations, climate change and future technology advancements which may identify additional opportunities and constraints associated with transport.

7.1 Electrification & Alternative Fuels

Long term and deep emission reductions within the transport and logistics land uses will generally be limited until the wider freight and transport sector is able to utilise electric powertrains or alternate energy fuelled freight vehicles/services. Day to day operations within the Inland Port have the potential to be fully electrified and sourced from renewable energy.

The SAP could support uptake of electric vehicles and/or hydrogen vehicles through development of supporting infrastructure and make the SAP 'EV Ready' or 'Hydrogen Ready'.

The technology to produce low-emissions hydrogen has been successfully piloted however, it is yet to achieve wide-spread use (WSP 2022). Hydrogen vehicles have been applied in the long-haul transport industry, due to the long travel distances that can be achieved. With Narrabri's position on the Newell Highway and the distance to major freight destinations/ports, the SAP is in a prime position to benefit from this (WSP 2022).

Newly constructed buildings and assets should consider the requirements for future uptake of electric and alternatively fuelled vehicles to support the state's overarching objective to achieve net zero emissions by 2050. This includes options such as minimum requirements for buildings and assets to install charging stations or appropriate conduit and electrical cabling to enable the installation of future charging stations in carparks and garages during initial construction phases.

Suitable infrastructure such as charging stations will also be required across the SAP to continue to promote the ongoing uptake of electrified or alternatively fuelled personal transportation vehicles in line with *NSW 2056 Future Transport Strategy*.

7.2 Active Transport

Active transport should be encouraged between key centres (existing active transport, residential areas and the town centre) and the Precinct and throughout the Precinct including dedicated off-road walking and cycling pathways. Opportunities for shared cycling schemes could also promote uptake of active transport options within the Precinct. Other sustainable intra-precinct transport options that could be implemented include providing cycle lockers, showers/changeroom amenities within businesses and considering appropriate crossing facilities aligned with pedestrian/cycle desire lines.

7.2.1 Public Transport

There are a range of opportunities for the connection and extension of current public transport services within Narrabri to the Precinct. Narrabri bus services are currently limited to business hours within the Narrabri CBD, by increasing the operational hours and routes of local bus services this will encourage shift workers within the Narrabri SAP to utilise public transport. Alternatively, 'on demand' services may be suitable to cater to shift workers as has been successfully trialled in other employment precincts.

Given the existing service provision and the operation of public transport being outside the direct scope of the SAP, it is recommended that the NSW Government collaborate with public transport providers to identify suitable options to enable the operation of public transport for workers within the Precinct.

7.2.2 Business Efficiency and Innovation

There is opportunity for the creation of an internal road network in the vicinity of the Northern NSW Inland Port and adjoining light industry, agriculture and food processing and manufacturing areas, that supports an intelligent road system to make use of circular economy opportunities and emerging technologies (optic fibre, light detection and ranging (LIDAR), dedicated short range communication (DSRC) and sensor technology) (WSP 2022).

7.3 Transport Measures

Table 7.1 provides a summary of the recommended transport measures. Further detail regarding these measures is provided within the recommendations in **Section 9.1.**

Table 7.1 Summary of Transport Measures

Measure	Site-Specific	Precinct Wide
Consider transport measures in the development of a place-based sustainability framework		X
Include infrastructure to support the future uptake of electric or alternative fuel vehicles	X	X
Integrate active transport connections within the Precinct		X
Include end of trip facilities and amenities within the Precinct	X	X
Partner with public transport providers to extend the bus route to capture the Precinct		X

8.0 Built Environment, Construction and Industry

Buildings account for over 50% of electricity use in NSW and Australia and represent over 25% of national emissions. According to the International Energy Agency, buildings offer the largest opportunities for low-cost carbon abatement in developed countries like Australia. Reducing energy use in buildings has the triple benefit of saving money, reducing emissions, and creating space in the grid for electrifying transport and heating[34].

The Narrabri SAP comprises developments proposed as part of precinct operations as well as other existing and proposed developments within the Narrabri township, including residential infrastructure to support the Precinct's developments. There are a range of sustainability measures and industry sustainability initiatives adoptable from preplanning and feasibility stages to the construction and ongoing operation. All of these opportunities are recommended to be encouraged and/or required for development within the SAP to reduce the energy demand of the Precinct and contribute to wider State and Federal commitments.

Given the 40-year timeline, it is also acknowledged that the Precinct will need to be agile and responsive to market fluctuations, climate change and future technology advancements which may identify additional opportunities and constraints associated with the built environment, construction and industry.

8.1.1 Best Practice Design and Rating Tools

Circular design principles and best practice rating schemes that will guide the design of new buildings and infrastructure in the SAP include:

The National Construction Code (NCC) Section J

- Since 2019 the NCC has been undergoing significant revision every 3 years, which has included a suite of changes along with upcoming proposed changes to improve energy efficiency including heating, cooling and lighting standards, ventilation, onsite energy installations (e.g., residential solar) and other infrastructure such as electric vehicle charging equipment provisions.

The Building Sustainability Index (BASIX)

- BASIX outlines minimum sustainability and energy efficiency requirements for new residential developments in NSW.

The Green Star Homes and Green Star Buildings Rating Scheme

- The Green Star Homes rating system is an industry led standard to reducing the residential sector's emissions footprint. The rating system was released during August 2021[35] and sets clear simple actions and targets for single family freestanding, attached and detached dual occupancy and townhouse dwellings.

[34] NABERS, 2022, Accelerating Net Zero Buildings Launches NSW Customers.
[35] Green Building Council Australia, 2022, Green Star Homes.

- The Green Star Buildings rating system similar to Green Star homes but applicable to other building classes.

National Australian Built Environment Rating System (NABERS)

- NABERS focuses on operational energy, water and waste performance of buildings rather than the design and construction phases of a building. NABERS is also partnered with Climate Active to provide options for buildings to attain carbon neutral certification.

The Infrastructure Sustainability (IS) Rating

- Infrastructure Sustainability Council (ISC) is a peak industry body which promotes the enabling of best practice sustainable outcomes across a diverse range of infrastructure developments through the administering of the IS rating scheme. Best practice sustainability outcomes for the SAP would likely include incorporating IS ratings, or similar into design and development requirements for relevant SAP projects.

Renewable Energy

As discussed within **Section 4.6**, installation of renewable energy resources should also be considered to meet any remaining energy demand within the Precinct. These include:

- Rooftop solar.
- Solar power infrastructure (such as solar powered streetlights).
- Biogas connected to Landfill (Export to Grid or Onsite use).
- Medium Sized Solar on rehabilitated land associated with the Council Landfill site.
- Electric Vehicle Charging Station.
- Large Scale Solar Farms (Export to Grid or Onsite use).

Uptake of these systems across the design, construction and operational phases of the SAP promote sustainability measures through raising the minimum sustainability requirements along with:

- Reducing emissions during construction.
- Reducing embodied emissions of materials.
- Reducing materials inflows.
- Reducing volume of virgin materials consumed.
- Reducing energy demand during operation.
- Diversion of waste from landfill.
- Energy and Resource Efficiency (passive design and implementation of efficiency measures).
- Low operational costs.

8.1.2 Circular Economy for the Built Environment

As the Narrabri SAP is mostly a greenfield site, there will inherently be new built elements developed to facilitate and service the businesses that locate in the SAP. For new buildings and infrastructure in the SAP, circular design principles and alignment with best practice rating schemes (IS and Green Star) should guide design for low whole-of-life impact. In practice, this includes for example using low embodied carbon, renewable and recycled materials; developing with zero construction waste; designing effective operational waste management systems into the SAP; designing adaptive and flexible spaces to maximise utilisation; enabling active and shared mobility and including infrastructure for electric vehicles; using product-as-a-service systems to incentivise high quality products and accountability for end-of-use management; and designing for disassembly of components and reuse at end-of-use.

The embodied carbon in materials can make up a significant portion of a built asset's overall carbon footprint. Newly constructed buildings and infrastructure in the SAP should select low embodied carbon materials as much as possible. Some examples include:

- Reused components such as bricks, beams, staircases, and other components where possible.
- Third-party verified carbon neutral or carbon negative materials.
- Concrete using mixtures that reduce Portland cement content.
- Steel manufactured with renewable energy or green hydrogen.
- Replacing steel with sustainably sourced structural timber.
- Aluminium manufactured with renewable energy.
- Asphalt avoiding the use of lime.
- Aggregates sourced onsite, locally or from construction and demolition waste, for application as reclaimed asphalt pavement in roads or gravel in concrete.

Currently, there are limited available ratings to drive resource efficient operations through monitoring and tracking outcomes for industrial precincts. For example, the only tenancies applicable to the SAP covered by the NABERS Waste rating scheme includes offices and warehouses.[36] It is recommended the Business Concierge stay abreast of expansions to NABERS Waste coverage or any relevant rating schemes which may come online by the time the SAP is operational.

8.1.3 Built Environment Measures

Table 8.1 provides a summary of the recommended built environment management measures. Further detail regarding these measures is provided within the recommendations in **Section 9.1**.

[36] NABERS, 2022, https://www.nabers.gov.au/waste

Table 8.1 Summary of Built Environment and Construction Measures

Measure	Site-Specific	Precinct Wide
Identify suitable best practice-built environment and construction sustainability tools and rating systems within the place-based sustainability framework		X
Promote or require the use of industry best practice tools and rating systems to achieve a sustainable built environment	X	X
Identify opportunities to consider circular economy principles within built environment design and delivery	X	X

9.0 Conclusion

Narrabri SAP Objectives

Resilience and Innovation – The design and delivery[1] of the Precinct will be adaptable to future changes including the impacts of climate change and technology innovations.

Optimal Resource Efficiency – The design and delivery[1] of the Precinct will harness and promote water, energy and waste efficiencies.

Regional Scale Circular Economy Exemplar – The design and delivery[1] of the Precinct will promote co location of land uses to optimise strategic benefits and maximise infrastructure capacity to support circular economy principles.

Guided by best practice frameworks, ratings and accreditations – The design and delivery[1] of the Precinct will be guided by best practice sustainability frameworks, ratings and accreditations.

9.1 Recommendations

Table 9.1 provides **a summary of the recommendations to achieve the sustainability objectives in the Narrabri Special Activation Precinct. The recommendations are identified by the likely mechanism for implementation of the recommendation across the Structure Plan, Master Plan, Delivery Plan or other where they sit outside the framework of the SAP. These recommendations can be used as Principles, Aims and Performance Criteria within relevant plans.**

Table 9.1 Summary of Sustainability Recommendations for Narrabri SAP

Recommendation	Structure Plan	Master Plan	Delivery Plan	Other
Develop a place-based sustainability framework specific to Narrabri SAP considering the principles of UNIDO Eco-Industrial Park framework and this report and the associated calculators	x	x	x	x
Develop and implement a Precinct wide EMS in accordance with ISO14001) EMS (including ISO Guide 84 principles		x	x	
Encourage or require tenants to comply with Precinct ISO14001 EMS or develop their own ISO14001 EMS and integrate with the place-based sustainability framework		x	x	
Implement the Climate Change Adaptation Plan	x	x	x	x
Undertake and maintain a precinct specific Climate Change Risk Assessment to consider climate change and adaptation risks regularly			x	x
Embed Climate Change Risk Assessments operational mitigation measures into the ISO14001 EMS requirements for tenants			X	x
Support increase to network capacity that would enable/facilitate additional renewable energy projects in the region and/or Precinct	x	x	x	

Recommendation	Structure Plan	Master Plan	Delivery Plan	Other
Promote and/or prioritise low energy intensity land uses within the Precinct	x	x	x	
Precinct design should include sufficient area for the development of a large-scale solar farm and battery energy storage system	X	X		
Include a large scale Solar Farm and Battery to be developed to provide an on-site renewable energy source	X	X	X	X
Energy land uses should be co-located with energy intensive land uses to maximise energy efficiencies	X	X	X	
Development should consider on-site renewable energy generation including battery storage		X	X	X
The Precinct should promote procurement of clean energy and/or on-site renewable energy generation		X	X	
The Precinct should continue to investigate electrification and alternative fuels to reduce reliance on natural gas			X	X
Precinct should include sufficient area for onsite water treatment to promote reuse and recycling	X	X	X	
Precinct should promote water efficiency		x	x	
Development should minimise impervious areas and where unavoidable consider rainwater capture		x	x	
The Precinct should include a blue green grid and infrastructure to retain water in the catchment and maximise benefits these land uses provide	X	X	X	X
To meet circularity ambitions, circular design principles and Lifestyle thinking should be considered through the Precinct design, and delivery			X	X
Precinct should consider industrial synergies to support circular economy outcomes	X	X	X	X
Consider the potential for activating circular economy through the Business Concierge			X	X
Precinct should consider selecting low embodied carbon materials during the construction and operation phases			X	X
The Precinct should consider the manufacturing of plant-based meat alternative products as a circular economy opportunity	X	X	X	
Precinct should consider opportunities for a range of waste processing activities	X	X	X	
The Precinct's Circular Economy Hub land use should be considered being used as for innovation or enabling activities for circular economy to thrive across the Precinct	X	X	X	
Consider the potential to embed circularity within the town and residential areas through strategies, systems and initiatives, such as an action plan for a net zero-waste town or a council-led shared services			X	X
Precinct should prioritise rail transportation of goods and materials	x	x	x	

Recommendation	Structure Plan	Master Plan	Delivery Plan	Other
Development should consider sustainability principles in the design, construction and operation		X	X	X
Built form should consider climate responsiveness and resilience in the design, construction and operation		X	X	X
Adopt requirements for best practice sustainability ratings or accreditation across the Precinct		X	X	
Infrastructure should achieve a IS Design & As Built Rating		X	X	
Infrastructure developed as future ready considering impacts of climate change		X	X	

10.0 References

Nous/Aurecon (2022), Narrabri SAP Economics Report (Nous/Aurecon, 2022).

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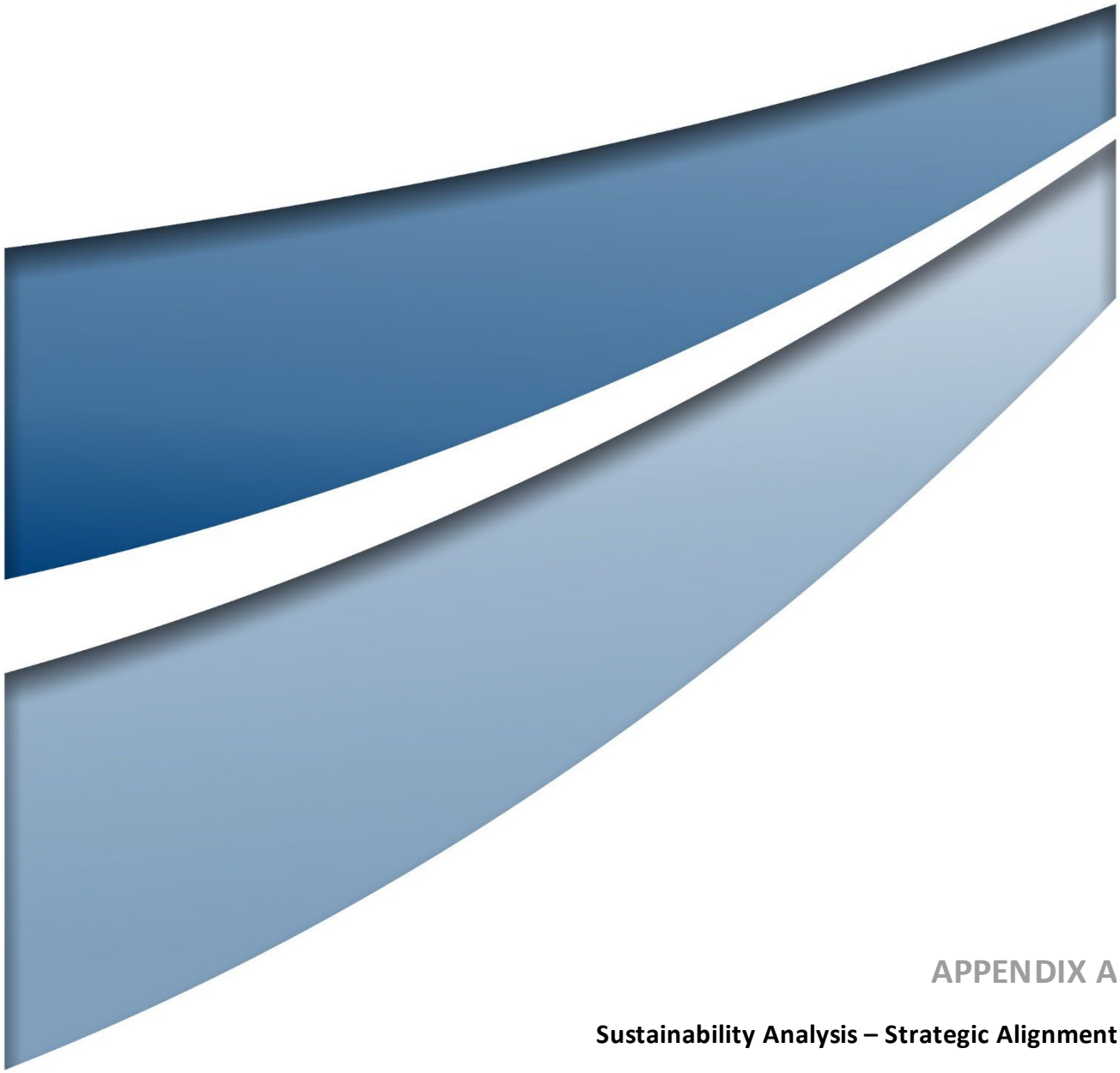
WSP (2022), Narrabri SAP, Water Demand Analysis (WSP, 2022).

WSP (2022), Narrabri SAP, Flooding and Surface Water Cycle Management Report (WSP, 2022).

Umwelt (2021), Williamtown SAP Energy and Carbon Calculator (Umwelt, 2021).

Moir (2022), Narrabri SAP, Landscape Plan (Moir, 2022).

Umwelt (February 2022), Climate Change Adaptation Considerations (Umwelt, February 2022).



APPENDIX A

Sustainability Analysis – Strategic Alignment

umwelt
Environmental & Social Consultants

HATCH | RobertsDay

STRATEGIC ALIGNMENT
APPENDIX A

Narrabri Special Activation Precinct

DRAFT

November 2022

STRATEGIC ALIGNMENT APPENDIX A

Narrabri Special Activation Precinct

DRAFT

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Report No.	R01
Date:	November 2022

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
01	Paul Douglass	4 November 2022	Paul Douglass	4 November 2022

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1.0 Strategic Alignment

Sustainability is not a static condition and the concept of sustainable development has evolved over time. This includes more detailed identification and analysis of the components of a sustainability framework, taking sustainability from a broad concept for the future to an operational process that can be implemented by businesses and communities in contemporary markets.

