Initial Advice Statement

ZeroGen Pty Ltd

530 MW Integrated Gasification & Combined Cycle (IGCC) with pre-combustion capture and CO_2 transport and storage

Initial Advice Statement — ZeroGen

Contents

Table of Figures

1 Introduction

ZeroGen Pty Ltd (ZeroGen) was established by the Queensland Government to facilitate the development and accelerated deployment of low emissions coal technology to preserve the State's competitive position in power generation and continued mining, use and exports of its extensive coal resources.

Never before have integrated gasification combined cycle (IGCC) and carbon capture and storage (CCS) technologies been brought together in a commercial setting to generate low emissions electricity. ZeroGen is on track to become the first in the world to deploy at commercial scale, low emission baseload power generation with the capture and storage of its carbon dioxide emissions. To facilitate the development and deployment of low emissions technology, the Queensland Government, Australia's black coal industry through the Australian Coal Association Low Emissions Technologies Pty Ltd (ACALET) and Japan's Mitsubishi Corporation (MC) and Mitsubishi Heavy Industries (MHI), are jointly funding ZeroGen's extensive pre-feasibility study of this $4.3 billion project.

The prefeasibility study will determine the most suitable locations for the power plant and for the CO_2 sequestration. The study is expected to be completed mid 2010. It is ZeroGen's strong desire for the project to be located in Central Queensland and a number of sites are being investigated.

CCS is widely recognised as a crucial element in the global efforts to reduce CO_2 emissions from power generation and address climate change. Both the Intergovernmental Panel on Climate Change and the International Energy Agency (IEA) have identified CCS as a critical technology to stabilise atmospheric greenhouse gas concentrations in an economically efficient manner. The Energy Information Administration (EIA) predicts world electricity generation will increase by 77 percent from 2006 to 2030 and non-OECD or developing economies including China and India, will account for 58 percent of world power use in 2030. The report also confirmed coal will continue to be the dominant fuel source for electricity generation globally.

Climate Q, the Queensland Government's response to the challenge of climate change, also highlights the importance of CCS and a commitment to accelerating investments to develop and demonstrate the technology.

Mitsubishi Heavy Industries will provide ZeroGen with the IGCC and CO_2 capture technology for the project's power plant. This partnership significantly reduces the technology risk for ZeroGen. This has allowed the project to proceed directly to commercial scale, rather than an earlier planned demonstration phase, thereby accelerating the deployment of this new advance in power generation.

On 11 October 2008, the ZeroGen Board and stakeholders (including members of the Queensland Government, Australian Coal Association Low Emissions Technologies Pty Ltd and the Queensland Clean Coal Council) clarified the ZeroGen mission as follows:

> *To deploy a commercial scale low emissions coal fired power project incorporating IGCC with CCS in Queensland within the timeframe 2015–2017.*

ZeroGen completed and submitted a Scoping Study and Business Case for a commercial scale IGCC with CCS project for consideration by the Clean Coal Council in early December 2008. The Scoping Study is based on MHI's technology and the Northern Denison Trough for CO_2 storage.

The plant will be designed for the generation of 530 megawatts (gross) of electricity with an initial carbon capture level of 65 percent but with the design and ability to move to 90 percent carbon capture during the demonstration period. The CO_2 transport and distribution systems will be designed for a future upgrade to achieve a carbon capture level of 90 percent. At 65 percent capture, approximately two million tonnes per annum (tpa) of CO_2 will be captured and transported by pipeline from the IGCC site to the CO_2 storage basin and injected into deep underground reservoirs. (A capture rate of 90 percent will increase the CO_2 sequestration to approximately 3 million tpa.) While several storage basins are under consideration, the investigations in the Northern Denison Trough is the most advanced, and is proposed for this project. ZeroGen has transitioned greenhouse gas storage tenements (exploration) from existing Authority to Prospect tenures (granted under Petroleum and Gas legislation) where it was conducting drilling and geosequestration storage investigations. These transitioned tenements cover over 1225 km^2 in that basin and are currently the only greenhouse gas tenements granted in Queensland.

Following the Clean Coal Council meeting on 11 June 2009, ZeroGen was authorised to proceed with a Prefeasibility Study for the commercial scale IGCC with CCS.

The scope of work includes the conduct of initial engineering studies, site selection investigations, coal supply studies and negotiations, preliminary environmental studies, development of contracting strategies for the construction and delivery of plant and equipment, stakeholder engagement, the assessment of the carbon dioxide storage area and the formulation of capital and operating cost estimates.

Given the national and international significance of the ZeroGen project, ZeroGen is seeking significant project status under Section 26 of the *State Development Public Works Organisation Act 1971* (SDPWO) based on the information provided in this IAS (refer Process Description: International Significance of ZeroGen). Additionally the project will be applying for recognition as a "Controlled Action" within the meaning of the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* (EPBC).

ZeroGen is committed to the preparation of an Environmental Impact Statement (EIS) as part of its obligations under both the SDPWO and the EPBC and has prepared this Initial Advice Statement to identify the items for consideration when developing a Terms of Reference for publication of the EIS.

The EIS for the project will be completed in accordance with the bilateral agreement between the Queensland and Commonwealth Governments which ratifies the SDPWO process for allowing a single EIS process.

The technology pathway that ZeroGen project presents offers significant long term benefits for the use of Queensland Coal in a carbon constrained world with additional social and environmental benefits. Construction impacts are expected to be commensurate with the construction of other black coal plants of similar size.

This IAS provides information and background material on the company, the project, and its likely effects and impacts on the environmental, social and economic values of the host region, including employment, emissions and the strategic global significance of the project.

2 State Development Public Works Organisation Act 1971

This Act provides a pathway for co-ordinating the EIS and approvals process for designated "Significant Projects". ZeroGen is applying for Significant Project status for the project. This IAS is prepared to provide information for consideration by the Co-ordinator General when making the decision under this Act.

The SDPWO identifies items that the Co-ordinator General must consider including:

- <u>IAS and the material submitted by the proponent</u> in relation to the nature of, reason for and potential impacts of the project.

- Planning Schemes and policy framework for the local authority areas and government agencies/policies including:
  - Queensland Government's Clean Coal Council; and
  - Queensland Government's Greenhouse Strategy.
- Potential effect on relevant infrastructure. ZeroGen will require access to water, and the electricity network and other state and local infrastructure providers such as Powerlink, Queensland Rail, Main Roads, Telstra, Water and Catchment Management authorities, local government to construct and operate the plant. Additionally, ZeroGen is evaluating gas as a potential start up fuel. In the event that gas is selected as a start up fuel then ZeroGen will require access to supply infrastructure.
- Employment Opportunities. The commercial-scale plant will provide a significant boost to the economy through the direct creation of at least 2,000 jobs during construction, and 200 jobs in the operational phase. Indirect employment will be consequently increased within the local and regional areas. Over the long term, this project will help ensure the ongoing viability of the Queensland coal industry, which is an important employer and component of the Queensland economy.
- Potential Environmental Effects. ZeroGen is likely to have a range of impacts on the local and regional environmental values including air quality, noise environment, surface and groundwaters, waste disposal, ecological process and ecosystems. ZeroGen will provide a development pathway for a low emissions future for the coal-fired electricity sector through the capture and sequestration of carbon and the consequential reduction of CO_2 and other emissions from power generation.
- Complexity of local, State and Australian Government requirements. ZeroGen will be involved in dealings with a number government agencies and departments including
  - Queensland Government
    - Department of Infrastructure and Planning
    - Department of Premier and Cabinet
    - Department of Communities
    - Department of Education and Training
    - Department of Employment, Economic Development and Innovation
    - Department of Environment and Resource Management
    - Queensland Police
    - Department of Transport and Main Roads
  - Four Local Authorities
    - Central Highlands Regional Council;
    - Banana Shire Council;
    - Isaac Regional Council; and
    - Woorabinda Shire Council;
  - Australian Government
    - Department of Resources, Energy and Tourism
    - Department of Environment, Water Heritage, and Arts
    - Department of Climate Change
    - Department of Prime Minister and Cabinet
    - Geosciences Australia

The project will require co-ordination across government departments at local, state and federal government level during the evaluation of the EIS and subsequent development of conditions of approval.

The Commonwealth Government will be involved in the approvals process through the interface with the EPBC and the use of the bilateral process for evaluation as enabled by the SDPWO will reduce the time taken for approvals and permitting of the project.

- Investment requirements. Funding partners for the commercial-scale project currently include the Queensland Government, ACALET, MC and MHI. It has attracted further interest from foreign investors, both private and industry. An application has been made for Australian Government funding under its Clean Energy Initiative through the CCS Flagship program and there is potential for investment by the Government of Japan.
- Strategic Significance of the Project. ZeroGen is a project of International significance, and has attracted considerable international attention, including recent recognition as one of the most important CCS projects in the world. The nomination was made by the Carbon Sequestration Leadership Forum which comprises Ministers from 22 sovereign nations (representing 60 percent of the world's population).