There are a diverse range of governance levels which influence the sustainability framework from within the SAP from global to local and regional approaches and strategies (see **Figure 1.1**). A high level summary of the key documents which influence the Sustainability framework is included below and how they may or may not influence the development and ongoing management of the SAP.

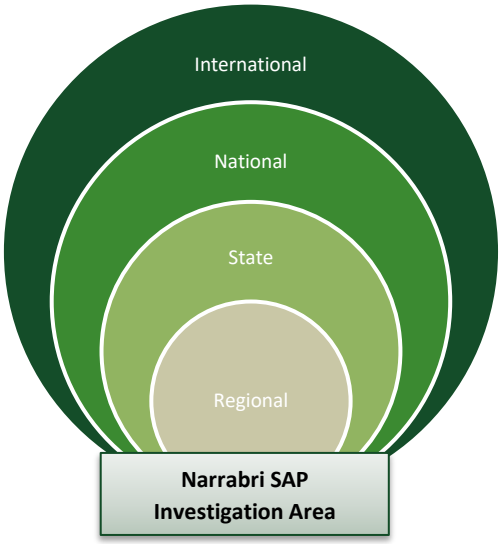

Figure 1.1 Framework Scales

1.1 International

1.1.1 Paris Agreement COP21

The Paris Agreement is an International agreement within the United Nations Framework on Climate Change (UNFCC) which aims to keep global temperature rise this century within 2 degrees Celsius (°C) of pre-industrial levels and further pursue options to limit the temperature rise to less than 1.5 °C above pre-industrial levels[1]

During 2016, Australia was one of 196 countries to commit to the agreement which Australia committed to reducing their emissions to below 26 - 28%. This agreement in turn set a benchmark for each state and territory to develop and set their own targets with an emphasis on meeting or exceeding this target.

[1] United Nations (2015) Paris Agreement to the United Nations Framework Convention on Climate Change

All Australian states and territories have set commitments or aspirations to achieve this minimum benchmark by 2030 and have made additional commitments to further committing to net zero emissions by 2050 (or earlier).

There is no defined end period for the Paris Agreement however a 'ratchet mechanism' was introduced where every 5 years, member countries would review their nationally determined contributions and effectively, 'ratchet up' their contributions with more effective and ambitious commitments. This was one of the primary purposes of the recent COP 26 conference in Glasgow. A contemporary example of this mechanism is the NSW State government increasing their commitment to reduce greenhouse gas emissions by around 50% before 2030

1.1.2 United Nations Sustainable Development Goals

The United Nation's Sustainable Development Goals (UN SDGs) are a set of 17 holistically developed goals (**Figure 1.2**) and associated sub-targets aimed to create a better global environment and community for current and future generations.

Figure 1.2 United Nations Sustainable Development Goals

The goals are intended to drive better outcomes in terms of the health, dignity and equality of people; sustainable management of natural resources (linked to earlier definitions and principles of ecologically sustainable development); economic prosperity; peace and cross regional to global partnerships (see **Figure 1.3**). These goals are linked to an ambitious, expansive and transformational vision. Each goal also has a subset of targets and indicators to drive the uptake and achievement of the SDGs.

During 2015, Australia was one of 193 countries to commit to meet the goals, to deliver the United Nation's 2030 Agenda for Sustainable Development. The adoption of these goals challenges the traditional 'business as usual' approach and with increasing adoption across the nation and globe, will result in better alignment with emerging government policy. They also provide a common framework for engagement with stakeholders across our region and beyond.

The goals have subsequently been adopted across various governance and corporate levels across Australia. It is expected that stakeholders, including all levels of government and private industry consider the goals relevant to their developments and understand their role in addressing these goals for the benefit of the global community.

A preliminary review of targets and potential opportunities with respect to the sustainability scope are listed in **Table 1.1**. These targets foreshadow the scope of change and innovation that could be considered for the SAP. The SAP will also indirectly contribute to a number of the SDGs across the wider region. In particular they highlight the role of new industry, infrastructure and technology to enhance sustainability outcomes not just within the estate, but promoting opportunities across a connected region and driving environmental improvements off site as well as within the development.

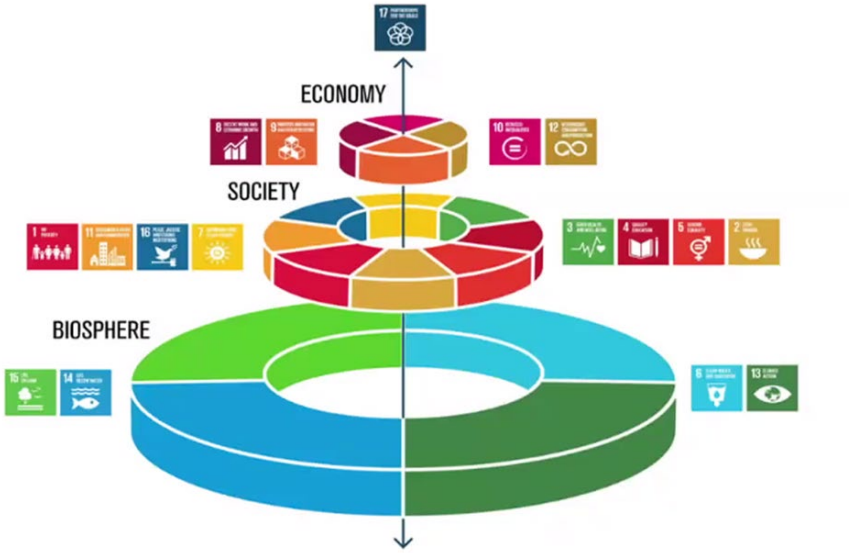

Figure 1.3 UN SDGs Categories

Table 1.1 Direct UN SDGs and relevant targets

Sustainable Development Goal	Relevant UN Targets linked to this goal	Link to SAP
Goal 6 Ensure availability and sustainable management of water and sanitation for all	6.3 By 2030 improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally 6.4 By 2030 substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of fresh water to address scarcity and substantially reduce the number of people suffering from water scarcity 6.5 By 2030 implement integrated water resources management at all levels, including through transboundary cooperation as appropriate 6.6 By 2020, protect and restore water related ecosystems including mountains, forests, wetlands, rivers, aquifers and lakes	• Ensure wastewater is treated safely and effectively. • Ensure no pollutants enter the aquatic environment. • Ensure net benefit of proportion of water bodies located within investigation area. • Create opportunities to reuse and recycle waste and process waters. • Reduce water use as much as possible across precinct lifecycle. • Improve downstream water bodies.
Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all	7.1 By 2030, ensure universal access to affordable, reliable and modern energy sources 7.2 By 2030 increase substantially the share of renewable energy in the global energy mix 7.3 By 2030, double the global rate of improvement in energy efficiency 7.a By 2030 enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced cleaner fossil fuel technology, and promote investment in energy infrastructure and clean energy technology	• Industry is electrified as much as practicable. • Electricity is sourced from renewable sources. • Ongoing investigation and uptake of clean fuels and technology. • Innovative, energy efficient transport technologies to access the site and to move materials around the site. • Lead, enable and facilitate adoption of modern renewable energy and transmission technologies across the Hunter region.

Sustainable Development Goal	Relevant UN Targets linked to this goal	Link to SAP
Goal 8 Promote sustained inclusive and sustainable economic growth, full and productive employment and decent work for all	8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors 8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead	• Industries and technologies which drive and demonstrate resource efficiency. • New industries are supported by regional education and training opportunities which enable regional employees to transition successfully from 'old' industry to 'new industries and technologies. • Development and employment which promote restoration and enhancement of natural systems. • Investment in industrial processes and technology which decouple alignment of revenue and emissions.
Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation	9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure to support economic development and human well being 9.2 Promote inclusive and sustainable industrialisation, and by 2030 significantly raise industry's share of employment and gross domestic product (with specific reference to least developed countries) 9.4 By 2030 upgrade infrastructure and retrofit industries to make them sustainable, with increased resource efficiency and greater adoption of clean and environmentally sound technologies and industrial processes 9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, including by 2030 increasing the number of research and development workers per million people and public and private research and development spending 9.6 Significantly increase access to information and communications technology	• Connect SAP to regional logistics and transport networks. • Introduce new advanced technology and low energy (or circular energy/economy) industries. • Facilitate regional transition away from old energy and industrial processes. • Link to research and development, and education opportunities and in technical education. • Innovative communication and system control technologies.

Sustainable Development Goal	Relevant UN Targets linked to this goal	Link to SAP
Goal 11 Sustainable Cities and Communities	11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management 11.8 Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.	• Promote clean energy technology for transportation and other industries in precinct. • Prioritise development on previously disturbed land. • Encourage circular economy and other waste initiatives to recue impacts on external municipal systems. • Encourage public and active transport uptake. • Ongoing development and encouragement of partnerships. • Decrease risk across precinct associated with impacts from resource efficiency, mitigation and adaptation to climate change.
Goal 12 Ensure sustainable consumption and production patterns	12.2 By 2030 achieve the sustainable management and efficient use of natural resources 12.4 By 2030 achieve the environmentally sound management of chemicals and all wastes throughout their lifecycle, in accordance with agreed international frameworks and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment 12.5 By 2030 substantially reduce waste generation through prevention, reduction, recycling and reuse 12.6 Encourage companies to integrate sustainability reporting into their reporting cycle 12.9 Rationalise inefficient fossil fuel subsidies that encourage wasteful consumption by removing market distortions in accordance with national circumstances	• Application of life cycle analysis to all materials used in construction and operation of industries/businesses on the site, to minimise use of 'virgin' materials. This could apply to concrete input materials, plastics, timber. • Focus on protection of local/regional natural resources such as sand and gravel, water, replacing them with recycled or reused material options. • Strengthen opportunities to link development of the Precinct to land and waterway rehabilitation, which will protect, restore and enhance high value (high ecosystem services or conservation value) natural systems and support sustainable natural systems with climate change. • Organisations operating within the precinct to account for and measure environmental and emissions footprint.

Sustainable Development Goal	Relevant UN Targets linked to this goal	Link to SAP
Goal 13 Take urgent action to combat climate change and its impacts	13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries 13.2 Integrate climate change measures into national policies, strategies and planning 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	• Consideration of opportunities for climate change adaptation and resilience in precinct design. • Combine mitigation opportunities (net zero carbon, 100% renewables, including export of renewable energy from this site) with adaptation and natural system management opportunities in relation to climate change. • Integrate climate change measures within SAP policies and guidelines, including procurement of goods and services.

1.1.3 United Nations Industrial Development Organisation Eco-Industrial Parks

The United Nations Industrial Development Organisation (UNIDO) contributes to the Sustainable Development Goals through facilitating Eco-Industrial Parks (EIPs). While many of the parks that have been developed are in countries with emerging economies, the principles are applicable in Australian contexts.

The International Framework for Eco-Industrial Parks (UNIDO 2017) provides the following definitions and aims:

EIPs are dedicated industrial areas, at suitable sites, which ensure sustainability through the integration of social, economic and environmental quality aspects of siting, planning, management and operations. The concept has been described since 1992.

> *"A community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance."*

An eco-industrial park is a community of businesses located on a common property in which businesses seek to achieve enhanced environmental, economic and social performance through collaboration in managing environmental and resource issues.

Performance requirements are linked to the 2030 SDGs for industry, innovation and infrastructure, as well as employment, economic growth and climate change. For instance, SDG 7 encourages doubling of the rate of energy efficiency improvement and significantly increasing the share of renewable energy by 2030.

The UNIDO EIP framework focuses on delivering beneficial outcomes across four themes:

- Park management
- Environment
- Social
- Economic

Prerequisites and performance requirements for UNIDO EIPs are outlined in **Table 1.2**. A preliminary review of pre-requisites indicate the SAP may have the capacity to meet the principles of the UNIDO EIP prerequisites.

The aim of eco-industrial parks is to promote resource efficiency and circular economy practices and better connect cities and industries, in particular the promotion of circular economy objectives is a key principle of the UNIDO Eco-Industrial Park Framework. Consistent with commitments made within the Parkes, Wagga Wagga and Moree SAPs, it is understood that the vision for the Narrabri SAP is also to adopt the Eco-Industrial Park framework, or at minimum the principles of the framework.

Development of such parks should commence in the initial design and planning phases to maximise industrial synergies across the precinct.

Additional consultation with the Department of Planning, Industry and Environment and Regional NSW personnel will be required to understand if and how these prerequisites can be formally met.

Table 1.2 UNIDO Eco-Industrial Park prerequisites

Topic	Sub-topic	Requirement	Application to SAP
Environment			
Management and monitoring	Environmental/Energy Management Systems (EMS and EnMS, respectively)	The park has an appropriate, functioning EMS and EnEMS systems (for example, ISO 14001 Environmental Management Standard and ISO 50001 Energy Management Standard) in place to set and achieve targets, and covering key issues (for example, energy waste and material use; water; point-source emissions; and the natural environment).	A precinct wide EMS or EnMS could be implemented across the SAP. Additional opportunity to use systems to encourage operators within the SAP to meet or exceed targets could also be implemented.
Energy	Energy efficiency	Energy efficiency strategies are in place for the park management infrastructure and major energy-consuming resident firms.	Energy efficiency measures, including objectives and targets could be implemented through the delivery plan and ongoing monitoring and management across the duration of the SAP term. This would include a long term target to source energy from renewable sources and offset unavoidable emissions.
	Exchange of waste heat energy	A program/mechanism is in place to identify opportunities for common energy and heat exchange networks to be established, including support programs to assist resident firms with implementation.	Opportunities for co-share and exchange of energy and heat and other resources can be investigated or provisions included in the masterplan to ensure capacity and encourage uptake of opportunities. Intra-precinct sharing opportunities may need further review and research due to geographical placement of sub-precinct land uses.
Water	Water efficiency, reuse and recycling	Water-saving and re-use plans are important to reducing total water consumption. The park and businesses should have systems in place to increase water savings and reuse.	Opportunities to maximise use, re-use, efficiency of resources is a key theme of promoting a circular economy. This is also a key theme of the SAP. Opportunities should also be considered as part of Water-Sensitive Urban Design (WSUD) considerations.

Topic	Sub-topic	Requirement	Application to SAP
Climate change and the natural environment	Air, GHG emissions and pollution prevention	The park seeks to limit and mitigate all point-source pollution and GHG emissions, including air, waterway, and ground pollution. A set of measures at the park level is introduced (for instance, low-carbon technologies, energy efficiency measures, waste heat) to reduce GHG emissions.	Opportunities to eliminate and reduce emissions is a key theme for the Project. The SAP aims to operate under a net zero emissions framework.
	Environmental assessment and ecosystem services	Protection of the sensitive natural environment is key to environmental and community well-being. The industrial park demonstrates an understanding of the potential impact of park activities on priority ecosystem services in and around the vicinity of the park.	The precinct can aim to retain natural systems function. This may include the retention of the environmental corridors, drainage systems or other aspects. This consideration can be adopted during the initial design and scenario process.
Park Management			
Park Management Services	Park management entity	A park management entity (or alternative agency, where applicable) exists to handle park planning, operations and management, and monitoring.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance.
	Park property, common infrastructure and services	The park management entity provides and facilitates common services and infrastructure to resident firms to ensure smooth operations.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance.
Monitoring and risk management	Monitoring performance and risks	The park management entity has established and maintains a system for monitoring achievement of threshold EIP performance targets and management of critical risk factors within the park.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance.
		The park management establishes measures to deal with climate change adaptation and disaster preparedness.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance.
	Information on applicable regulations and standards	Park management has a good understanding of regulations and international standards applicable to industrial park compliance.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance.

Topic	Sub-topic	Requirement	Application to SAP
Planning and zoning	Masterplan	A masterplan for the EIP should be developed by relevant authorities (for example by governments, land owners, and planning agencies); it should be applicable for both planning and operations.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance.
Social			
Social management systems	Management team	Functioning system(s) are in place for ensuring social infrastructure provisioning, operations and performance, as well as collecting, monitoring, and managing key social information and impacts relevant to the industrial park.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance. Technical studies undertaken during the SAP planning process can also inform systems and key features to be implemented across the precinct.
Social infrastructure	Primary social infrastructure	Provision of fundamental social infrastructure in the industrial park or its proximity also facilitate and encourage women's employment, for example, lavatories and public toilets (for men and women), drinking water fountains, provision of cafeterias within reach of the employees, recreational areas, and childcare programs. This infrastructure needs to be fully operational to encourage women's employment.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance. Technical studies undertaken during the SAP planning process can also inform systems and key features to be implemented across the precinct.
Economic			
Employment generation	Type of employment	An EIP has employment generation plans in place to provide opportunities for long-term employment.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance
Local business and SME promotion	SME development	An EIP provides opportunities for local, regional, and national SMEs, enabling them to benefit from EIP activities	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance

Topic	Sub-topic	Requirement	Application to SAP
Economic value creation	Market demand for EIP services and infrastructure	The development of an EIP, including green infrastructure and services, must be based on realistic market and industry demands to ensure economic feasibility.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance. Technical studies undertaken during the SAP planning process can also inform systems and key features to be implemented across the precinct.
	EIP meets economic interests of the government	The site is economically efficient in terms of achieving government targets, including investment, foreign direct investment, and tax revenue targets.	Department of Regional NSW, Regional Growth NSW Development Corporation or other, could provide support to manage and monitor precinct performance. Technical studies undertaken during the SAP planning process can also inform systems and key features to be implemented across the precinct.

1.2 National

1.2.1 Long-term Emissions Reduction Plan

Australia's Long-term emissions reduction plan – a whole-of-economy Plan to achieve net zero emissions by 2050 was released during October 2021. The plan aims to achieve net zero emissions by 2050 across four areas through a number of priority low emissions technologies. At a high level, the plan identifies a number of stretch goals between 2030 and 2040 to guide and encourage development[2] that are summarised in **Table 1.3**. Specifically, the plan outlines Australia's ambitions to produce ultra-low cost solar of $15/MWh before 2035 to drive energy transition. Reaching this goal will underpin the progress for other priority technologies including but not limited to green hydrogen production and low emissions materials.

The plan also outlines a number of additional strategies, plans and programs which include grants and funding options to encourage the uptake and transition to a net zero emissions landscape in regional Australian areas including the recycling modernisation fund, buildings better regions fund and modern manufacturing strategy.

Table 1.3 Summary of Australia Long-term emissions reduction plan

Action areas	Priority technologies	Stretch goal
1. Driving down technology costs	• Clean hydrogen	• Clean hydrogen production under $2 per kilogram by 2030
	• Ultra low-cost solar	• Solar electricity generation at $15 per MWh by 2035
2. Enabling deployment at scale	• Energy storage for firming	• Electricity from storage for firming under $100 per MWh by 2030
3. Seizing opportunities in new and traditional markets	• Low emissions materials	• Low emission steel and aluminium production under $700 and $2,200 per tonne, respectively by 2040
	• Carbon capture and storage	• CO_2 Carbon dioxide compression, hub transport and storage for under $20 per tonne of CO_2 by 2030
4. Fostering global collaboration	• Soil Carbon	• Soil organic carbon measurement under $3 per hectare per year by 2030

1.2.2 Climate Active Carbon Neutral Standard

Climate Active (formerly the National Carbon Offset Standard) is an Australian Government program designed to encourage voluntary climate action. Climate Active certifies carbon neutrality, and can be awarded to buildings, events, organisations, precincts, products and services. The Climate Active Carbon Neutral Standard – Precincts outlines the requirements for Climate Active certification.

Climate Active would be the determining authority for net zero certification across the Precinct.

[2] https://www.industry.gov.au/sites/default/files/October%202021/document/australias-long-term-emissions-reduction-plan.pdf

1.3 State

1.3.1 NSW Climate Change Policy Framework

The NSW Climate Change Policy Framework was released during 2016 and it provides the overarching framework which seeks to achieve net zero emissions by 2050 and maximise the economic, social, and environmental wellbeing of NSW.

The framework sets out seven key policy directions to achieve net zero emissions by 2050 whilst also ensuring the state is more resilient to climate change. These policy directions include:

1. Create a certain investment environment by working with the Commonwealth to manage transition.
2. Boost energy productivity, put downward pressure on household and business energy bills.
3. Capture co-benefits and manage unintended impacts of external policies.
4. Take advantage of opportunities to grow new industries in NSW.
5. Reduce risks and damage to public and private assets in NSW arising from climate change.
6. Reduce climate change impacts on health and wellbeing.
7. Manage impacts on natural resources, ecosystems and communities.

1.3.2 NSW Circular Economy Policy Statement

The NSW Government has developed a Circular Economy Policy to deliver positive economic, social, and environmental outcomes[3]. The circular economy is about changing the way we view the economy in the traditional sense of take, make and dispose, and transition to one underpinned by waste elimination, resources kept in circulation, and the regeneration of natural systems as illustrated in **Figure 1.4**.

[3] NSW Government Circular Economy Policy Statement Final

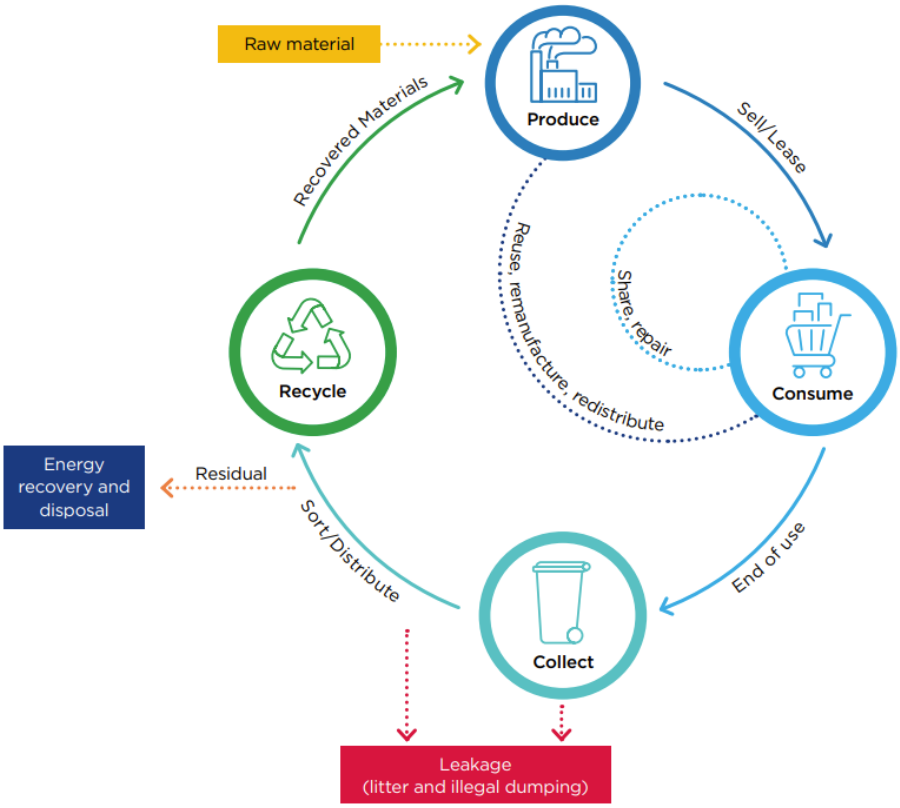

Figure 1.4 Circular Economy model keeping materials in the 'loop'

According to NSW Circular, the circular economy can generate up to 50,000 jobs in NSW over the next five years as the circular economy grows and is embraced by industry. This coupled with circular economy integration across a multitude of industries such as waste recovery, the built environment and transport can potentially add $210 billion to Australia's GDP by 2048[4]. Locally, in NSW, the share of the national additional GDP is expected to be 33%, around $69 billion.

This presents a massive opportunity for the state of NSW to ensure long term economic growth, aligned with the current global trajectory, aimed at sustainable growth through a circular economic model.

The NSW Circular Economy Policy Statement:[5]

- provides a common language and direction for a circular economy, through a definition and seven circular economy principles;
- defines the NSW Government's role in implementing circular economy principles across the state;
- provides clear principles that assist the NSW Government to embed circular economy principles in Government decision making, policies, strategies, and programs; and
- outlines immediate next steps and sets focus areas to guide planning and implementation.

[4] KPMG Economics, Potential Economic Pay-off of a Circular Economy, 28 April 2020

[5] NSW Government Circular Economy Policy Statement Final

1.3.3 NSW Waste and Sustainable Materials Strategy 2041

The NSW Waste and Sustainable Materials Strategy 2041: Stage 1 – 2021-2027 (WSMS) focuses on the environmental benefits and economic opportunities in how we manage our waste.[6]

The strategy includes clear targets to:

- reduce total waste generated by 10% per person by 2030
- have an 80% average recovery rate from all waste streams by 2030
- significantly increase the use of recycled content by governments and industry
- phase out problematic and unnecessary plastics by 2025
- halve the amount of organic waste sent to landfill by 2030.

Table 1.4 identifies the relevance and applicability of the principles set out in the NSW Circular Economy Policy and the NSW WSMS for the Narrabri SAP.

Table 1.4 NSW Circular Economy Policy and Waste and Sustainable Materials Strategy Principles

NSW Circular Economy Policy Principles	NSW WSMS (Principles)
Sustainable management of all resources • Replace raw materials with recycled products in order to reduce demand for virgin materials	Transitioning to a circular economy means • Increase the productivity of current resources and use them efficiently
Valuing resource productivity • Minimise inefficient use of 'virgin' materials and recognise the value of resources	Designing out materials that end up in landfill • A key principle to achieving a circular economy through designing out waste
Design out waste and pollution • Product design for longevity and resource recovery, sustainable packaging	Adequate and sufficient infrastructure • Ensure services and infrastructure are put in place to deal with waste safely
Maintain the value of products and materials • Increase the repairability and recyclability of products	
Innovate new solutions for resource efficiency • Capturing value from recycling resources in new ways, including innovative business models and services across different sectors.	
Create circular economy jobs • New jobs based on new manufacturing, repair, service, and recovery processes	
Foster behavioural change through education and engagement • Engaging with communities and businesses to communicate the benefits of a circular	

[6] NSW Waste and Sustainable Materials Strategy 2041

1.4 Regional

1.4.1 Narrabri Growth Management Strategy

NSC identified a demand for additional industrial land, in addition to the pre-existing and approved logistics and industrial hubs across the LGA. The Narrabri Growth Management Strategy also recognises a demand for green industries that will continue to emerge as the landscape transitions to a net zero economy[7].

'Green' industries are businesses, facilities, services or technologies that provide sustainable alternatives or solutions to environmental challenges. Examples include bottle recycling plants, waste management and treatment or research and development for clean energy. These sectors will be at the heart of considerable innovation and can gain greater success with local partnerships between industry, government and educational facilitates.

1.4.2 Northern Inland Regional Waste Strategy 2017-2021 and Action Plan 2017-2019

NSC is a member of the Northern Inland Regional Waste (NIRW) group. NIRW works collaboratively in pursuit of effective waste management and resource recovery across the region with 11 other member councils. Goals and actions for the NIRW group are summarised in the NIRW Strategy 2017-2021 and Action Plan 2017-2019.

This regional waste strategy is now outdated and does not reflect the huge increase in state and national strategic ambition in the last 2-3 years in relation to the management of waste and resources. Should an updated regional waste management plan be released during the course of this project, it will be reviewed and integrated.

To align with the level of ambition for the Narrabri SAP in relation to circular economy, it is recommended that the NSW Waste and Sustainable Materials Strategy is more relevant.

[7] Elton Consulting (2020) Narrabri Growth Management Strategy

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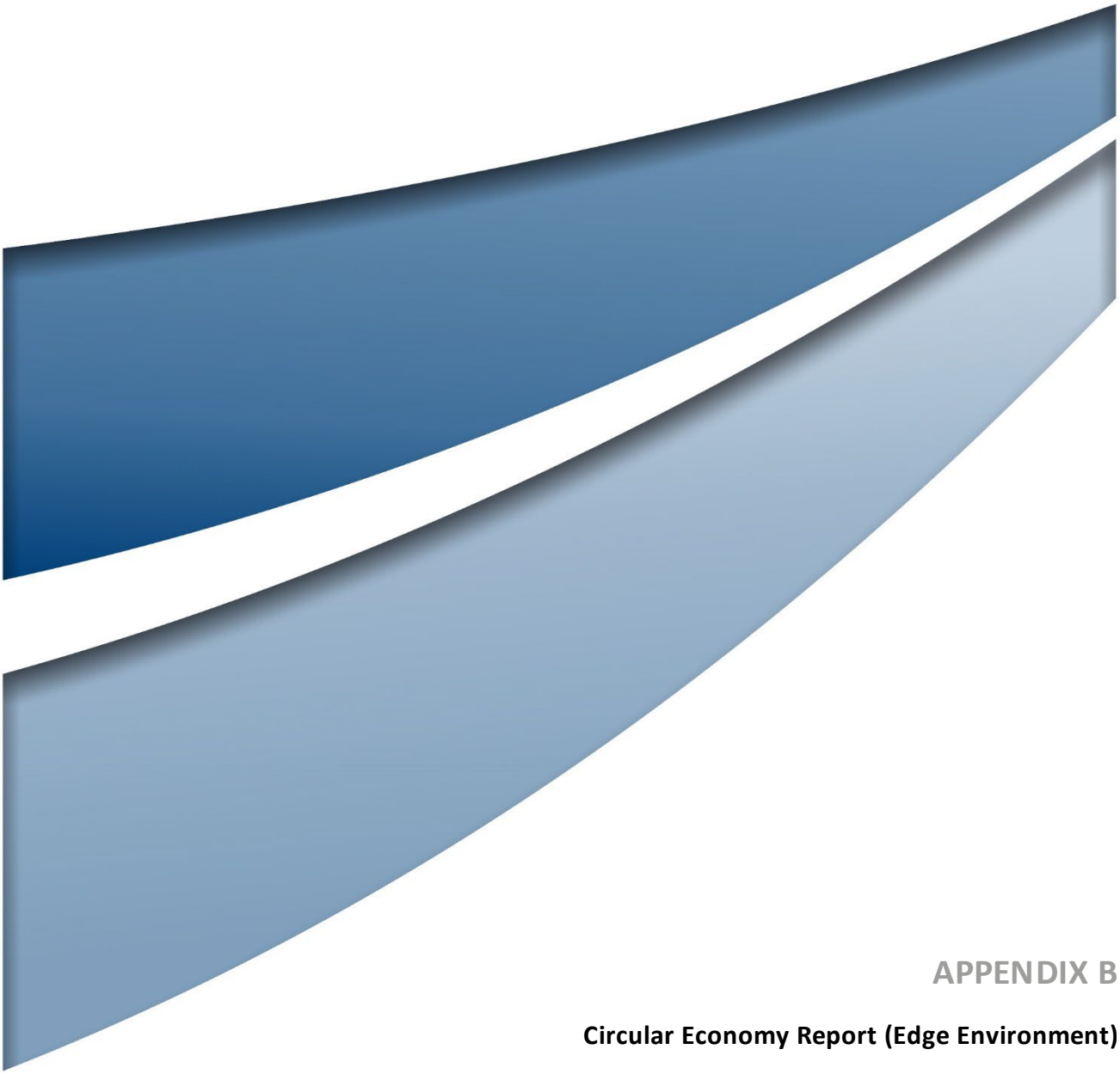

APPENDIX B

Circular Economy Report (Edge Environment)

umwelt
Environmental & Social Consultants

CIRCULAR ECONOMY REPORT APPENDIX B

Narrabri Special Activation Precinct

DRAFT

October 2022

CIRCULAR ECONOMY REPORT APPENDIX B

Narrabri Special Activation Precinct

DRAFT

Prepared by
Edge Environment Pty Ltd
on behalf of
Umwelt (Australia) Pty Limited

Project Director: Paul Douglass
Project Manager: Jessica Henderson-Wilson

Report No. 21727/RO7
Date: October 2022

Environmental & Social Consultants

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

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.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date

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Figures

Tables

1.0 Circular Economy

Resource efficiency and sustainability are key ambitions for the Narrabri SAP. The following objectives for the SAP will drive action on these ambitions:

- **Resilience and Innovation** – the design and delivery of the Precinct will be adaptable to future changes including the impacts of climate change and technology innovations.
- **Optimal Resource Efficiency** – The design and delivery of the Precinct will harness and promote water, energy and waste efficiencies.
- **Regional Scale Circular Economy Exemplar** – The design and delivery of the Precinct will promote co-location of land uses to optimise strategic benefits and maximise infrastructure capacity to support circular economy principles.
- **Guided by Best Practice Frameworks, Ratings and Accreditations** – The design and delivery of the Precinct will be guided by best practice sustainability frameworks, ratings, and accreditations.

The following section provides recommendations for embedding circular economy principles and functions into the precinct and tracking performance. It also provides practical opportunities for circular building design that could be incorporated into the delivery plan for the SAP. The discussion is presented as:

- Principles and functions applicable across the precinct.
- Circular economy for the built environment.
- Circular economy opportunities for key land uses.
- Performance measures.
- Circular economy opportunities for the town and residential area.

1.1 Principles and Functions Applicable Across the Precinct

Circular economy provides a framework to use and manage materials required to meet the needs of society in such a way that decouples economic growth from the depletion of finite resources, retains materials at their highest value in closed-loop systems, uses renewable energy sources, and adds value to ecological and social systems. To achieve this, the circular economy framework provides the following three guiding principles:[1]

- Eliminate waste and pollution,
- Keep materials in use, and
- Regenerate natural systems.

[1] Ellen Macarthur Foundation, What is circular economy?

To meet the circularity ambitions of the Narrabri SAP, these principles should be applied across the SAP's lifecycle, interfacing at all scales from nano to macro. These concepts are explained in more detail in the following sub-section.

1.1.1 Lifecycle thinking

Lifecycle thinking is the practice of considering the impact on sustainability issues across the full lifecycle when designing products or processes to minimise the whole-of-life impact.[2] Life Cycle Assessment (LCA) is the standardised method for quantifying impact across a range of sustainability issues across the lifecycle of a product or process, for example for the following environmental impact categories: global warming, depletion of abiotic resources (elements and fossil fuels), ozone depletion, water pollution and air pollution.

Lifecycle thinking should be applied to the Narrabri SAP throughout its lifecycle (shown in **Figure 1.1**) and from the nano scale to the meso scale (shown in **Figure 1.2**) to ensure truly sustainable and circular solutions. Lifecycle thinking at the design stage is particularly important as it can pre-determine much of the impact realised later in the lifecycle.

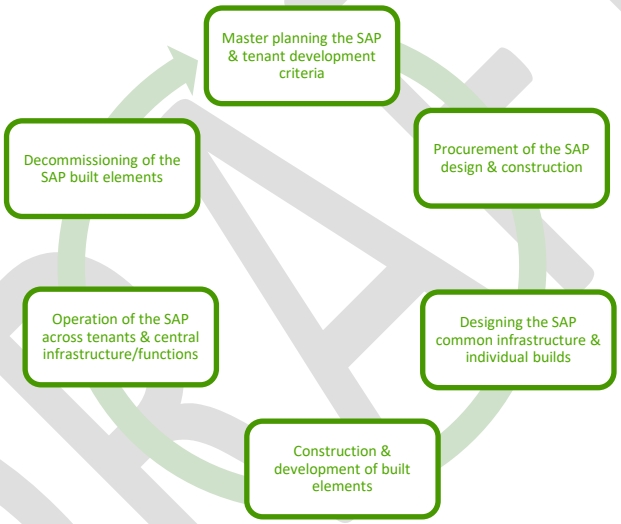

Figure 1.1 Lifecycle of Narrabri SAP

[2] Circular Economy Practitioner Guide, Life cycle thinking

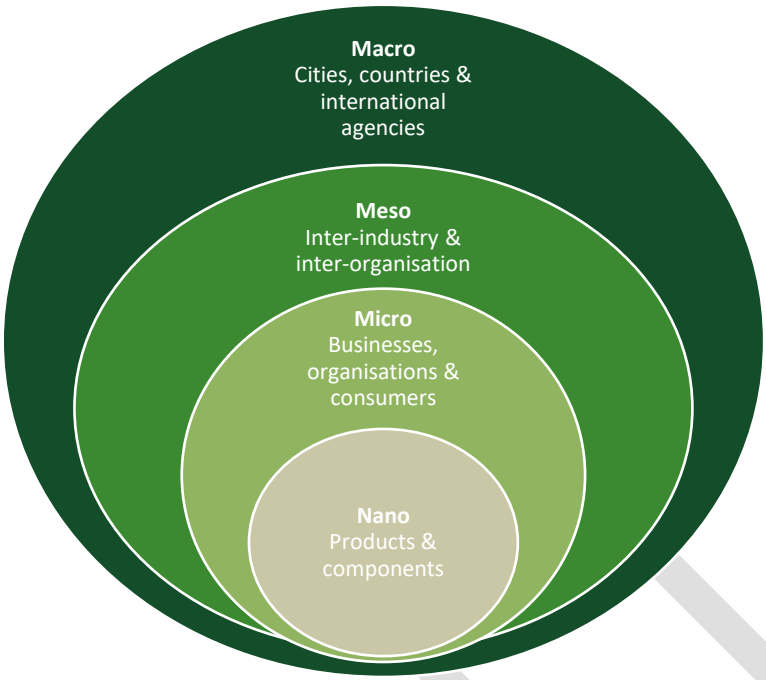

Figure 1.2 Scales of Measurement[3]

In the context of the Narrabri SAP, circular economy can be applied in a variety of ways across the SAP's lifecycle and at multiple scales (shown in **Figure 1.3**).