  The technology which ZeroGen proposes offers the potential for significant reduction in greenhouse gas emissions from the coal-fired power generation sector of the economy. There are significant strategic advantages in being able to de-couple the carbon emissions from Australia's low-cost reliable base load electricity generation especially in relation to preserving a viable export industry (coal) and supporting industry (especially the aluminium and minerals processing sector) as well as the general community with reliable energy supplies. Additionally ZeroGen provides a viable pathway to the hydrogen economy by providing a mechanism for the production of hydrogen from an abundant feedstock (i.e. coal).

Process Description: International Significance

ZeroGen is a project of world significance as part of the national and international collaborative effort to accelerate the deployment of low emission technologies.

CCS is widely recognised as a crucial element in the global efforts to reduce CO_2 emissions from power generation and address climate change. Both the Intergovernmental Panel on Climate Change and the International Energy Agency has identified CCS as a critical technology to stabilise atmospheric greenhouse gas concentrations in an economically efficient manner.

The Carbon Sequestration Leadership Forum, of which Australia is a member has recognised the project as one of the most important Carbon Capture and Storage projects in the world and it is one of the 10 new projects now added to the existing CSLF portfolio of Research and Developments projects.

The International Energy Outlook 2009, issued by the Energy Information Administration (EIA) predicts world electricity generation will increase by 77 percent from 2006 to 2030 and non-OECD or developing economies including China and India, will account for 58 percent of world power use in 2030. The report also confirmed coal will continue to be the dominant fuel source for electricity generation globally.

Climate Q, the Queensland Government's response to the challenge of climate change, also highlights the importance of CCS and a commitment to accelerating investments to develop and demonstrate the technology.

The International Energy Agency's recently released CCS Technology Roadmap envisions 100 CCS projects globally by 2020. This report says CCS is the only technology available to mitigate greenhouse gas emissions from large scale fossil fuel usage in fuel transformation, industry and power generation.

The IEA says OECD governments will need to increase funding for CCS demonstration projects to an annual level of USD 3.5 – 4 billion from 2010 to 2020.

The IEA Executive Director, Nobuo Tanaka is on record saying:

> "Now is the time for CCS. If we do not develop several large scale integrated CCS demonstration projects within the next decade, we won't be able to deploy the technology in time to prevent CO2 levels from exceeding allowable limits."

3 ZeroGen Overview

ZeroGen is a wholly owned Queensland Government company, with an independent board of directors, CEO and management. Its primary purpose is to deploy a commercial-scale low-emissions coal fired power project incorporating integrated gasification combined cycle (IGCC) (refer below for process description) with carbon capture and storage (CCS) in Queensland by 2015. Although ZeroGen is currently owned by the Queensland Government the final organisational structure will be negotiated and agreed upon by ZeroGen, the Queensland Government, ACALET, Mitsubishi Corporation and Mitsubishi Heavy Industries and other project parties. It is the intention of the current project parties (ZeroGen, the Queensland Government, ACALET, Mitsubishi Corporation and Mitsubishi Heavy Industries) that a Joint Venture Agreement will be entered into with other project parties to govern the relationships between the parties in carrying out the IGCC with CCS project.

ZeroGen commenced operations as a discrete entity in 2006 and has been active in the development of IGCC and CCS in Queensland. Initially ZeroGen proposed a demonstration scale IGCC with CCS in the Rockhampton Regional Council area before re-configuring the project into the current commercial scale proposal. In December 2007 ZeroGen was advised of a strong sentiment amongst direct stakeholders to accelerate development of commercial scale IGCC with CCS. In response, ZeroGen undertook a review of the parameters and risks associated with accelerated development of IGCC with CCS and reconfigured the project parameters accordingly, producing a scoping study in December 2008. The Clean Coal Council considered the scoping study and gave ZeroGen approval to proceed to a prefeasibility study based on the revised project. This IAS incorporates the revised project. The demonstration scale project, based near Rockhampton, was withdrawn and no longer forms part of ZeroGen's business model.

ZeroGen holds greenhouse gas exploration permits, which were transitioned to ZeroGen under the *Greenhouse Gas Storage Act 2009*, in the Northern Denison Trough (refer Figure 4-5) from existing Authority to Prospect tenements (issued under Petroleum and Gas legislation) that ZeroGen was using to conduct exploration activities. Twelve exploratory wells have been drilled as part of an investigation for a storage reservoir for CO_2 of sufficient size to sequester the CO_2 captured from the IGCC plant (refer below).

ZeroGen's objectives are:

- prove the effectiveness, safety and permanence of CO_2 geosequestration;
- validate the engineering, economic and environmental viability of advanced, coal-based, low-emission technologies so that technological risk should not be an impediment to the bankability of similar projects;
- document the minimum standards, codes of practices and specification for use in future deployment of the technology;
- standardise technologies and protocols for CO_2 injection measuring, monitoring and verification; and
- commence operation late 2015.

The stated development timeline for achievement of these objectives is outlined in Table 3-1. A critical component of the drilling program conducted by ZeroGen is to progress field exploration and technical investigations to determine, to at least a P_{50} confidence level for a transport and storage cost of less than \$50 per tonne by the end of Q1 2010. If transport and storage cost is P_{50} less than \$50 per tonne at completion of the prefeasibility study then the storage option will progress to the feasibility study phase.

Table 3-1: Implementation Plan for Commercial-scale Plant

Activity	Planned completion	Status
Concept/scoping study	November 2008 to May 2009	Complete
Clean Coal Council approval to proceed to prefeasibility	June 2009	Complete
Pre-feasibility	June 2009 to September 2010	Commenced
Feasibility/financial close	October 2010 to December 2011	Pending
Construction	January 2012 to September 2015	Pending
Commercial demonstration phase (operational)	September 2015 to September 2019	Pending
Full commercial operations	from 2020	Pending

The submission of an Initial Advice Statement, together with any Declaration of ZeroGen as a Significant Project, and a Controlled Action and the issue of a Terms of Reference for an Environmental Impact Study are prefeasibility study elements. Undertaking and publishing an Environmental Impact Statement and negotiation of applicable conditions of approval are elements of the feasibility study.

4 Project Overview

The commercial scale plant consists of four main elements:

- an IGCC 530 MW (gross) power generation plant with carbon capture;
- corridors for pipelines to transport liquid and gaseous inputs and CO_2 outputs;
- a corridor for powerlines to connect to the National Electricity Market via the Queensland power grid; and
- a geosequestration field including injection wells and associated infrastructure.

Construction of the facility is projected to begin in January 2012. The project is likely to directly employ up to 2000 workers across a number of skills and trades. ZeroGen anticipates that these workers will be housed in one or more construction camps to be established within the study area. These construction camps may be tailored towards specific elements of the construction program, for example one camp may house the employees constructing the IGCC and associated works on the power plant site and one camp housing the pipeline construction crews established along a pipeline route. The direct employment of 2000 personnel during construction will have consequential benefits in the surrounding community and is likely to result in substantial indirect employment. At this stage it is not possible to quantify the indirect benefit although this is expected to be completed during feasibility study and presented in the Environmental Impact Statement.

There are a number of sub-elements contained within the main plant elements. These are discussed in detail within each section.

4.1 Project Overview – IGCC

ZeroGen's IGCC is based on the MHI air-blown gasifier. This process was selected following a review of available gasification technology, conducted by ZeroGen in 2008. The MHI technology is expected to offer efficiency and availability benefits over other gasification designs. This gasification process will use Queensland black thermal coal feedstock and air which has been oxygen enriched to produce a high hydrogen synthetic gas (syngas).

Coal gasification is a process which produces a hydrogen rich syngas through the chemical conversion of coal. Although the hydrogen rich syngas can be used in a variety of downstream processes, ZeroGen will use it to generate base load electricity using a combined cycle gas turbine (refer explanatory text below). The production of hydrogen rich syngas coincidentally produces carbon dioxide, the majority of which can be captured from the mixed gas stream during the process. Captured carbon dioxide can be separated from hydrogen rich syngas by passing the mixed gas stream through solvents which preferentially capture the CO_2.

The captured CO_2 will be recovered from the solvents, dehydrated, compressed and transported for geological storage. The regenerated solvent will be recirculated through the capture plant multiple times. The amount of carbon dioxide captured will initially be 65 percent of the total CO_2 in the mixed gas stream, with a plant footprint capable of supporting a 90 percent capture. ZeroGen will move to a capture level of 90 percent during the operational life of the power plant.

Following removal of the carbon dioxide the hydrogen rich syngas is routed to a gas turbine where it is combusted and produces electricity through a two stage process referred to as combined cycle. The emission of carbon dioxide is reduced during power production through the removal of CO_2 from the syngas stream prior to combustion (a process known as pre-combustion capture).

The gross capacity of the IGCC plant is 530MW and the net capacity is 400MW. The IGCC plant site will require approximately 100 hectares including the location of the power plant, associated civil works such as dams, truck loading/unloading areas, car parks, slag disposal (if reuse is not possible).

Details of the project parameters are summarised in Table 4-1 below.

Table 4-1: Project parameter summary (approximate)

Project Element	Parameter	Units	Size
ZeroGen Project	Capital cost	$A(bn)	4.3
	Direct jobs (construction)		2,000
	Direct jobs (operation)		200+
	Indirect jobs		tba
IGCC	Output (gross)	megawatts (MW)	530
	Output (nett)	MW	400
	Coal consumption	tpa	1,500,000
	Water Consumption	megalitres per day	8
	Slag Production	tpa	140,000
	Start up Fuel (distillate)	tonnes per start	1500
	Start up fuel (natural gas) [a]	terajoules per start	50
	Sulphuric acid production	tpa	17,000
	CO_2 capture	tpa	2,000,000
	NO_x emission	ppm	75
	Approx Emission intensity (65% capture)	CO_2ekg/MW	350
	Approx Emission intensity (90% capture)	CO_2ekg/MW	100
	Design operational life	years	25
	Land area required	ha	100
CO_2 Pipeline	Length	km	TBA [b]
	Diameter	mm	500
	Pressure	MPa	15
CO_2 Sequestration	Injection pressure	MPa	TBA [c]
	CO_2 monitoring		TBA [d]

a: Natural Gas will be investigated as an optional start up fuel during the feasibility study.
b: To be determined through route selection during the feasibility phase.
c: To be confirmed from injection trials scheduled to commence in Q4 2009.
d: Monitoring of injected CO_2 will be undertaken with a range of technologies to be evaluated.

Sub-elements of the IGCC plant include (refer Figure 4-1)

- Air Separation Unit which separates the nitrogen and oxygen in the atmosphere using conventional cryogenic technology. The nitrogen is used in the coal/char feeding system and the oxygen to enrich the air used in the gasification process.
- Coal grinding, drying and feeding system similar to units used in conventional electricity generation using pulverised coal. The coal is crushed to a fine powder (approximately the same size as talcum powder), dried using waste heat from within the plant and conveyed into hoppers before being feed into the gasifier
- Gasifier combines coal and oxygen enriched air with steam under high pressure and temperature. The purpose of gasification is partial oxidation of the coal which is achieved through controlling the amount of oxygen relative to the coal. Only a small portion of the coal combusts during the gasification process.
- The chemical reactions which occur in the gasifier produce syngas (at this stage predominately comprising hydrogen (H_2) and carbon monoxide (CO), with a small amount of Carbon Dioxide (CO_2). Sulphur in the coal is reduced to hydrogen sulphide (H_2S) and partially oxidised organic species such as carbonyl sulphide and some organic nitrite compounds from reactions between carbon and nitrogen.

- Shift reactor includes a scrubber, the shift reactor and gas cleaning elements to further refine the syngas and remove impurities (for example carbonyl sulphide is oxidised to CO_2 and hydrogen sulphide and the organic nitrites are reacted to CO_2 and ammonia (NH_3)). The primary purpose of the shift reactor is to increase the syngas yield through reacting carbon monoxide with steam producing CO_2 and H_2. The output of the shift reactor is primarily CO_2, H_2, NH_3 and H_2S.
- SELEXOL™ unit removes the H_2S and most of the CO_2 from the syngas stream. The H_2S stream from the SELEXOL™ unit will be further reacted to sulphuric acid for subsequent sale. The CO_2 stream from the SELEXOL™ unit is treated to remove water before being compressed and transported to the sequestration field (expected to be in the vicinity of the Northern Denison Trough). The carbon dioxide stream is expected to be >95 percent CO_2 with traces of other gases. The cleaned, hydrogen rich syngas will be sent to the combined cycle power plant for power production.
- CO_2 dehydration and compression unit prepares the captured CO_2 for sequestration through removal of water and establishing the correct combination or temperature and pressure necessary to transport the gas to the sequestration area via a dedicated pipeline.
- Flare to control risks in the event of a plant trip. Under these conditions, gases from the various sub-elements of the plant will be sent to the flare for destruction.
- Ancillary equipment, including:
  - water treatment plants to treat raw water into a number of process waters at particular quality requirements (e.g. demineralised water for boiler feed, potable water for domestic consumption, or fire fighting). The plant is designed to be zero process water discharge.
  - storm water treatment systems to collect and treat site storm waters (e.g. from roofs). This water may be harvested for reuse or released as part of environmental flows.
  - dirty drains systems (for process waters and waters that may be potentially contaminated). Note that ZeroGen will be configured as a zero process water discharge site.
  - sewage treatment facilities for waste waters from ablution areas and similar.
  - storage tanks for startup fuels (such as diesel), or for resale products (e.g. sulphuric acid) with loading/unloading facilities.
  - coal handling facilities which may include either/or conveyor belts and rail facilities, depending on the location and method of delivery. The preferred option shall be determined during feasibility study activities.
  - slag handling for onsite storage or load out for resale.
  - flux handling depending on the properties of the ash in the coal it may be necessary to add a flux to improve slagging characteristics or handling. The flux, if required, will be limestone, and will require handling and storage on the gasifier site.
  - transformers and switchyards to condition and synchronise the power for transmission to the Queensland Power Grid.

Schematically the ZeroGen IGCC plant is shown in Figure 4-1 below

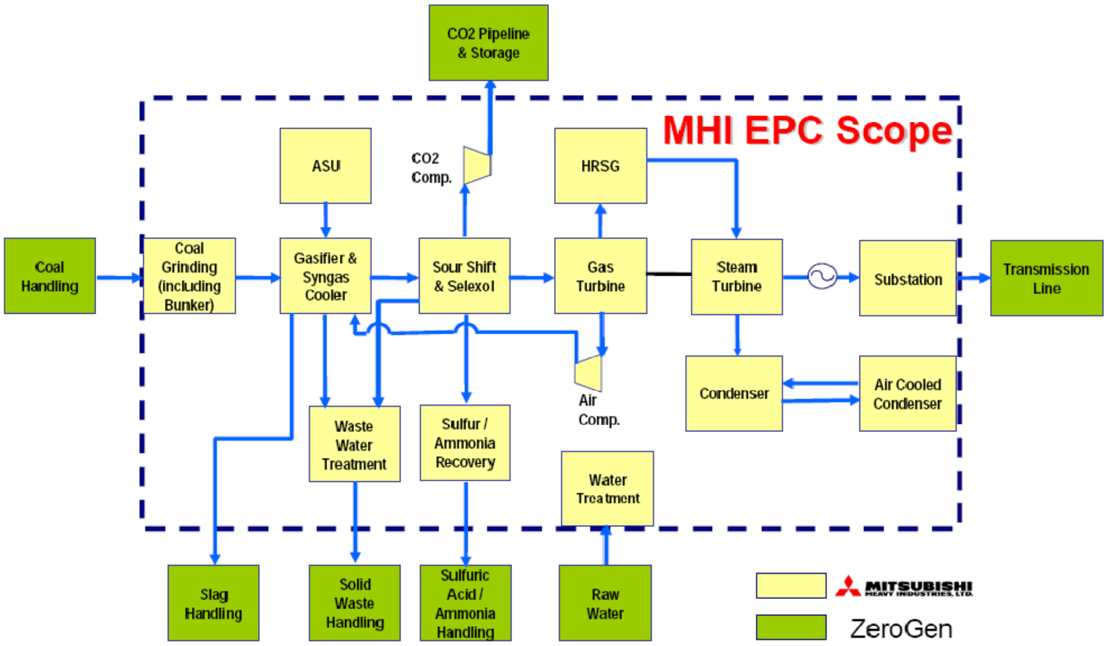


Figure 4-1 Schematic layout of ZeroGen commercial scale IGCC

Sub-elements of the combined cycle power generation facility include:

- Gas Turbine (GT) which combusts the hydrogen rich syngas in a stream of air. The intent of this plant is to maximise combustion of the hydrogen rich syngas in air. Gas Turbines are typically low NO_x, however the higher combustion temperatures associated with this plant may result in slightly higher NO_x than would be expected from natural gas fired GT technology. ZeroGen will be a low NO_x station comparative to traditional coal fired generating units with an overall NO_x reduction of an order of magnitude or more.
- Heat Recovery Steam Generator (HRSG) which will recover thermal energy downstream of the GT using this energy to produce steam for power production via a conventional steam turbine.
- Air cooled condenser as cooling for the steam cycle generating plant. This sub-element will minimise water usage at the plant.
- Main plant stack for discharge of flue gas from the power production block.

4.1.1 Cleaner Production

The ZeroGen Project will demonstrate emission reduction and cleaner production principals across a broad spectrum of potential impacts comparative to coal fired generating plants.

Unlike traditional coal fired power stations in use in Australia and throughout the world, ZeroGen is designed to be a world-first in significantly reducing the CO_2 emissions from coal fired electricity production. The plant will also demonstrate cleaner production and waste reuse concepts in addition to the reduction of carbon dioxide emissions. A comparison summary of the cleaner production design philosophy of ZeroGen is included in Table 4-2 below.