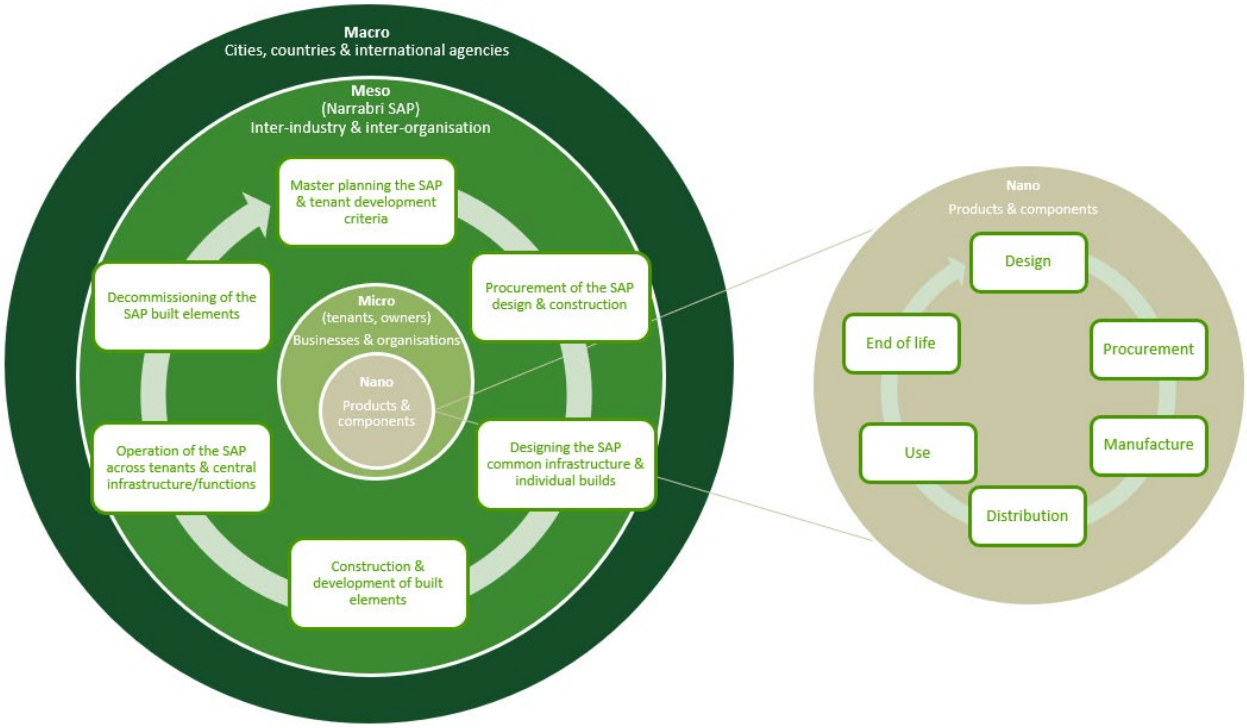

Figure 1.3 Scope and scale of circular economy in the SAP

[3] WBCSD (2018), Circular Metrics – Landscape Analysis

1.1.2 Circular design principles

Designing buildings, products or processes for a circular economy involves lifecycle thinking – designing not only for the user but for the whole system within which the design exists. There are several design principles that can assist in designing for circularity and reduced whole of life impact, including:[4]

- Design for multiple uses at the highest value– such as reuse, sharing, remanufacturing and refurbishment as preference to recycling.
- Moving from products to services – shifting from ownership to access. This allows higher utilisation of products across multiple users and can be facilitated through short-term rental, subscription, sharing or leasing rather than a one-time sale. It incentivises manufacturers to provide higher quality products and maximise the use of the resources in a cost-effective manner.
- Product life extension – design products that are both physically and emotionally durable or adaptive to a user's changing needs over time. Such products can be reused by a single user for a long-time or can be reused by many different users.
- Safe and circular material choices – avoid materials that are harmful to humans or the environment, including materials with high-embodied carbon which contributed to global warming. See **Section 1.2** for low carbon materials for the built environment.
- Dematerialisation – minimise the resource requirements required to deliver utility, for example through digitisation.
- Modularity and design for disassembly – to make buildings and products easy to disassemble, repair, remanufacture and upgrade. Modular systems are also easy to customise, adapting to a variety of users' needs and allowing for extended use.

The above circular design principles should be considered in designing across the scales and lifecycle stages of the SAP.

1.1.3 Supporting a decarbonised economy

Circular economy aligns with net zero carbon emissions ambitions and covers all aspects of the precinct value chain across its lifecycle. Furthermore, consumer and investor expectations are moving rapidly towards net zero carbon standards and meeting these standards is seen as key to being competitive in the market and attractive to investors. This is backed increasingly by policy both in Australia and from international trading partners. Circular economy design principles, and lifecycle and systems thinking seek to activate collaboration across the value chain to circulate materials at their highest value, with reducing embodied carbon in products being a key co-benefit. Opportunities relating to circulating materials for the SAP have been discussed throughout **Section 1.0**, while opportunities and constraints relating directly to energy and emissions have been discussed in Section 5.2 of the Sustainability Report.

[4] Ellen Macarthur Foundation, Circular design

1.1.4 Industrial synergies

Industrial symbiosis is of keen interest for the SAP and represents one type of industrial synergy that supports resource efficiency and circular economy outcomes. The four key industrial synergy opportunities for the Narrabri SAP include (highlighted in the UNIDO Eco-Industrial Park framework[5]):

- Supply synergies and co-location of suppliers and clients in the value chain.
- Sharing utility infrastructure, such as water, energy, and materials management infrastructure.
- Sharing services, such as waste collection, maintenance, or staff training.
- Exchange of by-products (solid, liquid or gas) between businesses or facilities, harnessing opportunities to optimise industrial processes and use underutilised resources. This is often referred to as industrial symbiosis.

Industrial symbiosis can be maximised through monitoring and forecasting resource flows (including materials, energy, heat, and water) to identify opportunities, co-locating complementary tenancies, and collaboration driven through the Business Concierge. Strategic co-location of tenants within the SAP should reduce the costs and increase the feasibility of sharing complementary resource flows to achieve resource efficiencies and keep materials in closed loops.

There are various options for governance models to manage collaborative partnerships.[5] Long-term industrial symbiosis arrangements between specific parties will be supported by a collaborative business environment and governed by specific terms and arrangements among partners. It is recommended that the Business Concierge play an active role in identifying potential collaboration opportunities and a supporting role in the development of these partnerships, such as through developing and providing model contracts.

To capitalise on short-term industrial symbiosis opportunities, it is recommended that the SAP also provide access to a digital platform, such as ASPIRE,[6] which can facilitate and verify transactions for the trading of reusable products and materials among tenants. ASPIRE allows for the development of an 'ecosystem' which could provide access for businesses both within the SAP and in the broader Narrabri region to scale the benefits.

1.1.5 Sustainability ratings and monitoring

All new precinct infrastructure and buildings should be guided by recognised sustainability rating schemes, including the IS Rating Scheme and Green Star to ensure design minimises whole of life impact of assets, and is informed by evidence through lifecycle analysis. Examples of design techniques to minimise whole-of-life impact include using low-embodied carbon materials, buildings are flexible to adapt to different users, and building elements are designed for disassembly and reuse at their end of life. Design for circularity in the built environment has been further discussed in **Section 1.2**.

[5] United Nations Industrial Development Organization, 2017, Implementation Handbook for Eco-Industrial Parks
[6] ASPIRE, 2022, https://aspiresme.com/

Currently there are limited available ratings to drive resource efficient operations through monitoring and tracking outcomes for industrial precincts. For example, the only tenancies applicable to the SAP covered by the NABERS Waste rating scheme includes offices and warehouses.[7] It is recommended the Business Concierge stay abreast of expansions to NABERS Waste coverage or any relevant rating schemes which may come online by the time the SAP is operational.

In the absence of an applicable scheme, the precinct should align to the requirements of the NABERS Waste scheme (as well as NABERS Energy and Water discussed in the above sections), which includes ongoing monitoring of waste volumes and intensity, maximising the segregation of waste materials into high value streams for reuse and recycling, and regular waste auditing to identify opportunities for improvement. Waste flow tracking for specific tenancies and common facilities can be streamlined through incorporating into the SAP weight-based measurement infrastructure (such as on-site scales or scales on waste collection vehicles) and digital data tracking and reporting platforms, such as BinTracker.[8]

1.1.6 Activating circular economy through the Business Concierge

Many enabling functions for circular economy adoption across the precinct could be delivered through the Business Concierge. It is recommended that the below key functions should be delivered for the SAP. Several of these functions have been referred to as the "soft infrastructure" in a review paper on circularity in NSW precincts necessary for creating the collaborative environment that enables "hard infrastructure" to be effective and efficient in creating circular material loops.[9]

- Data collection and analysis – implement precinct scale data collection systems, for example, for types of materials flowing through the SAP, material flow weights, controlling entities; and undertake centralised analysis of material flows. This will help actively identify industrial symbiosis, resource recovery, and other circular economy opportunities, and allow for benchmarking performance against specific industry peers or suitable precinct reference points to motivate action.
- Lead a collaborative and cooperative business culture for the SAP to encourage industrial synergy initiatives across multi-stakeholders; and promote and sustain cooperation, ownership, and action. An engagement plan should be developed in due course, with potential activities including regular networking events hosted at a dedicated space in the Circular Economy Hub.
- Provide oversight and assistance in attracting investment, co-locating entities to align complementary resource flows and environmental requirements and maximise the use of the SAP's buildings and infrastructure.
- Market the broad benefits (environmental, social, and economic) of circular economy to investors, owners, and tenants.
- Develop and provide access to training material and operating manuals on how to meet circular economy and sustainability requirements. Connect stakeholders with external education and inspiration for how to embed circular economy and lifecycle thinking into goods and service design and tenant operations.

[7] NABERS, 2022, https://www.nabers.gov.au/waste
[8] BinTracker, 2022, https://bintracker.com.au/
[9] Prepared for NSW Circular by The University of Sydney, The University of Newcastle, Regional Growth NSW Development Corp., CSIRO, Macquarie University, UTS, Clean Core Development, 2022, Embedding circular economy principles within precincts and infrastructure business case processes in NSW

- Develop and maintain a stakeholder map for the precinct, including for example precinct management, developers, owners, tenants, and employees. The stakeholder map should also include what their role is in the SAP, what their role is for delivering circular economy in the SAP, and what training, resources or documents they need to access to deliver their role.

- Develop and drive the implementation of a Circular Economy Strategy for the SAP and provide support to tenants to develop their own Circular Economy Strategies. The strategies should include relevant targets to drive performance improvement, such as waste minimisation and material productivity (the economic value gained from materials consumed).

The above functions require specialist capability and appropriate resourcing. Drawing on RGDC's team of circular economy specialist, a regionally focused full-time resource responsible for activating circular economy at the operational stage across Narrabri and Moree should be considered. Furthermore, KPIs should be put in place for the dedicated resource / Business Concierge to activate circular economy across the SAP's lifecycle and at different scales. Examples could include KPIs related to awareness of circular economy among stakeholders, engagement in the collaboration/networking events, or number of collaborative partnerships in each SAP.

1.2 Circular Economy for the Built Environment

As the Narrabri SAP is mostly a greenfield site, there will inherently be new built elements developed to facilitate and service the businesses that locate in the SAP. For new buildings and infrastructure in the SAP, circular design principles and alignment with best practice rating schemes (IS and Green Star) should guide design for low whole-of-life impact. In practice, this includes for example using low embodied carbon, renewable and recycled materials; developing with zero construction waste; designing effective operational waste management systems into the SAP; designing adaptive and flexible spaces to maximise utilisation; enabling active and shared mobility and including infrastructure for electric vehicles; using product-as-a-service systems to incentivise high quality products and accountability for end-of-use management; and designing for disassembly of components and reuse at end-of-use.

The embodied carbon in materials can make up a significant portion of a built asset's overall carbon footprint. Newly constructed buildings and infrastructure in the SAP should select low embodied carbon materials as much as possible. Some examples include:

- Reused components such as bricks, beams, staircases, and other components where possible.

- Third-party verified carbon neutral or carbon negative materials.

- Concrete using mixtures that reduce Portland cement content.

- Steel manufactured with renewable energy or green hydrogen.

- Replacing steel with sustainably sourced structural timber.

- Aluminium manufactured with renewable energy.

- Asphalt avoiding the use of lime.

- Aggregates sourced onsite, locally or from construction and demolition waste, for application as reclaimed asphalt pavement in roads or gravel in concrete.

1.3 Circular Economy Opportunities for Key Land Uses

Building on the general principles and activating functions discussed in **Section 1.1,** opportunities for investment that align to circular economy principles have been put forward in this section for key land uses appearing in the final structure plan for the Inland Port Hub of the Narrabri SAP. Specific opportunities for the land uses within the Energy Hub have not been discussed in this **Section 1.3** as they relate more directly to energy and emissions opportunities and constraints explored in section 5.2 of the Sustainability Report, however the general principles discussed above in **Sections 1.1** and **1.2** apply, and the enabling functions delivered through the Circular Economy Hub (discussed in **Section 1.3.5**) will support circularity across both the Inland Port Hub and the Energy Hub.

1.3.1 Transport and logistics

The most impactful circular economy opportunity from the Inland Port in the SAP is its influence on accessibility to markets and driving down the cost of transporting materials within circular supply chains across Australia. The regional location of the SAP presents challenges for transport and logistics which can potentially be overcome through the increased efficiency possible with the Inland Rail. The cost of shipping will drastically be reduced (up to 39% reduction compared to road freight)[10] and unlock geographical markets that were previously closed to Narrabri. This is particularly relevant for businesses moving materials into and out of the SAP, especially within the waste management and recycling, agriculture and food processing, and manufacturing land uses. In addition, investment in intermodal facilities will maximise efficiencies and could shift agricultural freight from bulk to smaller volumes by packaging in containers which would provide access to a greater range of export destinations.[11]

1.3.2 Agriculture and food processing

One key circular economy aligned opportunity identified for the agriculture and food processing land use is manufacturing plant-based meat alternative products. There is strong growing demand for plant-based meat alternatives both domestically and internationally.[12] Narrabri is well positioned to support the growing demand for these products through the local production of key relevant agricultural commodities,[13] connection with rail transportation and appropriate zoned land for the development of production and storage facilities. An investment in plant-based meat alternative would place Narrabri at the forefront of the global transformation of the food system, aligning with circular economy principles through providing low-embodied carbon sources of protein, with the potential to support regenerative agriculture practices through partnerships with local farmers.

Narrabri has a strong agricultural presence and produces crops such as wheat and chickpeas, two major inputs for plant-based meat alternatives production and creating more demand for these commodities would support the continued agricultural tradition in the area. Narrabri could produce the highest quality plant-based alternatives by sourcing the high-quality local materials in place of internationally sourced synthetic materials. Lupin is also grown in the area and is an example of another crop where expanded production could be explored should a plant-based meat production facility arise. Some products may be

[10] Inland Rail to save $170 million annually in transport costs - CSIRO
[11] New-England-North-West---Final-regional-plan-2017-09.pdf (nsw.gov.au)
[12] Good Food Institute, 2021, Plant-based meat: Anticipating 2030 production requirements
[13] Australian Bureau of Statistics, Value of Agricultural Commodities by Local Government Area - 2020-21

better suited to local production than others, for example textured vegetable protein which is shelf-stable/doesn't require cold chain distribution.

The procurement of local agricultural commodities to support domestic plant-based protein production will also reduce international supply chain, price volatility and commodity quality risk that Australian manufacturers of finished products are currently exposed to.

A cost-benefit analysis was conducted on a small-scale and large-scale plant-based meat manufacturing facility which demonstrated a negative net present value for the small-scale facility, and a positive net present value for the large-scale facility. The establishment of a large-scale facility could also generate an additional 50 – 170 ongoing jobs for the region as well as additional jobs during the construction phase.

1.3.3 Waste management and recycling

Given the small population and business community around Narrabri (even with the additional activity from the SAP), aggregating sufficient tonnages of wastes is a key consideration and constraint for any waste processing facility looking to locate in the SAP. The Inland Rail and Port will be key in accessing sources of wastes from population centres in NSW, QLD, and Vic, and reducing the cost of transporting wastes to the SAP. To negotiate the constraint, waste processing businesses in the SAP could explore small-scale material processing technologies to suit specialised local waste streams, focus on high-value and low-weight wastes, optimise transport economics through reverse logistics, and seek complementarity between the nearby Moree SAP to ensure the impact of each individual SAP is amplified by being part of a network.

Nonetheless, waste processing activities are critical to enabling materials to recirculate in a circular economy and the area has already proven the commercial viability of a plastics recycling facility, Australian Recycled Plastics, through using reverse logistics to import 50 tonnes of plastic packaging waste per week from outside the region, reprocessing into plastic flake for remanufacturing.[14] Further, expanding Australia's domestic recycling infrastructure capacity is also a current focus of policy, backed by several funding programs from federal and state government, such as the $190 million Recycling Modernisation Fund from the Australian Government.[15] The following waste processing activities have been highlighted as potential opportunities for the SAP:

- **Plastics recycling**: Two million tonnes of plastic waste are generated in NSW and QLD alone per year, with only 18% being recovered.[16] To support a circular economy for plastics in Australia, a range of recycling technologies were considered for suitability for the SAP. Chemical recycling was short-listed due to its broad acceptance of plastic waste feedstocks including low-value streams that otherwise have a high risk of ending up in landfill, and the technology's production of a range of output products, diversifying income streams.