Table 4-2: Cleaner Production Philosophy — ZeroGen

Resource Use / Emission	ZeroGen Design Consideration	Best Practice (coal fired power basis)
Mineral Matter in coal	Inert vitreous slag with reuse potential as road base and other industrial applications. [a]	Bottom ash/fly ash with limited reuse opportunities outside of cement industry.
Particulate	Captured as slag within the gasifier. Emission less than 0.01 kg/tonne coal (as PM10)	Approximately 99.9 percent of fly ash captured residual fly ash emitted as PM10 and PM2.5. Emission approximately 1.5 kg/tonne coal.
Sulphur in coal	Converted to sulphuric acid for industrial sale. Emission is expected to be approximately 0.01 kg/ tonne coal.	Emitted to environment as gaseous SO_x via the stack. Emission approximately 10.45 kg/tonne coal.
Carbon in coal	Captured as CO_2 for geosequestration. Emission intensity expected to be approximately 350 $kg/MWh_{sent\ out}$ at a capture rate of 65 percent and approximately 100 $kg/MWh_{sent\ out}$ at a capture rate of 90 percent.	Emitted as CO_2 with implications for climate change. Average emissions intensity across the Queensland grid is approximately 920 $kg/MWh_{sent\ out}$.
Water	Minimised through use of dry (air) cooling throughout the plant. ZeroGen will consume approximately 1.0 $kL/MWh_{sent\ out}$	Older stations wet cooled: stations constructed recently tend to be dry cooled. Wet cooled stations consume approximately 2.2 $kL/MWh_{sent\ out}$. Dry cooled stations will reduce the water consumption by up to 90%. These are calculated on the premise of no carbon capture. Adding carbon capture will increase water consumption by approximately 0.7 $kL/MWh_{sent\ out}$.
Oxides of Nitrogen	ZeroGen's NO_x emissions will be substantially lower than what is achievable with current Best Practice coal through use of gas turbine combustion. Fuel nitrogen will be converted to ammonia via the gasifier and captured for either reuse or sale. Emission is expected to be approximately 0.7 kg/tonne coal	Fuel nitrogen converted to NO_x and emitted. Thermal NO_x related to combustion conditions (e.g. flame size, residence time and temperature) within the boiler. Emission will vary between individual facilities within an expected range of 5.0 to 8.7 kg/tonne coal.
Ammonia	May be captured and reused or sold	No capture possible, ammonia formation low (refer discussion on NO_x above)
Chloride in coal	Captured in water stream during the shift reaction. Treated in wastewater system.	Emitted as hydrochloric acid in vapour phase.

a: refer Process Description: TCLP for results from laboratory testing of a sample of gasifier slag.

Process Description Slag Production

Coal contains small amounts of mineral matter which occur through the coal seams and are inseparable from it. The mineral matter is derived from the minerals present in the vegetation that formed the parent coal, soil and rock particles that were part of the earth at the time the vegetation was growing and therefore formed part of the coal matrix or silts and mud that were washed into the buried vegetation during the development of the coal seams. A further type of mineral matter includes the rocks and soil that become associated with the coal during the mining process. The mineral matter forms ash following combustion and slag following high temperature gasification.

Gasification Slag

The gasification process operates at much higher temperatures and pressures than combustion boilers as well as under reducing conditions (lower concentration of oxygen in the combustion zone). The higher temperature and reducing conditions affects the behaviour of mineral matter in the coal.

Mineral matter in coal is melted at the higher temperatures and is continuously captured on the walls of the gasifier where it assists with forming a protective coating. Under the influence of gravity the molten slag runs down the gasifier walls and drops into a water bath. Thermal shock tends to shatter the slag into small pieces and it forms a vitreous solid.

The slag has significantly different mechanical and leaching properties from combustion ash (either bottom or fly). The slag produced by gasification is a vitreous, high density solid that is inert and non-toxic. Gasifier slag has inherently lower carbon than combustion related ash. A sample of slag was tested to determine whether the slag will leach contaminates into the environment (refer below to Process Description: TCLP testing). The reuse potential of gasifier slag is greater than combustion ash and includes:

- *abrasive media (such as sand blasting grit);*
- *landscaping;*
- *cement kiln feed;*
- *sand substitutes in cements; and*
- *asphaltic concrete aggregate.*

Combustion Ash (not produced by ZeroGen)

In a conventional pulverised coal boiler the mineral matter present in the coal is heated during combustion (i.e. under oxidising conditions) and transformed into ash in the boiler in traditional coal fired power generation. During combustion the mineral matter melts and coalesces then cools to a solid as it leaves the flame front. Cooled particles of mineral matter are called ash. Larger ash particles fall to the bottom of the boiler (i.e. bottom ash) to be captured and transported to storage areas. Lighter and smaller ash particles form fly ash and are carried on the hot combustion gases through the boiler and are captured on specific equipment such as bag houses or electrostatic precipitators. A portion of the fly ash passes through the equipment and is discharged into the environment via the stack. A modern, well functioning bag house can capture 99.9 percent of the fly ash in the gas stream.

Some of ash can be reused, typically as an ingredient in cement, although other reuses can include filler for paints and plastics. However, the reuse is limited by the size of the market, transport distances, the particle shape, size, density and chemical composition of the ash.

Unless treated appropriately combustion ash can leach contaminants into the environment. Consequently, fly ash from power stations is a regulated waste in Queensland (except where reused).

Process description Toxic Characteristic Leaching Potential (TCLP)

TCLP is an analytical procedure which examines the mobility of potential contaminates through soil and other materials. It was developed by the USEPA (and published as Method 1311 and 1312). The test is based on the well understood principle that acids can mobilise compounds and result in environmental release.

The process varies slightly between laboratories but usually involves challenging a sample with an acid for a fixed period of time. Analysis of the leachate provides an indication of the ability of the sample to retain contaminates. Inert materials will have low levels of contaminates in the leachate.

ZeroGen has examined gasifier slag using the TCLP methodology (using hydrochloric acid as the leach medium) and the material is regarded as inert. The results of the testing are presented in Table 4-3 below.

Table 4-3: TCLP Test Results (Gasification slag)

Compound	Units	Concentration in Slag	TCLP Results
Arsenic	mg/kg	<5	<0.1
Barium	mg/kg	330	0.8
Beryllium	mg/kg	3	<0.05
Cadmium	mg/kg	<1	<0.05
Chromium	mg/kg	21	<0.01
Cobalt	mg/kg	12	<0.01
Copper	mg/kg	22	<0.01
Lead	mg/kg	<5	<0.01
Manganese	mg/kg	589	0.2
Nickel	mg/kg	24	<0.01
Vanadium	mg/kg	30	<0.01
Zinc	mg/kg	13	0.2

Process explanation: Combined cycle electricity generation

Combined cycle electricity generation is a two stage process, which offers a high efficiency process for power production.

The primary stage consists of a gas turbine which combusts the syngas in a stream of compressed air to create a high temperature, high velocity gas stream. The gas stream is directed onto a series of turbine blades which rotate and convert mechanical energy into electrical energy.

The second stage is to take the high temperature gas stream at the turbine exhaust and direct it into a Heat Recovery Steam Generator (HRSG). This plant is essentially a boiler and uses the residual heat from the turbine exhaust gases to generate steam. The steam is directed to a steam turbine which enables further electrical energy to be generated (refer Figure 4-1 *for schematic diagram).*

After the HRSG the gases are directed to the power plant stack for release.

Process description: Supercritical fluids

For storage applications, using a dense material affords efficient usage of volume. Gases have low density and would take up too much volume per unit weight making it inappropriate as a medium for geosequestration. Similarly, solids, although having a higher density, have significant materials handling issues and are inappropriate for pipeline transport and injection.

ZeroGen intends to employ the natural laws of physics, with respect to the states of matter, to increase the density of the CO_2 (thereby minimising the required storage volume) while maintaining it as a fluid to facilitate transport and injectivity.

Phases of a substance

A substance may be found in variety of states or phases. Phases which are in common experience include: solid, liquid, and gas. Dry Ice is the solid phase of CO_2, while liquid CO_2 is used for refrigeration and transport. At room temperature and atmospheric pressure CO_2 is a gas.

Substances may move between states through the application of temperature and/or pressure. For example, at atmospheric pressure lowering the temperature of water column to zero degrees (C) will cause the water to change to a solid state (ice), similarly raising the temperature to 100 degrees (C) will cause it to boil off as a vapour. Adjusting the pressure will change the temperature at which the phase change will occur (e.g. water will boil at a <100 degrees (C) on the top of a mountain due to the reduction in atmospheric pressure).

The phase change occurs up to the Critical Point. Above the critical point, the liquid – vapour boundary disappears. A liquid above the critical pressure, upon heating will become a supercritical fluid. A gas that is compressed above its critical pressure undergoes an increase in density to that of a supercritical fluid.

For carbon dioxide, the Critical Point occurs when the pressure is 73.9 bar, at a temperature of 31.1 degrees (C). Above this point the CO_2 can be maintained as a dense phase or supercritical fluid. A depth of approximately 750 metres below ground level provides sufficient pressure to maintain the sequestered CO_2 as supercritical fluid.

Density increase of supercritical carbon dioxide

Carbon dioxide at conditions of one atmosphere pressure and 0ºC has a density of 2.8 kilograms per cubic meter (kg/m3) and the storage of 60 million tonnes would take up an unacceptably large volume. At supercritical conditions, it has a density of at least 467 kg/m3, with further density increases possible at greater pressures. The storage volume required is correspondingly reduced.

ZeroGen proposes to transport and store the CO2 as a supercritical fluid.

4.2 Project Overview – Pipelines and transmission

The ZeroGen Project will develop pipeline corridors and transmission routes for a range of products or supplies including:

- Water supply – ZeroGen will enter into offtake agreements to secure a reliable supply of water for its operations. The water will be transported to the site in a pipeline buried along a secured route.

- Natural gas – ZeroGen will investigate the option of using natural gas as a start up fuel for the IGCC. If feasible, ZeroGen will develop a route for a natural gas pipeline from a suitable pipeline supply point to the site.
- Carbon dioxide – ZeroGen will develop and construct a suitable route for the transportation of CO_2 from the IGCC plant to the sequestration fields planned in the Northern Denison Trough. The CO_2 will be at ambient temperature but at supercritical pressure (refer process description of supercritical pressure).
- Transmission lines – ZeroGen will connect to the Queensland Power grid via a 275 kV transmission line between the ZeroGen plant and an existing node (such as Calvale or Lilydale substations).

Pipeline routes will be co-located wherever practical. Constraints on co-location could be terrain (for example natural gas can cope with greater changes in elevation along the pipeline route than supercritical carbon dioxide), length of pipeline route, the beginning and end points for the pipeline, and risk. The routes will be secured through registered easements and other appropriate instruments of tenure.

Pipeline and transmission route selection will incorporate negotiation with affected landholders, and be cognisant of the environmental values and the nature of surrounding land uses. Pipeline routes and engineering specification will be subject to a risk assessment using acceptable Australian or International Standards or protocols (e.g. AS 2885:1997 *Pipelines – Gas and liquid petroleum*, or ASTMB318 *Gas transmission and distribution piping systems*). Post construction rehabilitation of the affected pipeline Right of Way (ROW) will be undertaken to suitable standards including weed management and control.

Route selection requires detailed consideration of several criteria, including:

- Minimising the length of the corridor which can reduce the disturbance to land holders and cost savings on construction
- Minimising any terrain constraints which include both significant slopes and pipeline bends. These can interfere with the pressure and flow characteristics of the pipeline and may limit diameter or require increased pumping pressures or supplementary booster pumps along the route. Steep areas usually contain rock which is a construction constraint.
- Maximising ease of access can influence the logistics of the pipeline construction and maintenance as well as costs. It can also affect construction impacts especially disturbance where additional tracks may need to be constructed to the pipeline ROW.
- Minimising construction constraints such as avoiding areas subject to inundation, or where soil stability and erodibility may result in post construction problems, avoiding areas of extensive rock, reducing the number of watercourse and infrastructure crossings and working in third party easements.
- Minimising disturbance to existing landholders and land use including towns and urban areas and farming operations.
- Minimising disturbance to areas of known ecological values to reduce impacts during construction and operation of the pipeline. Where disturbance occurs, then rehabilitation activities or other mitigation measures will be undertaken.
- Minimising disturbance to areas of known heritage values, utilising predictive assessment of areas where archaeological sites may be present and the potential significance of sites.
- Minimising potential interference from or to other infrastructure to reduce disturbance or maintenance and operational issues, for example collocating metal pipeline with transmission lines or electrified rail can lead to increased corrosion in metal pipes.

Pipeline easements are negotiated with individual landholders, companies, leaseholders, local government authorities and applicable government departments (such as Queensland Transport for rail line/main road crossings) and similar parties along the proposed route. Compensation agreements are negotiated with individual landholders based on existing valuation of land, land use and level of disturbance.

The key phases of pipeline lifecycle are:

- Construction will involve the clearing of a suitable corridor, digging a trench of a suitable width for the pipeline, installation of the pipeline including on-site welding, laying of the pipe into the trench and back filling, and reinstatement of the land to its original contours. All compacted areas will be relieved and the topsoil, which is segregated during the clearing operations, respread over the area. Erosion protection measures will be installed and rehabilitated via reseeding to promote rapid restabilisation of the ground (refer Figure 4-2 for typical section of pipeline trenching) or regeneration via root stock.
- Commissioning of the pipeline will include filling the pipe with water and pressurising it (i.e. hydrotesting) to check the integrity of construction work and checking of all the communications and emergency facilities.
- Operation of the pipeline will include regular monitoring to ensure there is no interference from third parties; that the corrosion protection mechanisms are functioning; and to ensure that revegetation, erosion protection and weed management are being successfully implemented.
- Decommissioning is anticipated to include the removal of all the above ground structures, capping of the pipe and leaving it in-situ. The pipe will be designed for a 40 year life which may be extended through maintenance and upgrades. When the pipeline is no longer required it will be decommissioned in accordance with the regulatory requirements at that time.

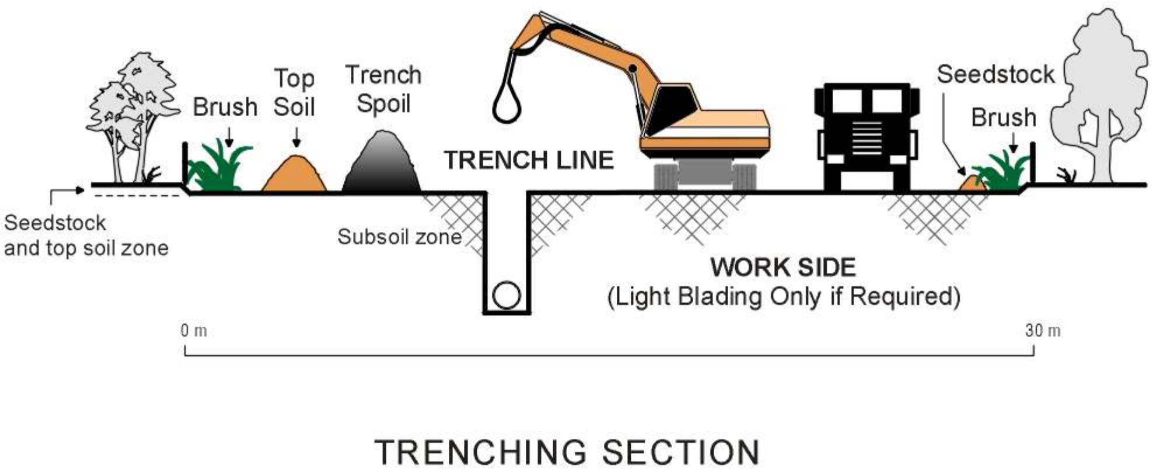


Figure 4-2: Typical cross section of pipeline laying operations

4.3 Project overview – Geosequestration

A principal component of the ZeroGen project is the sequestration of carbon dioxide in underground strata in the Northern Denison Trough. ZeroGen is investigating the injection capacity of the region and a level of confidence in the ability of the Northern Denison Trough to accept at least 60 million tonnes of CO_2 at the rate of 2 – 3 million tpa over the life of the IGCC plant.

To maintain CO_2 as a supercritical fluid (refer process description supercritical gas) the sequestration zone will need to be deeper than approximately 750 metres. Below this depth the pressure exerted by the earth's crust ensures that the CO_2 remains in a supercritical state.

A suitable storage area for sequestration of carbon dioxide requires a number of characteristics including:

- Secure Storage – the location must have the ability to securely store the CO_2 for geologic time periods. In the Northern Denison Trough there are a number of potential reservoirs separated from each other by sealing strata:
  - Seal strata - these are rock formations that act as a barrier to the vertical migration of CO_2. The seal rocks have a tight non-porous structure that does not permit carbon dioxide to pass through it. In the case of the Northern Denison Trough a cap formation identified as the Black Alley Shale (refer Process Description: Geology of the Northern Denison Trough) sits above the target sequestration strata and acts as a regional scale shield preventing the migration of carbon dioxide from the sequestration strata to the surface. Additionally, in the case of the Northern Denison Trough, there are seal formations separating the target sequestration strata and providing effective local barriers to the subsequent release of the sequestrated CO_2 (refer Figure 4-3).
  - Sequestration strata which are rocks with porosity and permeability characteristics that permits the ingress of CO_2 under pressure. Typically these are sandstones below the regional seal rock and at a depth necessary to maintain the CO_2 in a supercritical state. In the Northern Denison Trough there are a number of target sandstones that may be developed for successful sequestration. These are known as the "Aldaberan", "Frietag" and "Catherine" formations and are the subject of ongoing investigations to further characterise their storage potential (refer Figure 4-3).
  - Seismic activity – the seismicity, or the frequency and magnitude of earthquake activity in a region is an important factor when considering the suitability of a site for long term storage. A sequestration area should not be located in an area where there is an appreciable risk of an earthquake resulting in surface release of sequestered CO_2. Currently, the northern Denison Trough is not seismically active. The probability of the CO_2 injection site being affected by significant earthquake activity is extremely low (refer Geoscience Australia). Should an earthquake occur, the chance of CO_2 reaching the ground surface is extremely low because the thick inter-bedded shales within the basin should keep any resulting fault throw sealed.
  - Adequate Storage capacity thickness and lateral extent of the sequestration strata to provide capacity for large injection volumes. This is one of the factors under further consideration during the ongoing investigation work in the Northern Denison Trough.