  The primary target feedstocks could be agricultural and industrial plastics, to provide complementarity with the existing Australian Recycled Plastics PET recycling facility in Narrabri SAP, and the planned Brightmark 200,000 tonnes per annum pyrolysis facility in Parkes SAP which will target mixed container plastics from municipal kerbside collections. The targeted industrial plastics could include pallet wrap waste generated at the inland port and agricultural plastics which may become a significant regional waste stream once the agricultural plastics product stewardship scheme takes shape (currently

[14] Narrabri Shire (2020), *Growth Management Strategy*, Narrabri Shire, accessed 4th May 2022
[15] Department of Agriculture, Water and the Environment (DAWE) (2022), *Investments in Recycling Infrastructure*, DAWE, accessed 4th May 2022
[16] Envisage works (2021), Australian Plastic Flow and Fates Study 2019-20

Australia generates 93,000 tonnes per year of agricultural plastics waste, recovering only 17%)[16]. Residual plastics from Australian Recycled Plastics' operations could also provide a minimal feedstock stream, which although negligible in terms of scale, would provide an opportunity for industrial symbiosis between the two facilities, and leverage the benefits of being co-located.

In the medium term, the outputs of a chemical plastics recycling facility in Narrabri would need to be upgraded at refineries, which currently there are two in Australia: in Geelong Victoria and Lytton Queensland.17 However, future synergies across the plastics value chain (pictured below) could be explored should there be sufficient demand for local refining and packaging manufacturing to meet the needs of nearby food manufacturers and agribusinesses.

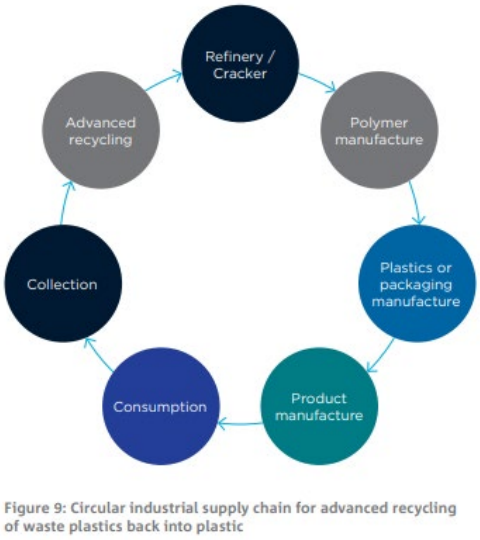

Figure 9: Circular industrial supply chain for advanced recycling of waste plastics back into plastic

Figure 1.4 Plastics value chain. Source: CSIRO, 2021, Advanced Recycling Technologies to Address Australia's Plastic Waste

An academic study into the economic feasibility of pyrolysis on waste plastics in Australia found that 15,000 tonnes per annum facilities can achieve a 54% return on investment, with this figure increasing for larger facilities due to economies of scale.18 However, a cost-benefit analysis conducted on a 25,000 tonnes per annum facility for Narrabri SAP has demonstrated a negative net present value, under the modelling assumptions provided in the accompanying cost-benefit analysis report.

Additional investigations on such a facility should look particularly at testing the assumptions around capturing a greater volume of local and non-local plastic waste feedstocks to support a larger facility, as well as the willingness of the market to pay a gate fee for processing their wastes. In particular, the agricultural plastics product stewardship scheme may change the market dynamics around this feedstock stream. Should a zero-waste target be introduced to the Narrabri SAP, then tenants generating plastic wastes will likely be willing to pay for local waste processing as a preference to incurring transport fees to process wastes outside the region.

[17] Advanced Recycling Feasibility Study, 2021, Geelong-Altona Industrial Corridor, The opportunity for a local circular economy for plastic
[18] Ghodrat et al. (2019), Economic feasibility of energy recovery from waste plastic using pyrolysis technology: an Australian perspective, International Journal of Environmental Science and Technology,16:3721–3734

Currently, the domestic end-market for oil (refineries) is in Geelong, Victoria and Lytton, Queensland. However, with the National Packaging Targets adopted by retailers and food manufacturers, a business case may develop for a more local refinery (e.g., in Parkes SAP) which would further strengthen supply chain synergies and the economic feasibility of a chemical plastics processing in Narrabri SAP.

- **Solar PV recycling:** With the North West New England region poised for a big increase in the amount of solar panels installed. [19] The SAP could leverage the opportunity to establish itself as a leader in solar PV remanufacturing and recycling to service the broader Australian market, and the local market boom that would be anticipated in 25-30 years' time when the imminent increase in solar panels come to their end of life. Australia currently has few solar PV recycling facilities, with Lotus Energy in Melbourne one of the first, claiming to recycle 100% of the end-of-life solar PV modules and all associated materials recovered – inverters, cables, optimisers, mounting structures – using no chemicals.[20] An investigation could look into the feasibility of transporting decommissioned solar panels at scale via the Inland Rail to feed a similar solar PV recycling facility in the SAP.

- **Textiles recycling:** An estimated 780,000 tonnes of textiles waste (or 31 kg per capita) is generated in Australia, with very low recovery rates of around 7 percent recycled and limited on-shore options for dealing with textiles at their end-of-life.[21] The Federal *Inquiry into Australia's Waste Management and Recycling Industries* and resulting recommendations included adding clothing textiles as a priority product for stewardship to prompt action from industry.[22] The Australian Government has also allocated $1 million in funding for the Australian Fashion Council to address textile circularity.[23] This could result in better capture of waste textiles and presents an opportunity for textiles recycling in the region. Technology developed in Australia to chemically breakdown cotton and polyester textile waste for reuse in fabric or as a soil ameliorator has opened a pilot plant in Bundaberg, QLD. With significant additional processing capacity expected to manage textiles waste from NSW and VIC, Narrabri could be a strategic location to capture and process volumes transported on the Inland Rail at scale.

  With existing local expertise in cotton production, the region could become leaders in circular textiles through expanding activities across the value chain with the added recycling capability, and exploration of R&D and production of recycled fabrics further into the future.

- **Tyres recycling**: Given the mining presence around Narrabri and the large-scale generation of tyre waste, the SAP could facilitate more circular outcomes for tyres in the region. Depending on the solution, other rubber waste generated in the region, such as conveyor belts, could be captured. There are multiple circular treatments for end-of-life tyres (see **Figure 1.5**) including re-treading, shredding, and pyrolysis (heating in the absence of air or oxygen to break product down, e.g., into char or oil).[24] These allow tyres to be reused, developed into crumb rubber product for asphalt applications, or converted into fuel. Of the available solutions, re-treading of tyres provides the most circular solution as it allows tyres to be reused, offers the same quality as a new tyre, and uses one-third of the oil required to manufacture a new tyre.[25] However, uptake of this solution has declined in Australia due to

[19] New-England-North-West---Final-regional-plan-2017-09.pdf (nsw.gov.au)
[20] Australia's first solar panel recycling plant swings into action | RenewEconomy
[21] Blue Environment (2020), National Waste Report, Department of Agriculture, Water, and the Environment. Accessed 26th October 2022.
[22] Department of Industry, Science, Energy and Resources (DISER) (2022), *Australian Government response: Inquiry into Australia's Waste Management and Recycling Industries,* DISER, accessed 4th May 2022
[23] Department of Industry, Science, Energy and Resources (DISER) (2022), *Australian Government response: Inquiry into Australia's Waste Management and Recycling Industries,* DISER, accessed 4th May 2022
[24] Edge (2022), *Greenhouse gas emissions analysis of waste tyre recovery*, TSA, p.31
[25] Edge (2022), *Greenhouse gas emissions analysis of waste tyre recovery*, TSA, p.25

availability of cheap new tyres, and the need to tightly manage the quality of re-treaded tyres for compliance assurance. The current dominant outcome in Australia is recycling through shredding and application of tyre-derived-product (TDP) to infrastructure purposes. Recycling solutions can realise significant avoided emissions[26] with the use of TDP seeing a 10-21% improvement in GHG emissions compared to the traditional material for crumb rubber, up to 96% improvement for pyrolysis formed TDP, and 13-16% for rubber granule applications.

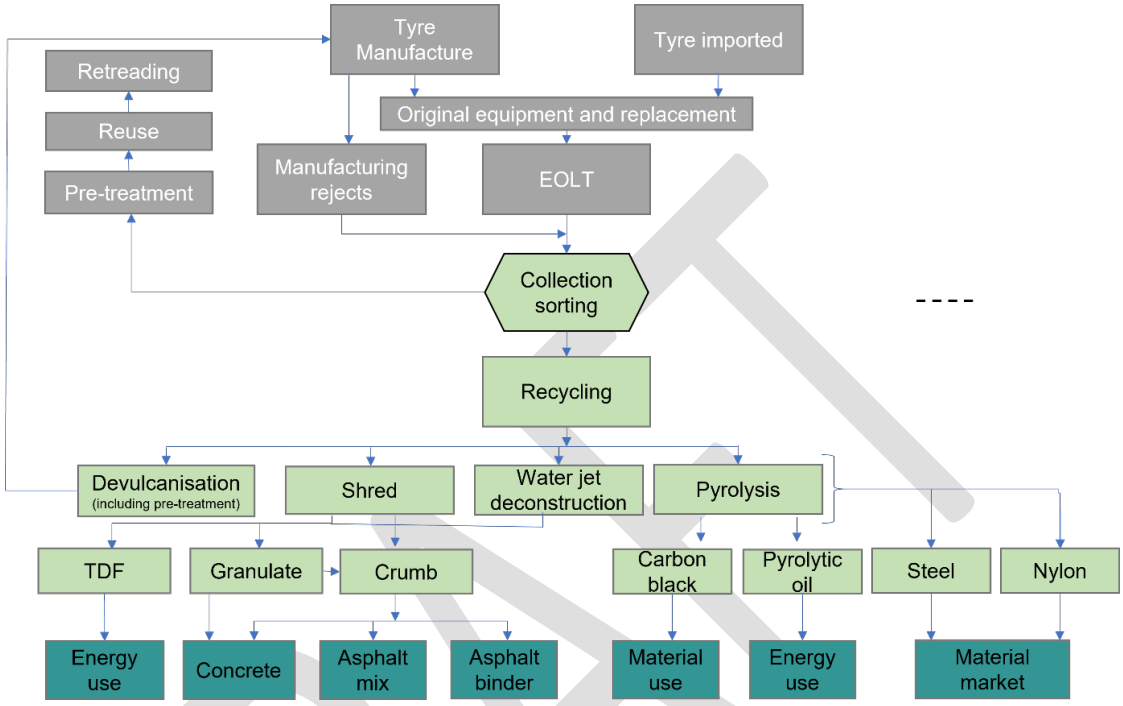

Figure 1.5 Overview of a Tyre Lifecycle and Available End-of-Life Applications (Edge Environment,2022)

Australia's waste export ban commenced implementation in 2021, driving an increase in onshore processing of waste plastics, paper, glass, and tyres.[27] The ban includes actions to build industry capacity and infrastructure to recycle materials and funding allocations[28] which present potential for high-value recycling of tyres from agriculture and mining industries that are significant in Narrabri.

The existing momentum for Narrabri Shire Council to attract investment for tyre processing in the Narrabri region is highly aligned with realising the economic, social and environmental benefits of a circular economy within the current context of the barriers and opportunities of tyre management in Australia.

- **Council's existing landfill** falls within the waste management and recycling land use area. It is understood that Council is currently developing a waste management strategy which should aim to ensure maximum waste diversion prior to waste reaching the landfill, to retain value from materials and extend the life of the landfill. Initiatives that promote a zero-waste SAP and township will interface with this.

[26] Edge (2022), *Greenhouse gas emissions analysis of waste tyre recovery*, TSA, p.5
[27] Australian Government (2019), *National Waste Policy Action Plan 2019*, accessed 4th May 2022
[28] Australian Government (2019), *National Waste Policy Action Plan 2019*, accessed 4th May 2022

- **Organics:** Narrabri Shire Council's organic waste is currently processed in Moree into products for beneficial reuse, further supporting the Moree area as being the biological reprocessing hub. It is also understood that water effluent from the local wastewater treatment plant has an established outlet on a private farm near Narrabri. These factors combine to make the development of an organic waste processing facility unviable due to insufficient feedstocks locally in the near-term. Future investigations could consider processing of specific organic wastes that may become available through businesses in the SAP's agriculture and food processing land use.

- The land use for Energy could include a gas fired power station, which would create residues that could potentially be upgraded, such as salt waste. This process has not been investigated as gas fired power generation itself does not align with circular economy principles.

1.3.4 Manufacturing

With advanced manufacturing identified by Regional NSW as an emerging industry for the region, circular economy within the manufacturing sector should be underpinned by the principles of designing out waste, enhancing resource efficiency, renewable energy powered, and utilising by-products or waste to create new products.

- **Critical minerals manufacturing hub that supports a circular economy**: The critical minerals economy presents an opportunity for Narrabri SAP to participate in meeting the growing demands of the world consumer class for high-tech materials while simultaneously securing long-term opportunities for sustainable mining.

New South Wales has a diverse range of rare and untapped critical minimal deposits as demonstrated in **Figure 1.6** with Narrabri in close proximity to gold, copper, scandium, rare earth elements, and platinum group elements[29]. The NSW Government has acknowledged this opportunity by implementing the *Critical Materials and High-Tech Metals Strategy*[30] to support the growth of this emerging sector in regional areas by investing in exploration, mining, processing, downstream industries, and recycling.

The emerging critical minerals sector also plays a key role in enabling global and domestic industries needed for the future including advanced manufacturing, battery manufacturing, defence, aerospace, ag-tech, renewable energy, and automation.

The current state focus on critical minerals in Dubbo and Parkes SAP could lead to potential expansion to Narrabri in the long-term horizon for the SAP. The hub could include value-added processing located close to existing, approved and potential mining developments, as well as e-product recycling from domestic or imported markets.

[29] NSW Government (2021), *Critical Materials and High-Tech Metals Strategy*, NSW Government, accessed 5th May 2022
[30] NSW Government (2021), *Critical Materials and High-Tech Metals Strategy*, NSW Government, accessed 5th May 2022

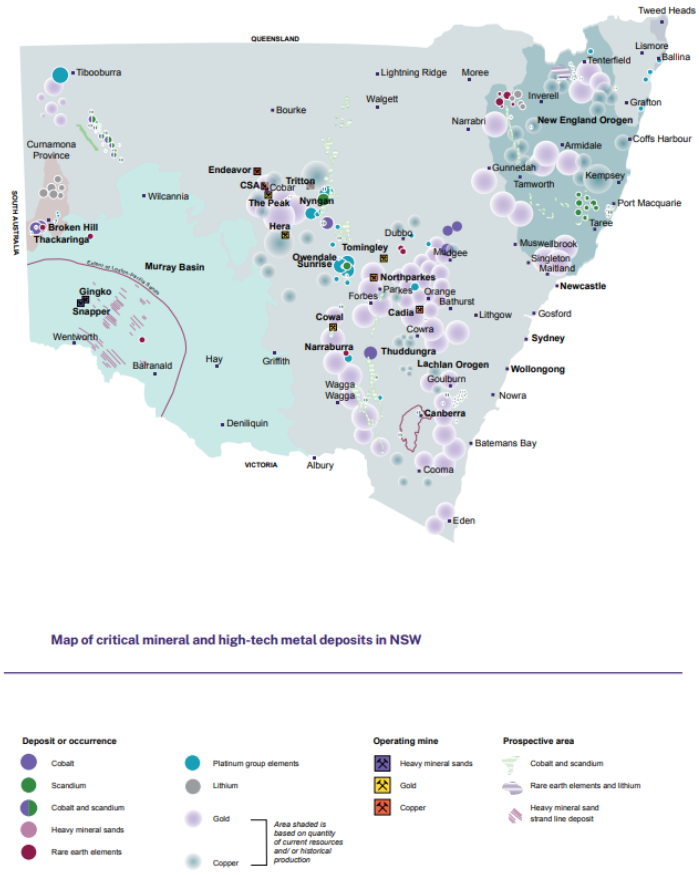

Figure 1.6 Critical mineral and high-tech deposits in NSW

1.3.5 Circular Economy Hub

A 169.47 ha area has been designated in the final structure plan as a 'Circular Economy Hub'. While circular economy principles should be embedded across all land use areas, the area designated for the Circular Economy Hub could be used for innovation or enabling activities for circular economy to thrive across the precinct, or for circular economy aligned tenancies that either are not captured by the other land uses or are additional to the developed tenancies in the other land uses. This could include:

- Collaboration and networking space – servicing the SAP and the wider business community in Narrabri and surrounds.
- Business concierge office – provision for a physical presence to host strategic appointments or activities. There is potential for this to be shared with Moree SAP business concierge, and/or to house educational displays or collateral (most critically these resources should be available online but could be brought to life by physical artefacts from the SAP).
- Reusable materials storage – physical storage facilities that can be used to house used products or materials in anticipation for their reuse. A key challenge in reusing products and materials is misaligned programs, where the right quality of material in the right quantity becomes available at the wrong time, or sufficient scale of materials for reuse has to be aggregated over time. Having storage space available can help to overcome this challenge.

- Innovation and research – provision for a physical space that could be developed in the future for R&D focused on circular products and services aligned with key industries in the SAP. For example, research on manufacturing recycled fabrics from textiles waste that could be processed in the precinct.
- A space dedicated for the sharing and repair economy servicing both businesses within and outside the SAP and the broader community, such as repair cafes and tool libraries. The sharing economy promotes reduced material consumption and increased material efficiency, provides incentives to extend the life of products, centralises control of products at their end of life to achieve higher order waste management outcomes, and in many cases supports upskilling labour and the community in product repair and maintenance.
- Education activities more broadly – focused on critical skills for SAP industries, including dedicated sustainability and circular economy modules so that these priorities become embedded across the workforce and decision makers over time.

1.4 Performance Measures

Performance measures to activate circular economy in the SAP are shown in the table below. These measures provide tangible goals to assess circular economy performance across lifecycle stages of the SAP, enable ongoing resource monitoring to identify and track improvements over time, and put in place strategic support and plans to activate partnerships and strengthen circular economy ambition for the SAP and its tenants overtime.