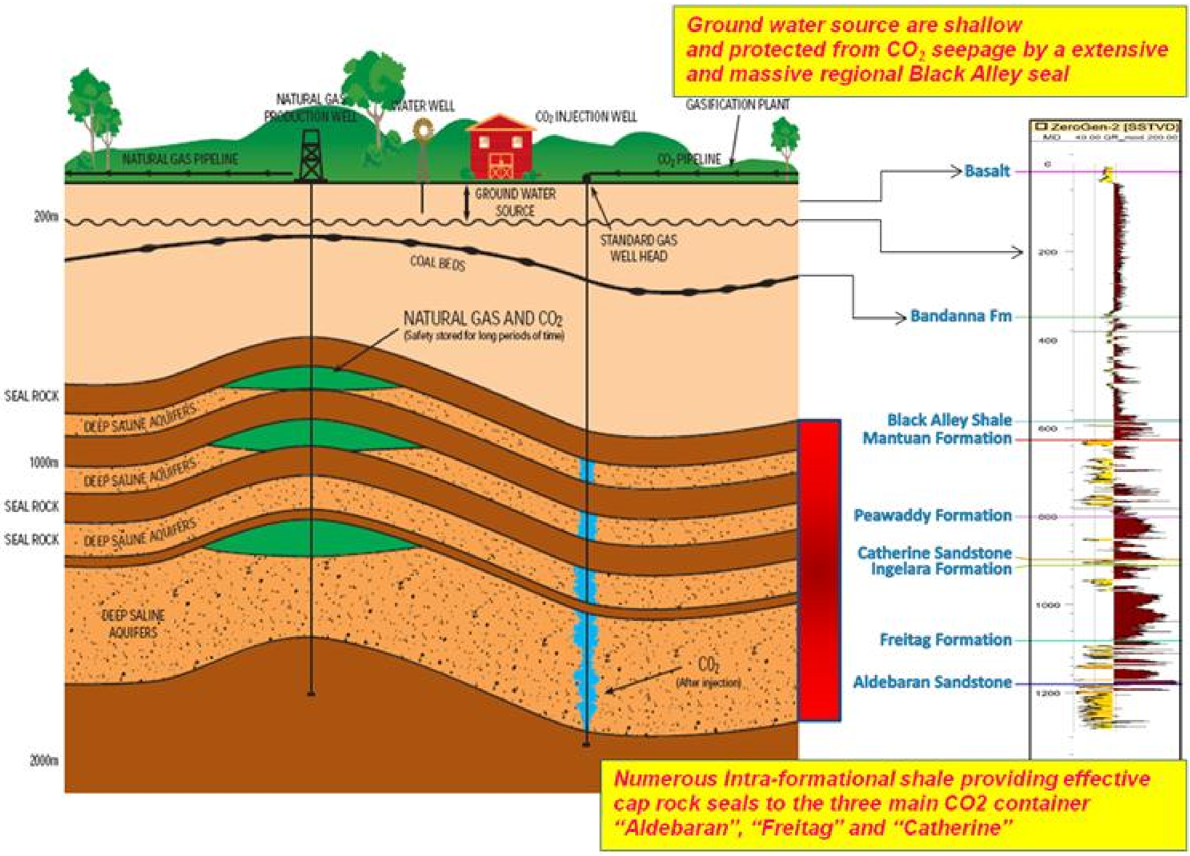


Figure 4-3: Schematic of sequestration strata in Northern Denison Trough

- Affordable cost there is a relationship between porosity and permeability and costs (good injectivity will require fewer injectors and hence less cost of sequestration) (refer Figure 4-4).

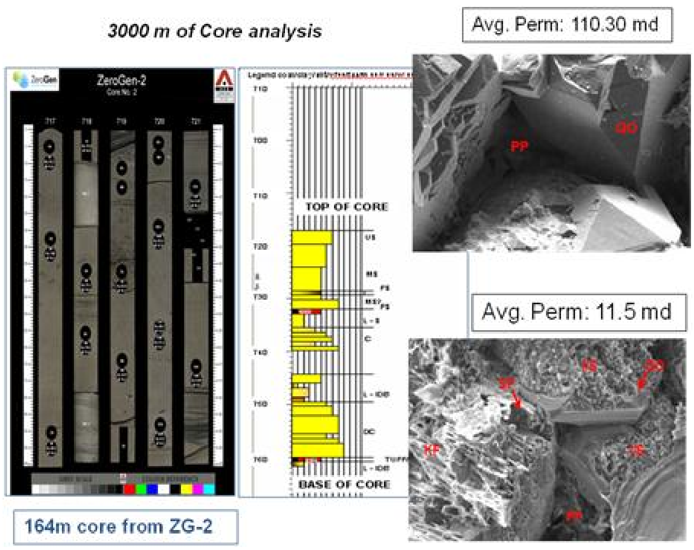


Figure 4-4: Electron microscopy analysis of ZG2 core

Note that structures identified with "pp" above are the pore spaces which would be flooded with supercritical CO_2.

ZeroGen commenced studies in this area in 2004. In 2006 two wells drilled for the purpose of investigating the storage and injection potential of this region. ZeroGen has an active three-phase investigation program in this region including:

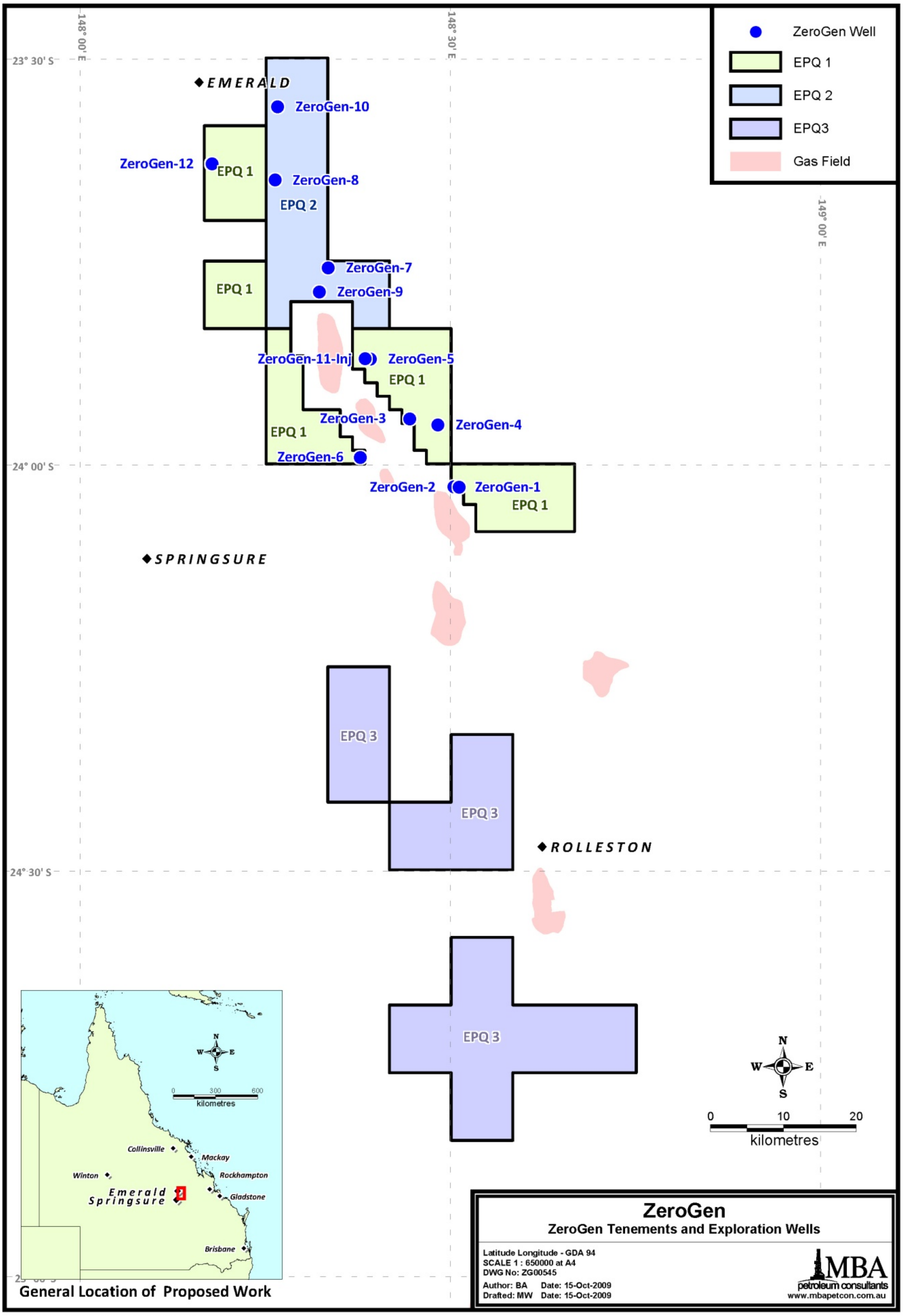
- Data collection and evaluation which focuses on establishing the geological characteristics of the reservoir and conditions supporting storage of CO_2. The data acquisition phases includes:
  - Desktop investigations based on known information about the geology and geomorphology of the region to highlight prospective areas;
  - Seismic surveys to confirm the results of desktop findings and to assist with refining the prospective strata and identify areas for exploratory drilling;
  - Drilling stratigraphical wells to assist with delineation of the storage basin. An essential component of the drilling program is obtaining cores of the subsurface strata for laboratory analysis. The cores are typed and used to compare rock characteristics from across the Trough to assist with modelling reservoirs and examine the suitability for CO_2 injection.
  - Analysis and testing of drill core- This program examines the characteristics of the reservoirs and the interbedded sealing shales and provides information for the assessment of the risks associated with the storage and the capability of the area to safely store sixty million tonnes of CO_2 over the anticipated operational life of the ZeroGen Project. Analysis provides information on the porosity and permeability of the rock, the characteristics of the seal rock (refer process description below), rock chemistry, geomechanical and other factors contributing to the level of confidence associated with the storage of CO_2 (refer Figure 4-4).
- CO_2 Injection testing conducted to determine the validity of reservoir models and confirm injectivity of the carbon dioxide. Injection trials are proceeding in accordance with a test plan submitted under the ***Greenhouse Gas Storage Act 2009*** (GGSA) and conducted within an Environmental Authority for the exploration tenements issued to ZeroGen under the GGSA.
- Water Injection testing will be used as an analogue to CO_2 injection to provide further information in relation to the storage potential of the Northern Denison Trough.