Table 1.1 Proposed Circular Economy Performance Measures

Performance criterion	Rationale	Lifecycle stage(s)	Scale(s)	Responsible stakeholder(s)
ISCA certification	Embeds circular economy design across several aspects of built infrastructure.	Planning, design, development, operations	Meso	Government agencies (e.g., Transport for NSW)
GBCA certification	Embeds circular economy design across several aspects of built structures.	Design, development, operations	Micro	Owners, developers, government agencies
NABERS Waste, Energy and Water Ratings	Encourages towards zero operational waste, emissions, and water recycling. Sets minimum standards for waste, energy and water consumption monitoring.	Operations	Micro	Tenants, owners
ISO 20400	Embeds circular economy and lifecycle thinking across the procurement of goods and services.	Design, development, operations	Meso, micro, nano	Tenants, owners, developers, precinct management, government agencies

Performance criterion	Rationale	Lifecycle stage(s)	Scale(s)	Responsible stakeholder(s)
Material and waste flow monitoring and reporting	Provides key evidence to underpin circular design decisions, measure the efficacy of operational improvements, and identify opportunities for industrial symbiosis.	Planning, design, operations, decommissioning	Meso, micro, nano	Tenants, owners, developers, precinct management
Circular Economy KPIs determined for the Business Concierge	Activates and monitors circularity maturity and outcomes across the SAP's lifecycle and at different scales. Could include KPIs related to awareness of circular economy among tenants, engagement in the collaboration/networking events, or number of collaborative partnerships in the SAP.	Planning, design, development, operations, decommissioning	Micro	Business Concierge
Circular Economy Strategy with targets for the SAP and tenants, updated every 3-5 years	Embeds circular economy into the operations, and strategic plans of the SAP and tenants. Underpinned by targets to drive tangible action, such as zero waste to landfill by 2030. Driven at the tenant level, and by the Business Concierge for the SAP.	Operations	Meso, micro	Business Concierge, Tenants, owners
Life Cycle Assessment and product-level sustainability certifications	Informs product and process design and material choices for low whole-of-life impact, verified by credible third-party certifications, such as Cradle to Cradle.	Design, operations	Meso, micro, nano	Tenants, owners, developers, precinct management

1.5 Circular Economy Opportunities for the Town and Residential Area

Circular economy principles can be applied within the town and residential areas to preserve value in the form of energy, labour and materials. Beyond the recommendations for circularity in the built environment in Section 1.2 and the recommendations provided in Section 5 of the Sustainability Report. for energy and water, there is also opportunity to embed circularity through strategies, systems and initiatives such as:

- **Setting the ambition and action plan for a zero-waste town** for example through adequate resource management infrastructure; facilitating business-to-business connections for material reuse; engaging with retailers; and community engagement and education to prompt a mindset and lifestyle shift that values resources.

- **Establishing a thriving secondhand market.** For residents, the provision and consumption of second-hand goods can be enhanced through platforms such as the Charitable Recyclers network, Gumtree, eBay, or Facebook Marketplace. There is also opportunity to leverage recommended features of the SAP's Circular Economy Hub such as the reusable materials storage and sharing economy services that facilitate reuse of materials for businesses and residents.

- **Renewable energy used** to power homes and businesses.

- **Council-led shared services** (building on the recommendation of shared services within **Section 1.3.5**). For example, council could provide financial or in-kind support for a tool library, or facilitate the availability of Product as a Service transport models for bikes and scooters.

At the time of preparing this report, the Narrabri Shire Council is in the process of developing a waste strategy which could be the mechanism through which some of the above initiatives are driven. However, these would also work as standalone initiatives to engage with, and create optimal outcomes for, community and businesses.

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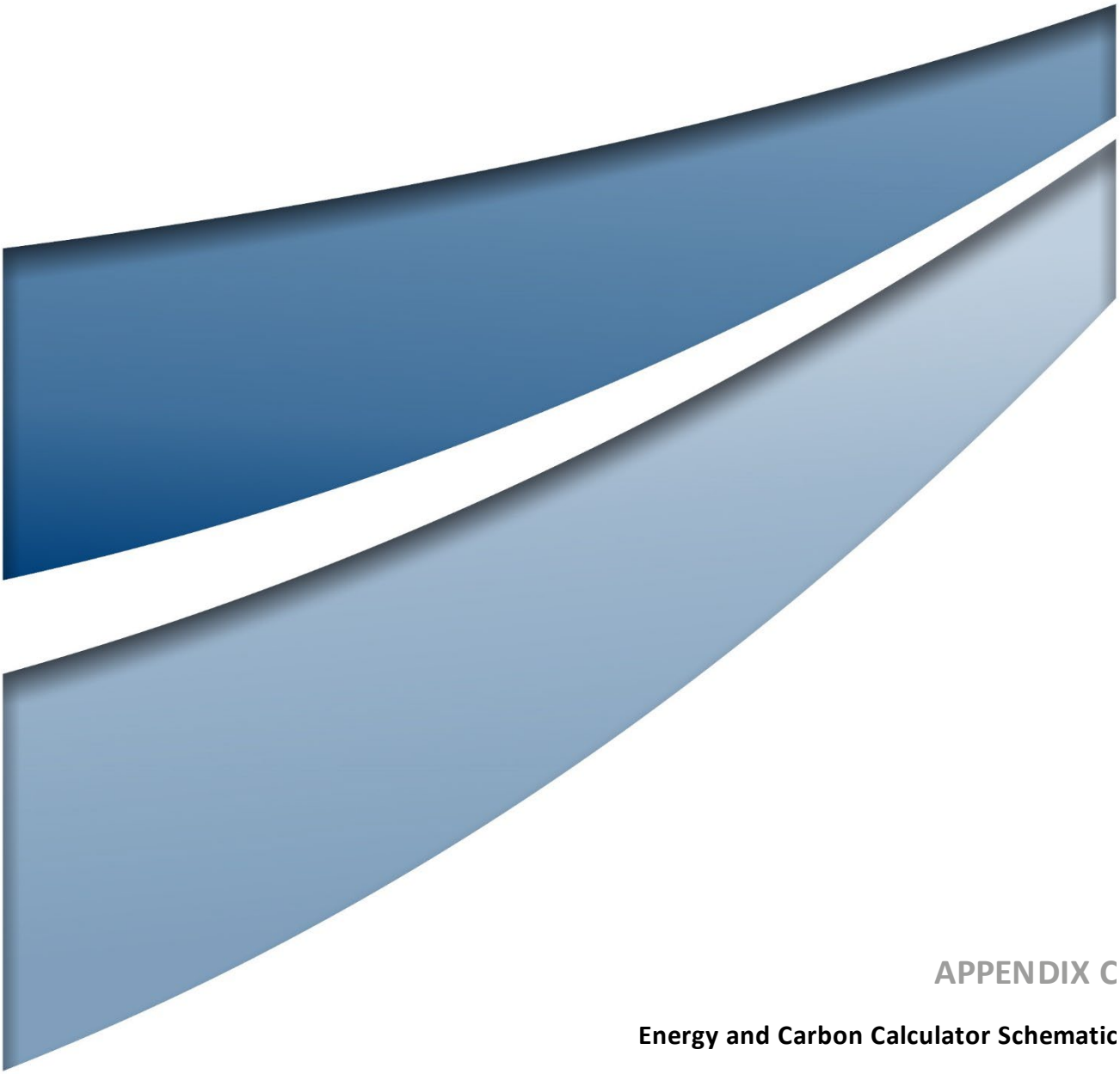


APPENDIX C

Energy and Carbon Calculator Schematic

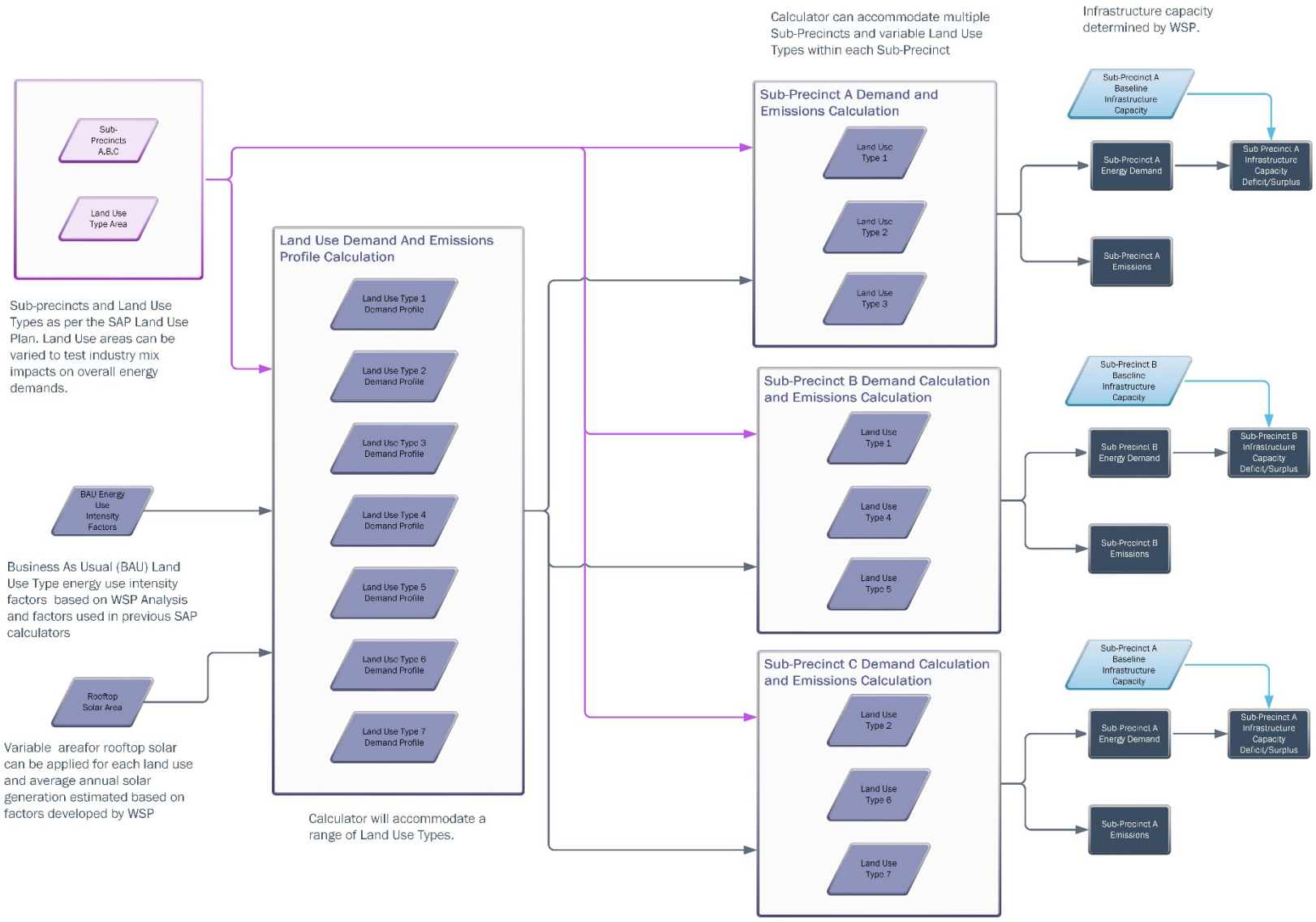
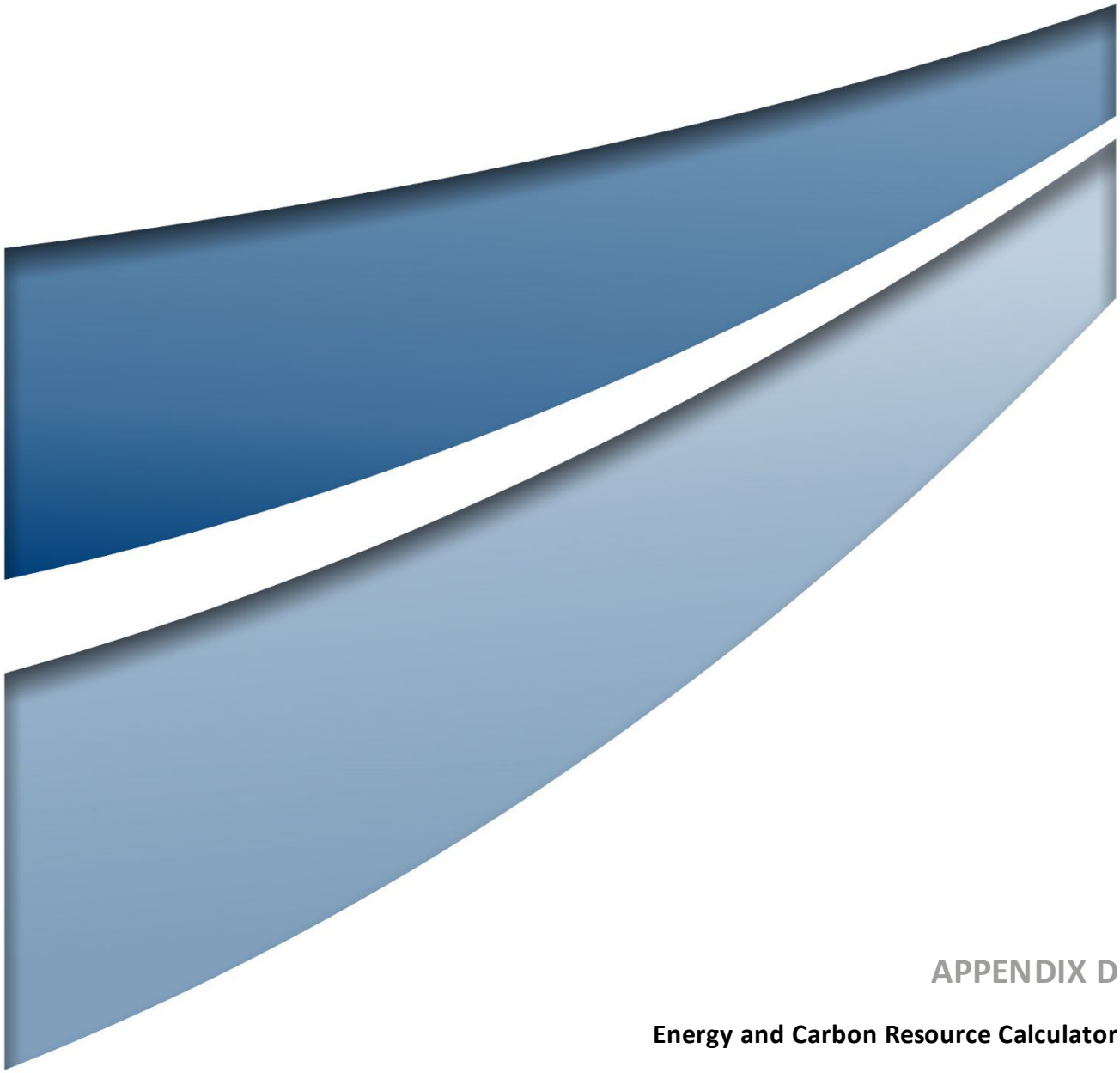


Figure 1.1 Energy and Carbon Calculator Schematic



APPENDIX D

Energy and Carbon Resource Calculator

Narrabri SAP Energy Calculator - Results Summary

Electricity (MWh/year)

Sub Precinct	Demand - Business as Usual (MWh/year)	Demand - Rooftop Solar Applied (MWh/year)	Demand - Rooftop Solar & Gas Electrification Applied (MWh/year)
Inland Port	2,368,406	2,245,289	2,245,289
Energy Hub	477,814	461,333	461,333
-	-	-	-
-	-	-	-
Precinct Total	**2,846,220**	**2,706,622**	**2,706,622**

Gas Demand (GJ/year)

Sub Precinct	Demand - Business as Usual (GJ/year)	Demand - Gas Electrification Applied (GJ/year)
Inland Port	7,274	7,274
Energy Hub	484	484
-	-	-
-	-	-
Precinct Total	**7758**	**7758**

Electricity by Land Use

Land Use	Demand - Business as Usual (MWh/year)	Demand - Rooftop Solar Applied (MWh/year)	Demand - Rooftop Solar & Gas Electrification Applied (MWh/year)
Commercial/Office Space	0	0	0
Transport & Logistics (non-refrigerated)	0	0	0
Transport & Logistics (refrigerated)	366825	354517	354517
Agriculture and Food Processing (low demand)	0	0	0
Agriculture and Food Processing (medium demand)	357299	336624	336624
Agriculture and Food Processing (high demand)	0	0	0
Manufacturing (low demand)	0	0	0
Manufacturing (medium demand)	285391	268877	268877
Manufacturing (high demand)	0	0	0
Bioproducts (low demand)	0	0	0
Bioproducts (medium demand)	160368	151088	151088
Bioproducts (high demand)	0	0	0
Waste Management & Recycling (low demand)	0	0	0
Waste Management & Recycling (medium demand)	370824	355803	355803
Waste Management & Recycling (high demand)	0	0	0
Circular Economy (low demand)	0	0	0
Circular Economy (medium demand)	666280	627726	627726
Circular Economy (high demand)	0	0	0
Hazardous Uses (low demand)	0	0	0
Hazardous Uses (medium demand)	75446	71081	71081
Hazardous Uses (high demand)	0	0	0
Light Industrial	0	0	0
Inland Port	246340	230661	230661
Energy	317446	310244	310244
Fertiliser & Chemicals	1835180	1785221	1785221

Gas by Land Use (GJ/year)

Land Use	Demand - Business as Usual (GJ/year)	Demand - Gas Electrification Applied (GJ/year)
Commercial/Office Space	0	0
Transport & Logistics (non-refrigerated)	0	0
Transport & Logistics (refrigerated)	1156	1156
Agriculture and Food Processing (low demand)	0	0
Agriculture and Food Processing (medium demand)	1079	1079
Agriculture and Food Processing (high demand)	0	0
Manufacturing (low demand)	0	0
Manufacturing (medium demand)	862	862
Manufacturing (high demand)	0	0
Bioproducts (low demand)	0	0
Bioproducts (medium demand)	484	484
Bioproducts (high demand)	0	0
Waste Management & Recycling (low demand)	0	0
Waste Management & Recycling (medium demand)	1120	1120
Waste Management & Recycling (high demand)	0	0
Circular Economy (low demand)	0	0
Circular Economy (medium demand)	2012	2012
Circular Economy (high demand)	0	0
Hazardous Uses (low demand)	0	0
Hazardous Uses (medium demand)	228	228
Hazardous Uses (high demand)	0	0
Light Industrial	0	0
Inland Port	818	818
Energy	0	0
Fertiliser & Chemicals	217232	217232

Total Emissions (TCO2-e/year)

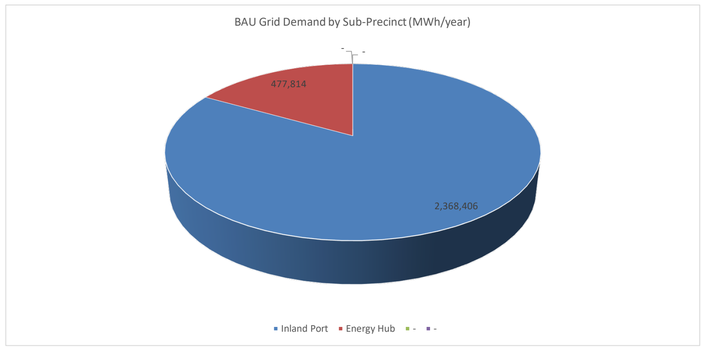
Sub Precinct	Emissions - BAU	Emissions - Rooftop Solar Applied	Emissions - Rooftop Solar & Gas Electrification Applied
Inland Port	1,910,258	1,810,976	1,810,976
Energy Hub	385,334	372,044	372,044
-	-	-	-
-	-	-	-
Precinct Total		**2,183,020**	**2,183,020**

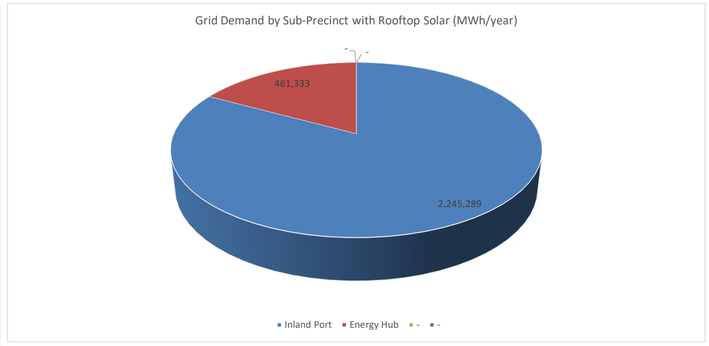
Total Emissions by Land Use (TCO2-e/year)

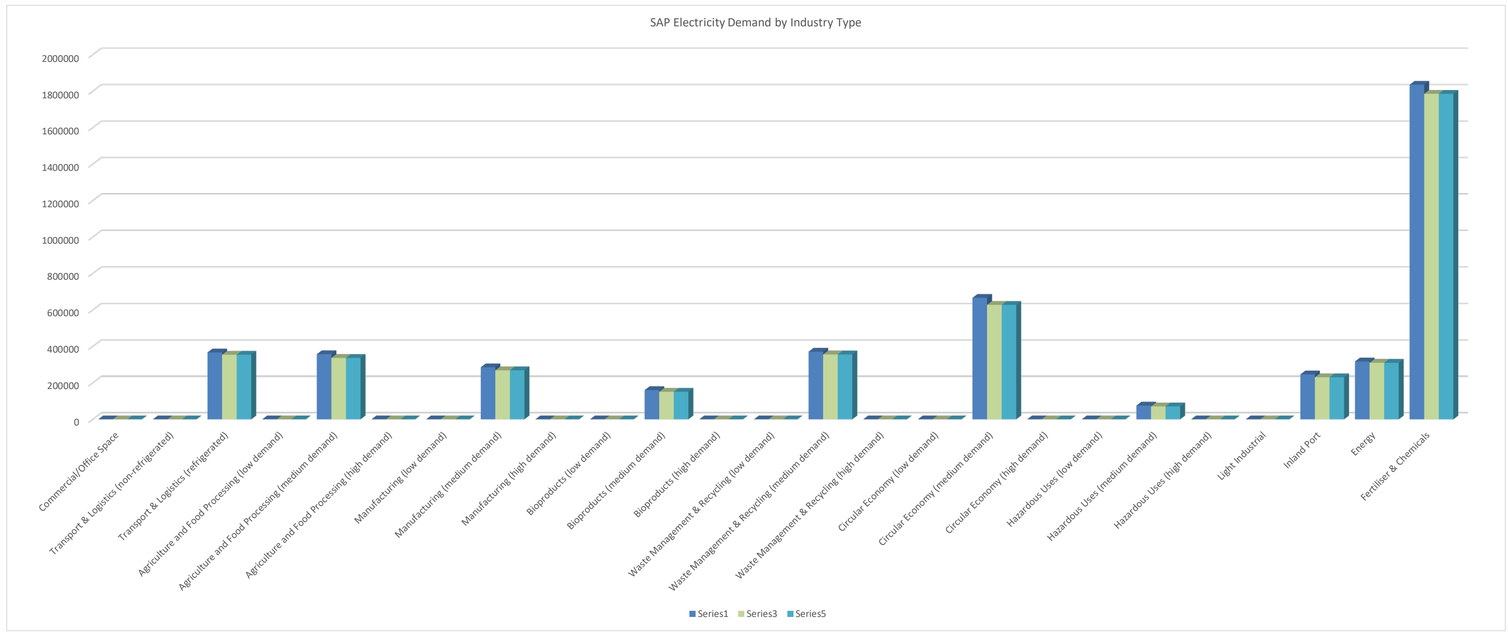
Land Use	Emissions - Business as Usual	Emissions - Rooftop Solar Applied	Emissions - Rooftop Solar & Gas Electrification Applied
Commercial/Office Space	0	0	0
Transport & Logistics (non-refrigerated)	0	0	0
Transport & Logistics (refrigerated)	295867	285942	285942
Agriculture and Food Processing (low demand)	0	0	0
Agriculture and Food Processing (medium demand)	288182	271509	271509
Agriculture and Food Processing (high demand)	0	0	0
Manufacturing (low demand)	0	0	0
Manufacturing (medium demand)	230184	216867	216867
Manufacturing (high demand)	0	0	0
Bioproducts (low demand)	0	0	0
Bioproducts (medium demand)	129346	121863	121863
Bioproducts (high demand)	0	0	0
Waste Management & Recycling (low demand)	0	0	0
Waste Management & Recycling (medium demand)	299090	286978	286978
Waste Management & Recycling (high demand)	0	0	0
Circular Economy (low demand)	0	0	0
Circular Economy (medium demand)	537392	506302	506302
Circular Economy (high demand)	0	0	0
Hazardous Uses (low demand)	0	0	0
Hazardous Uses (medium demand)	60852	57331	57331
Hazardous Uses (high demand)	0	0	0
Light Industrial	0	0	0
Inland Port	198691	186047	186047
Energy	255988	250181	250181
Fertiliser & Chemicals	1491083	1450796	1450796