Since 2006, ZeroGen has developed an evaluation program into the potential of the Northern Denison Trough to provide a low risk opportunity for sequestration of CO_2. This program has resulted in ZeroGen completing a drilling program of 11 cored wells and one CO_2 injection well. The program has produced 6,000 metres of core for subsequent analysis and is the most advanced of its type in the world. The operational phases are outlined in Table 4-4.

Table 4-4: ZeroGen Exploration Program — Northern Denison Trough

Exploration Phase	Program Date	Comment
DP1	Completed August 2007	Drilled two wells (ZG1 and ZG2). These wells confirmed that the geology of the Northern Denison Trough was suitable for storage of CO_2.
DP2a	Completed Q1 2009	Drilled a further four wells (ZG3, ZG4, ZG5 and ZG6) to appraise the geology of the Northern Denison Trough and to assist with defining the size of the reservoir. Program obtained 3,000 metres of stratigraphic core for detailed analysis.
DP2b	March 2009 - current	Drilled further five stratigraphic wells (ZG7, 8, 9, 10 – ZG & 12). Have drilled the ZG 11 well for the purpose of undertaking trial injection of both water and CO_2 in the vicinity of ZG5 to calibrate subsurface models and assist with evaluation of reservoir potential and storage risk. Additional water injection trials are being undertaken in ZG7, ZG8, ZG9, and ZG10

The location of the ZeroGen exploration wells is located in Figure 4-5.



File: ZG00545 ZeroGen Tenements and Exploration Wells - 15Oct09.WOR

Figure 4-5 ZeroGen tenements and exploration wells

Process description: Geology of the North Denison Trough

The proposed storage site is located in the Northern Denison Trough, which is part of the Bowen Basin (refer **Error! Reference source not found.***). The Denison Trough stratigraphy is shown on the left hand side of the* **Error! Reference source not found.** *below.*

The surface geology consists of recent alluvium and weathered Tertiary sediments. Near surface basalt intrusions and lava flows are the remnants of Tertiary volcanic activity. Tertiary sediments unconformably overlie continental Triassic sediments of the Rewan Formation. These in turn sit on the fluvio-deltaic volcanoclastics of the late Permian Bandanna Formation which contains thin non-commercial coal seams at this location. The regional seal is the Black Alley Shale which is a marine anoxic siltstone and shale some 40m thick and is present across the entire storage site.

The formation of the Black Alley Shale was preceded by a series of platform deltas that emanated from the western cratonic margin (Mantuan/Peawaddy, Catherine/Ingelara, and the Freitag). Lithologies within the Mantuan, Catherine and Upper Freitag are considered to be possible storage reservoirs whilst the marine shales and siltstones within the Peawaddy, Ingelara and Lower Freitag are effective seals.

Earlier subsidence resulted in deposition of the upper Aldebaran Sandstone coarse clastics of fluvio-deltaic origin, representing the deepest formation that will be used for storage in the Northern Denison Trough site.

The Denison Trough is a significant petroleum (natural gas) province and contains several natural gas fields that are currently operated by Origin Energy on behalf of the Denison Trough Joint Venture (Origin Energy 50 percent, Santos Ltd 50 percent). The reservoirs are the same as those in which it is proposed to store CO_2 and a typical gas analysis identifies the presence of CO_2 naturally occurring within the gas produced from the reservoir. The CO_2 storage site will be down dip of the existing natural gas fields, outside of structural closure, in synclinal areas where the occurrence of trapped hydrocarbons is unlikely.

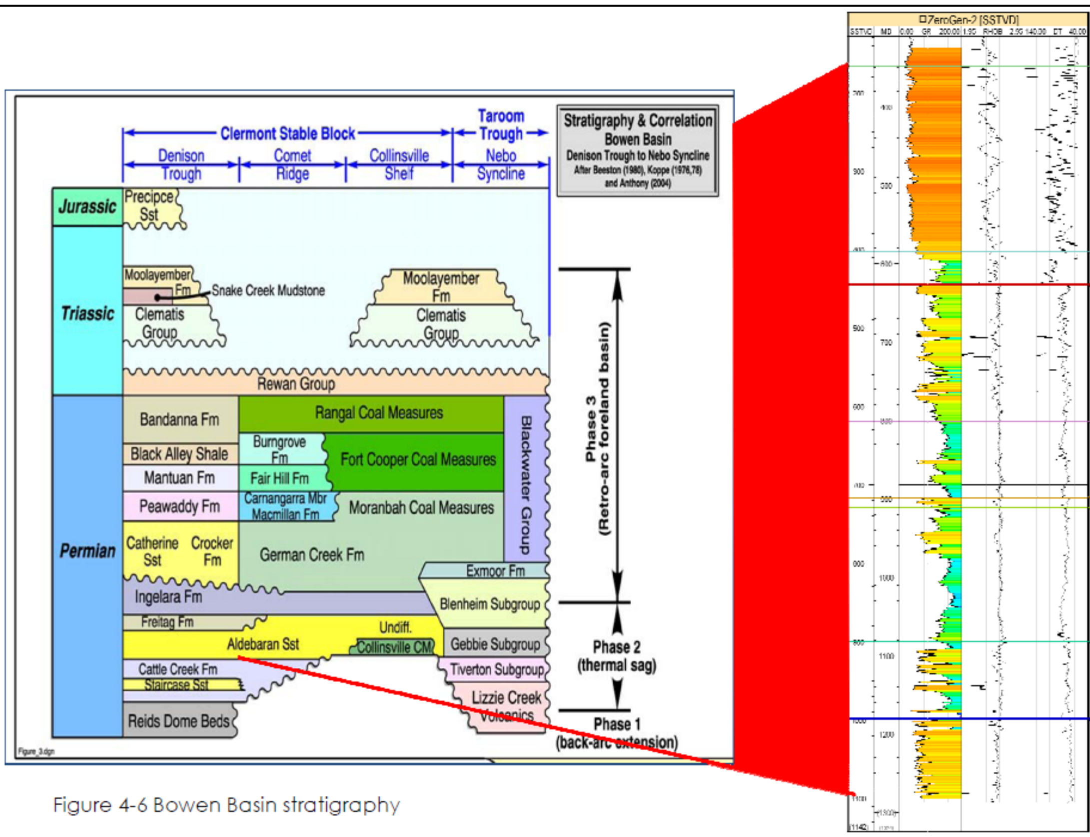


Figure 4-6 Bowen Basin stratigraphy

Additionally, the establishment of the sequestration field will require some surface infrastructure including:

- Well heads for each of the injection and monitoring wells with connection flanges for pipelines, valves and related equipment. The surface footprint required for each well head is small (in the range of a few tens of metres). The number of well heads will be determined by the outcomes of studies such as the injection trials and geological investigations.
- Distribution pipework connecting the main pipeline with the well heads. This network is a smaller diameter than the main pipeline between the IGCC plant and the sequestration field.
- Surface infrastructure at the end of the main pipeline. Some surface infrastructure may be required to link the main pipeline with the distribution network, for example buffer storage or booster pumps. The level of infrastructure required will be dependent on factors such as injection pressure necessary for geosequestration, the length of the main pipeline, pressure drop at the terminus end of the main pipeline (which may necessitate the need for booster pumps), shut in valves for safety and risk management and scraper stations for pipe cleaning.