Narrabri SAP - Electrical Energy Calculator Results

Electricity Demands

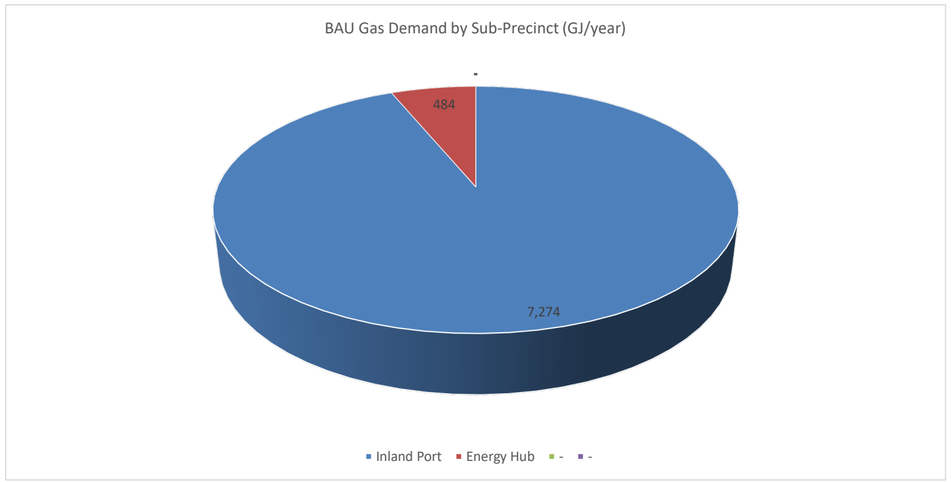


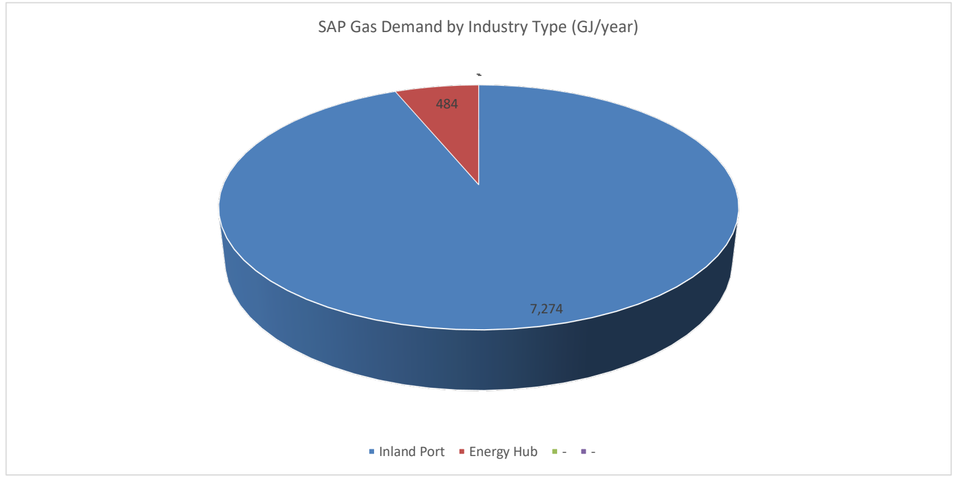


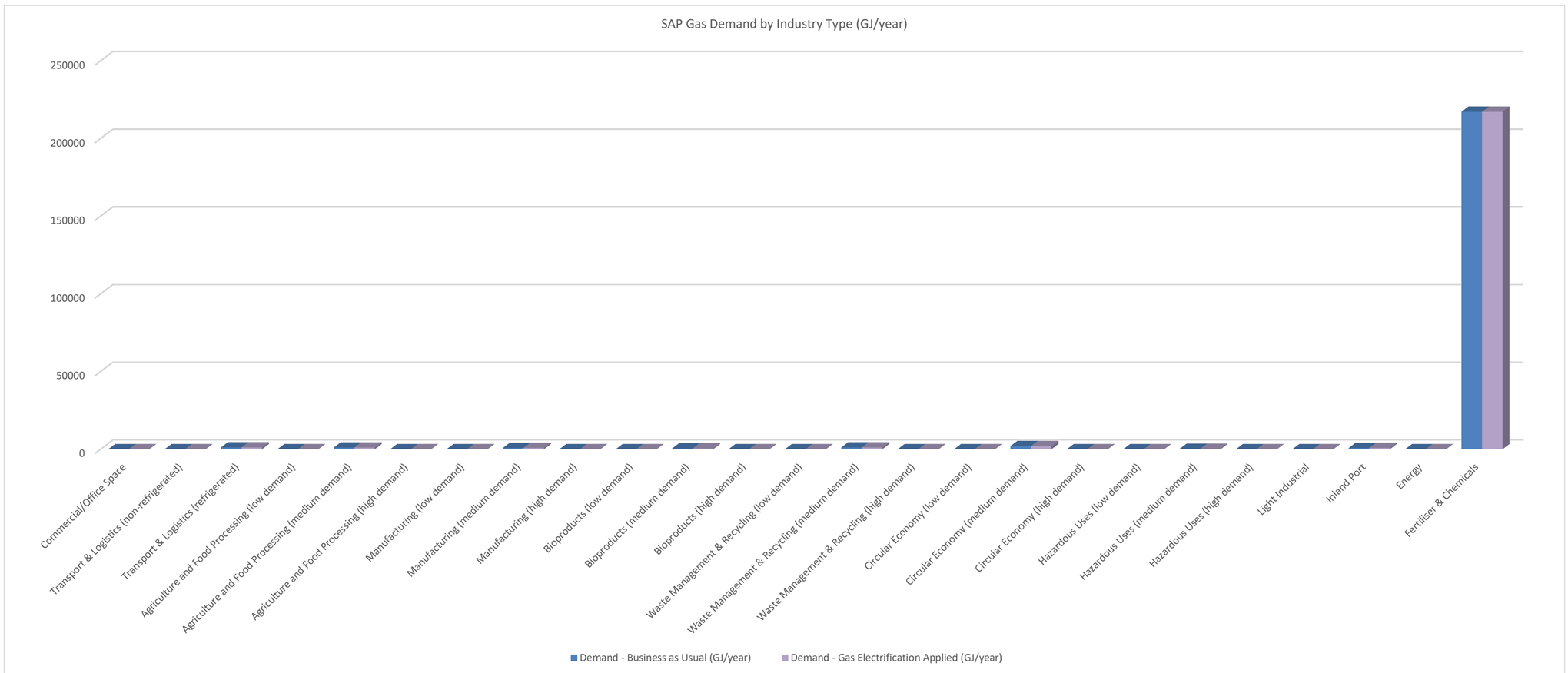


Narrabri SAP - Gas Energy Calculator Results

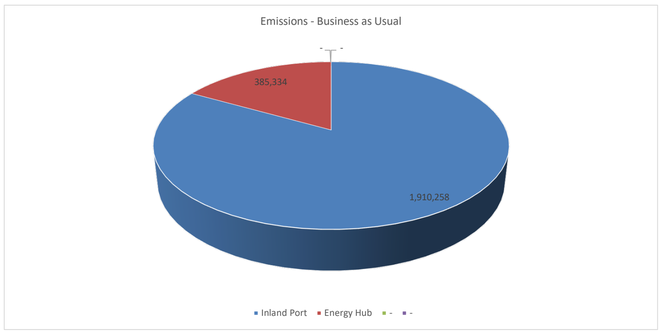
Gas Demands

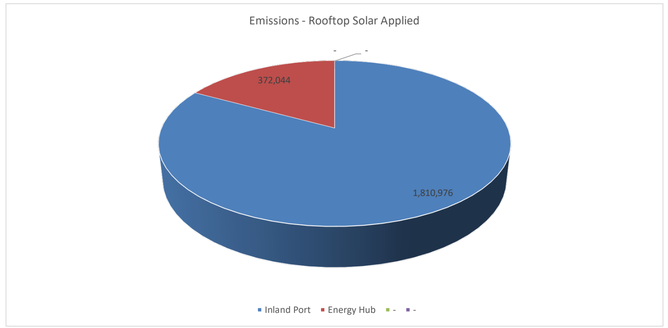


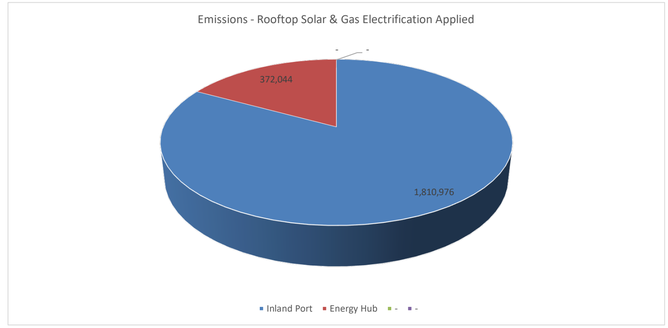


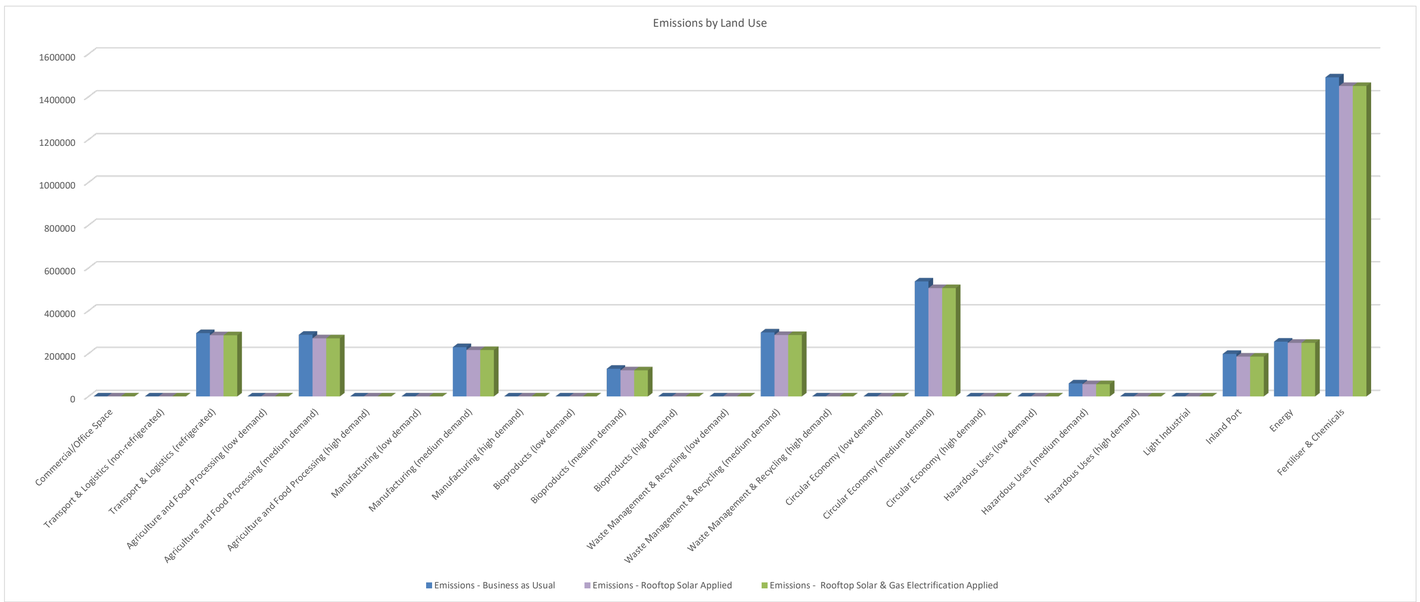


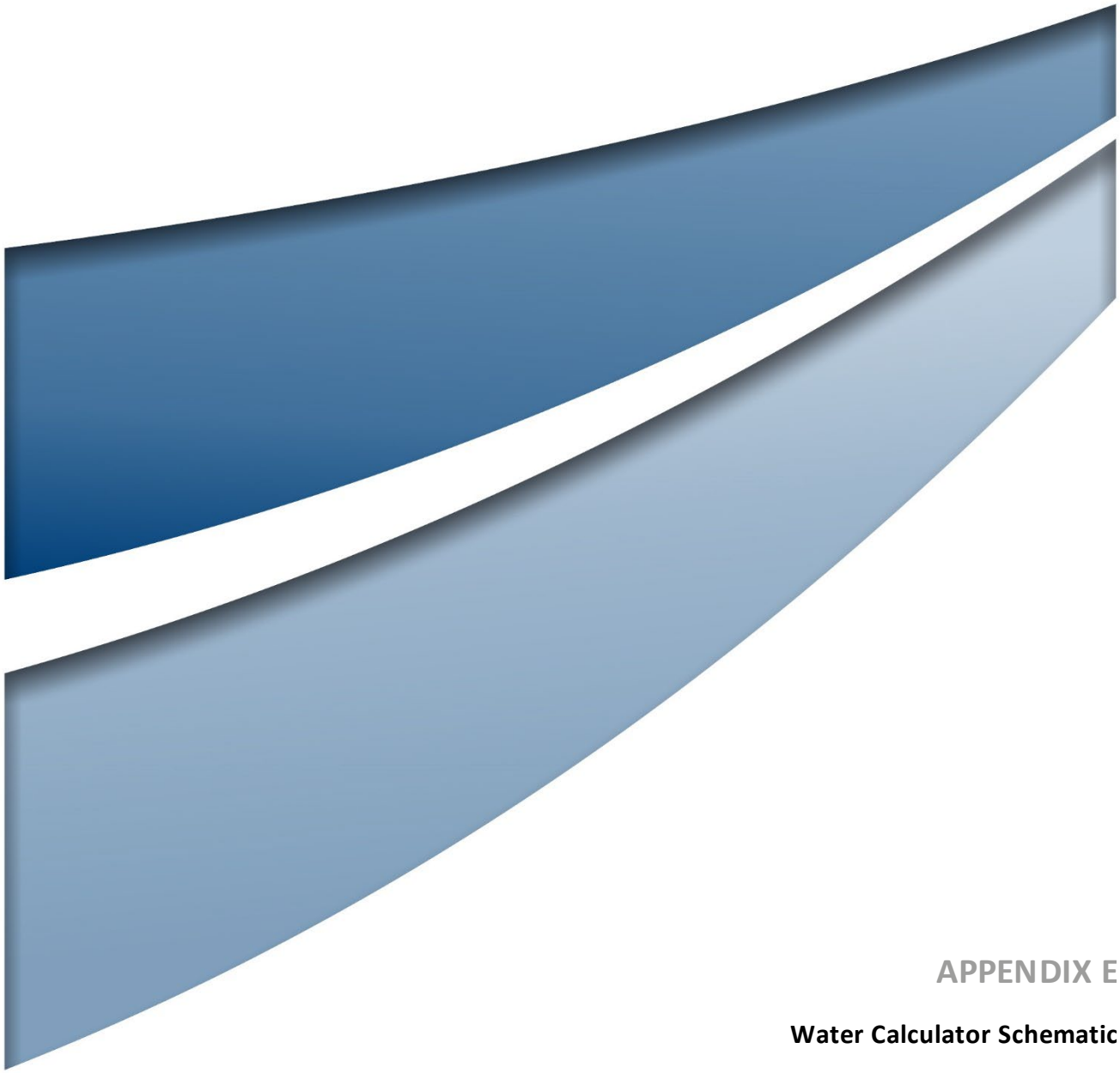
Narrabri SAP - Emissions Calculator Results











APPENDIX E

Water Calculator Schematic

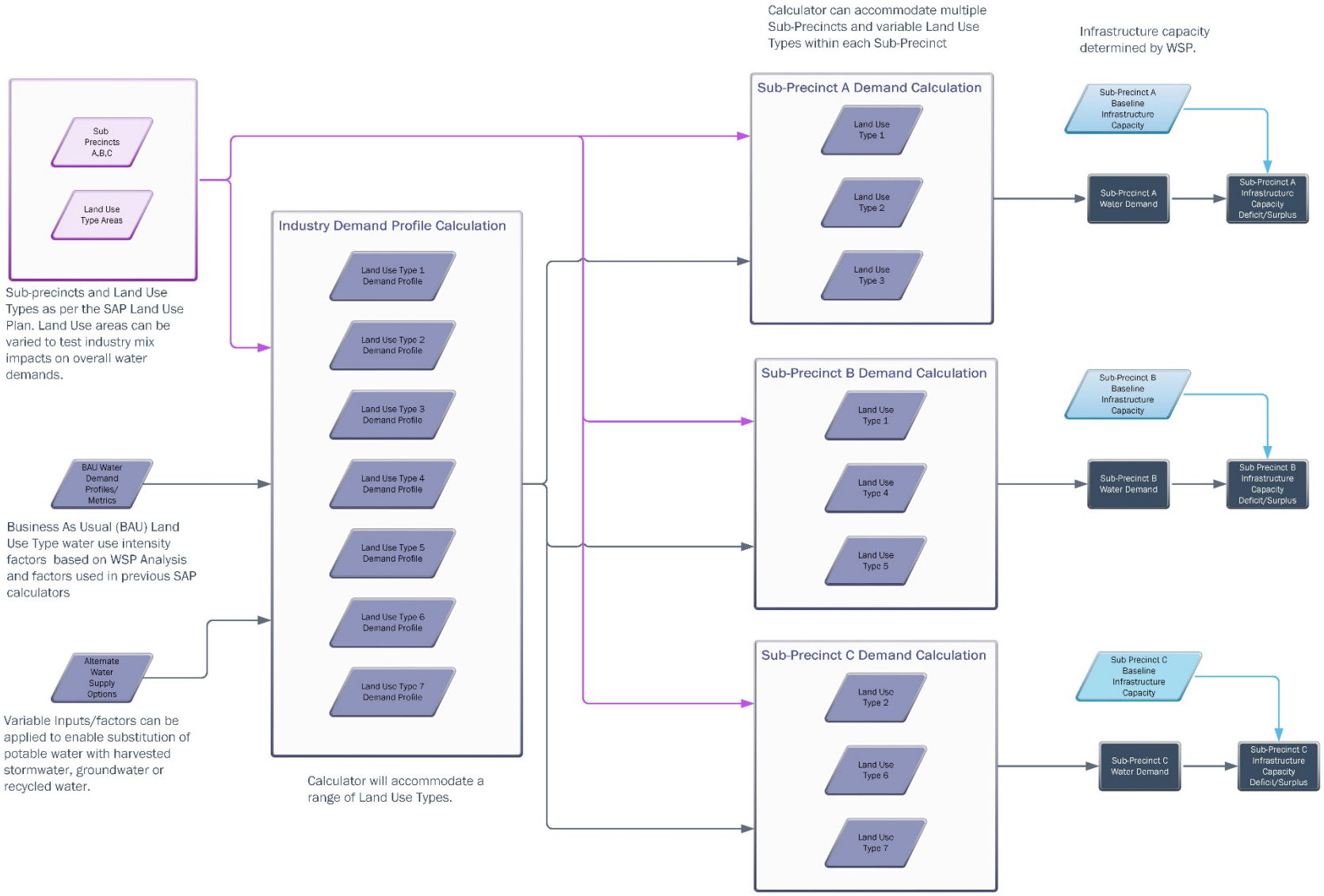
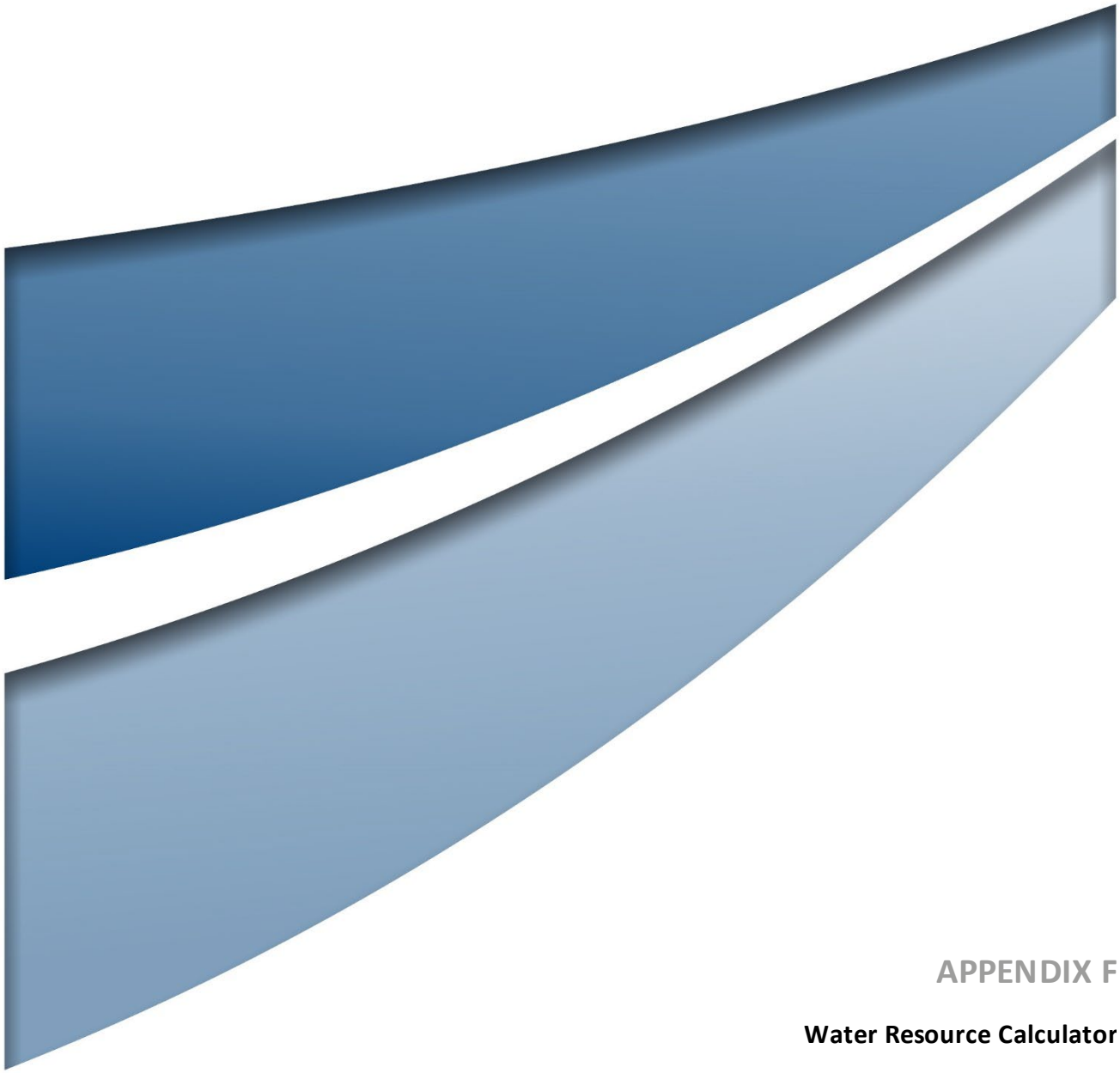


Figure 1.1 Water Calculator Schematic



APPENDIX F

Water Resource Calculator

Narrabri SAP Water Calculator - Results Summary

Water (ML/year)

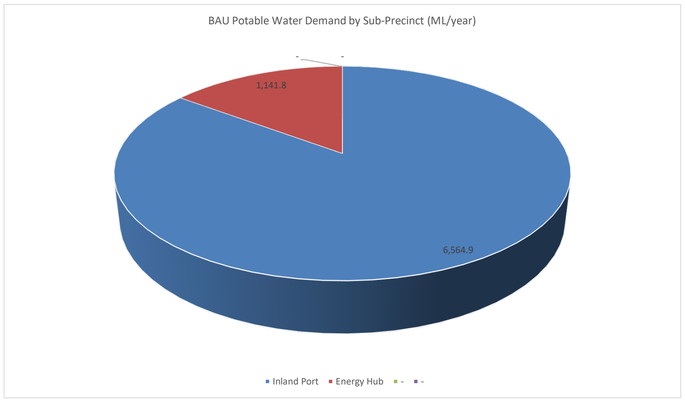
Sub Precinct	BAU Potable Demand (ML/year)	Net Potable Demand with Stormwater Harvest & Recycled Water/Groundwater Use (ML/year)	Stormwater Harvest & Recycled Water/Groundwater Use (ML/year)
Inland Port	6,564.9	1,641.2	4,923.7
Energy Hub	1,141.8	285.4	856.3
-	-	-	-
-	-	-	-
Precinct Total	7,706.7	1,926.7	5,780.0

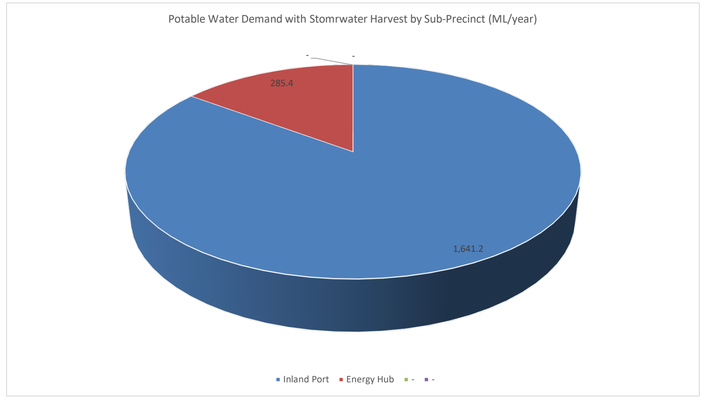
Water by Land Use

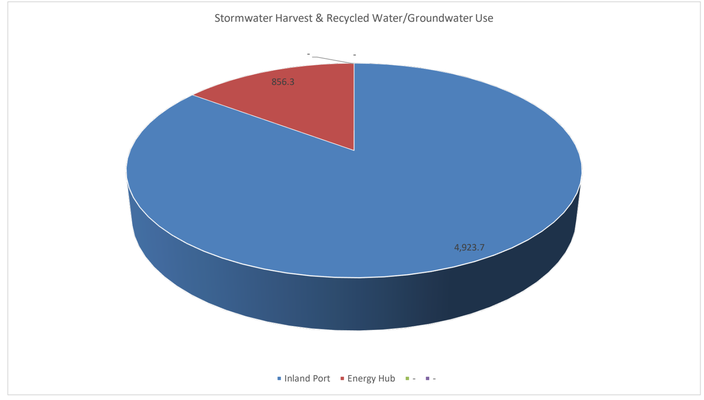
Land Use	BAU Potable Demand (ML/year)	Net Potable Demand with Stormwater Harvest & Recycled Water/Groundwater Use (ML/year)
Commercial/Office Space	-	-
Transport & Logistics (low demand)	-	-
Transport & Logistics (medium demand)	553.0	138.3
Agriculture and Food Processing (low demand)	-	-
Agriculture and Food Processing (medium demand)	-	-
Agriculture and Food Processing (high demand)	3,972.6	993.1
Manufacturing (low demand)	-	-
Manufacturing (medium demand)	371.0	92.8
Manufacturing (high demand)	-	-
Bioproducts	122.8	30.7
Waste Management & Recycling (low demand)	-	-
Waste Management & Recycling (medium demand)	351.8	87.9
Waste Management & Recycling (high demand)	-	-
Circular Economy (low demand)	-	-

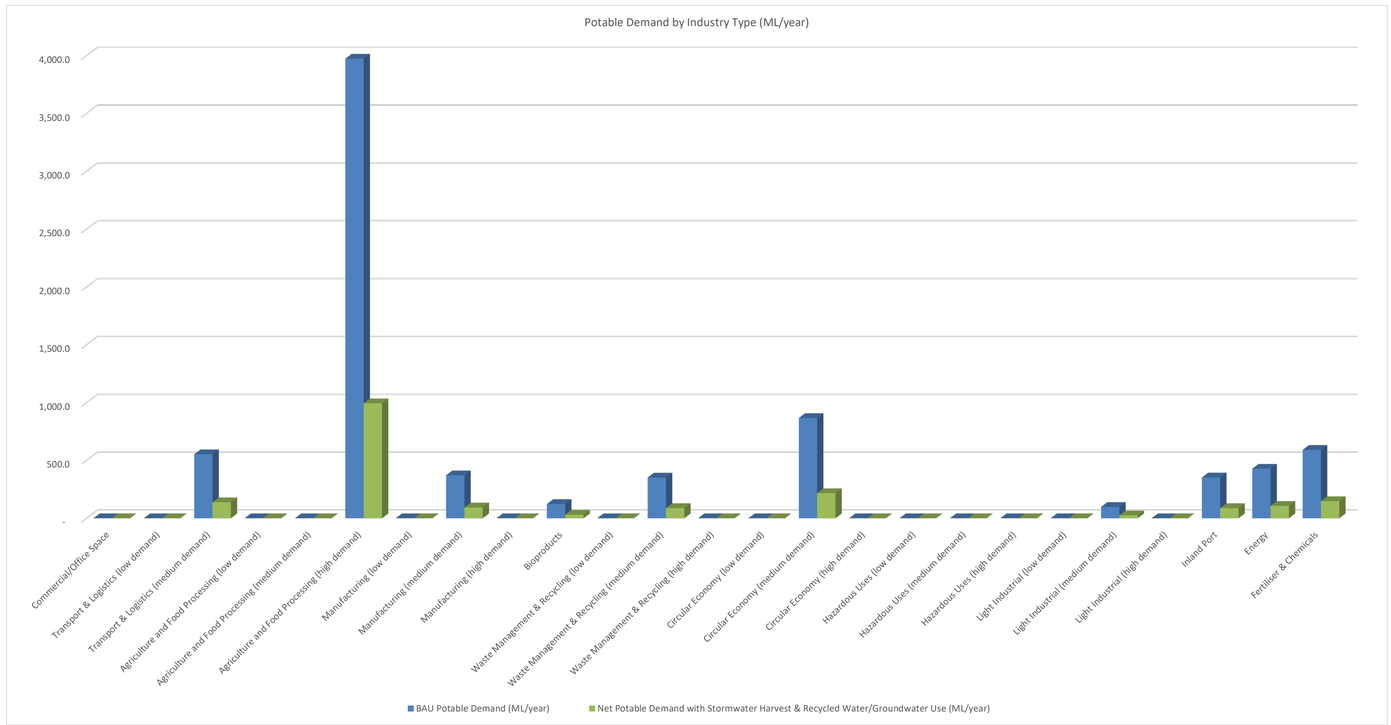
Circular Economy (medium demand)	866.2	216.5
Circular Economy (high demand)	-	-
Hazardous Uses (low demand)	-	-
Hazardous Uses (medium demand)	-	-
Hazardous Uses (high demand)	-	-
Light Industrial (low demand)	-	-
Light Industrial (medium demand)	98.1	24.5
Light Industrial (high demand)	-	-
Inland Port	352.3	88.1
Energy	427.8	107.0
Fertiliser & Chemicals	591.2	147.8

Narrabri SAP - Water Calculator Results









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