5 Study Area

ZeroGen is undertaking investigations to determine a suitable site for the location of the IGCC, pipeline corridors and sequestration areas. The power plant site will be constructed at a location in Central Queensland in close proximity to a coal mine. The particular location will be determined from a diverse group of specific engineering, environmental and logistical studies. The study area for the IGCC plant is identified in Figure 5-1(below). The ZeroGen study area and EPQ boundaries are shown in Figure 5-2 (below).

The eastern extent is located to the east of Callide and Biloela and includes Kroombit Dam. The southern boundary of the study area commences south of Biloela and runs westwards to the south of Moura and Bauhinia. The study area then heads north-west crossing the Expedition Range and finishing east of Springsure. The western boundary runs generally north from this point (to the east of Emerald) finishing south-east of Tieri. It includes the eastern side of Fairbairn Dam. The northern boundary runs generally east from this point, then south crossing the Capricorn Highway near Duaringa and then south-east until meeting the eastern study boundary near the Callide Range.

The total area under consideration for the ZeroGen project is 29,438 km^2. Specific siting studies for the IGCC plant are being conducted during 2009 and are expected to conclude during the pre-feasibility study. The EIS for the ZeroGen project will focus on the selected site for the IGCC, corridors between this site and the geosequestration area and an area within the tenements for the development fo the geosequestration field and related surface infrastructure.

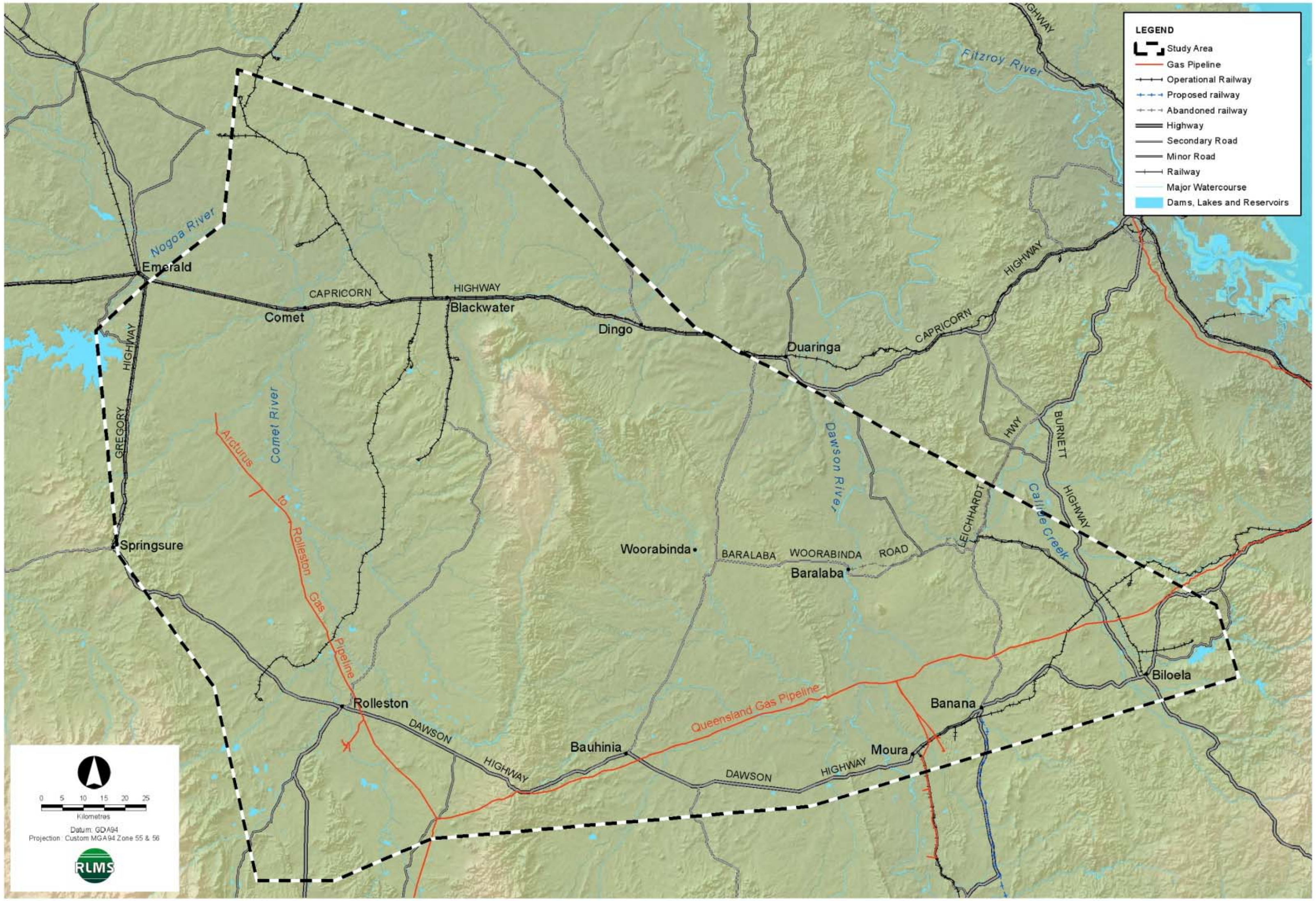


Figure 5-1 ZeroGen commercial scale plant study area

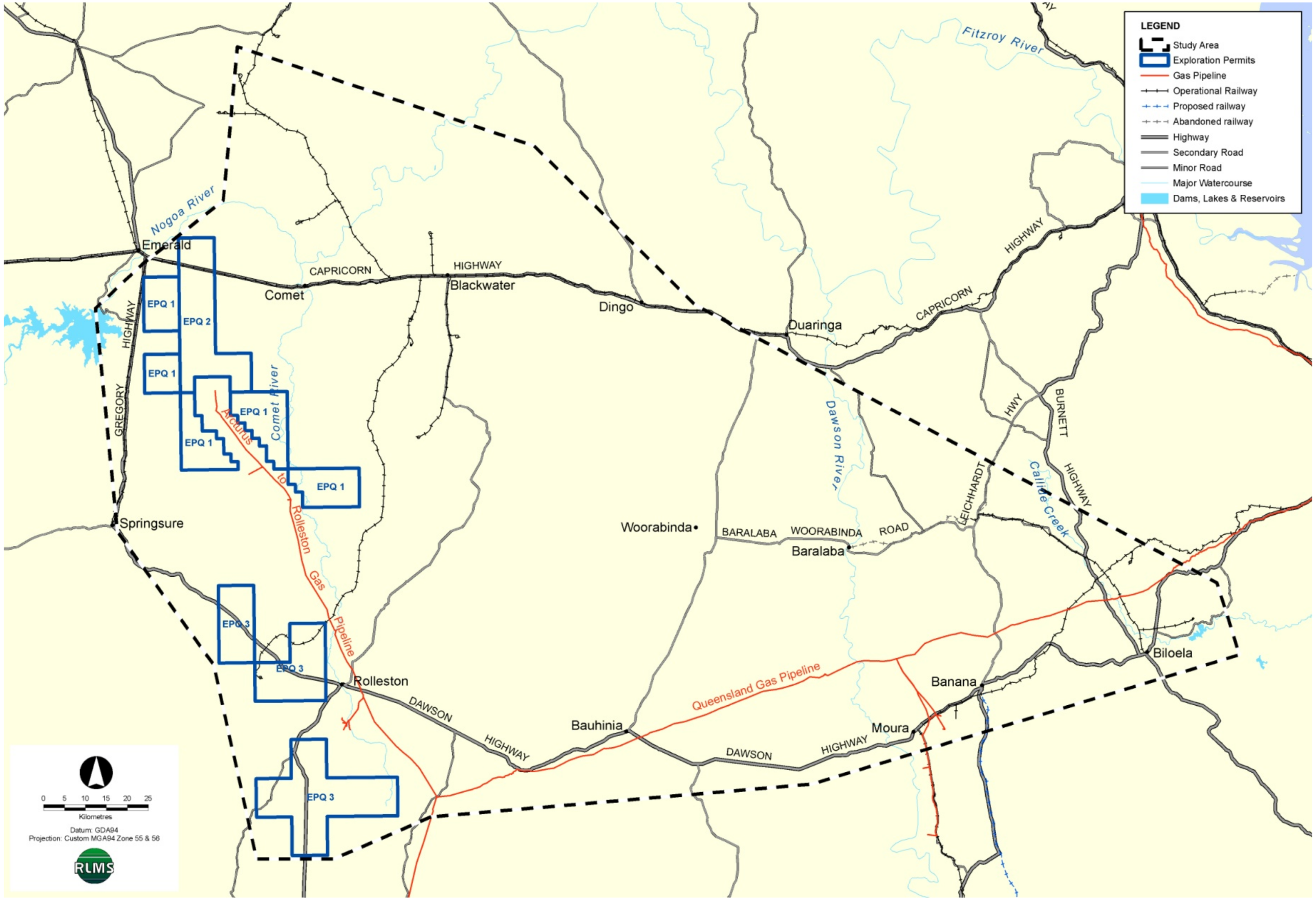


Figure 5-2 ZeroGen Project study area and EPQ boundaries

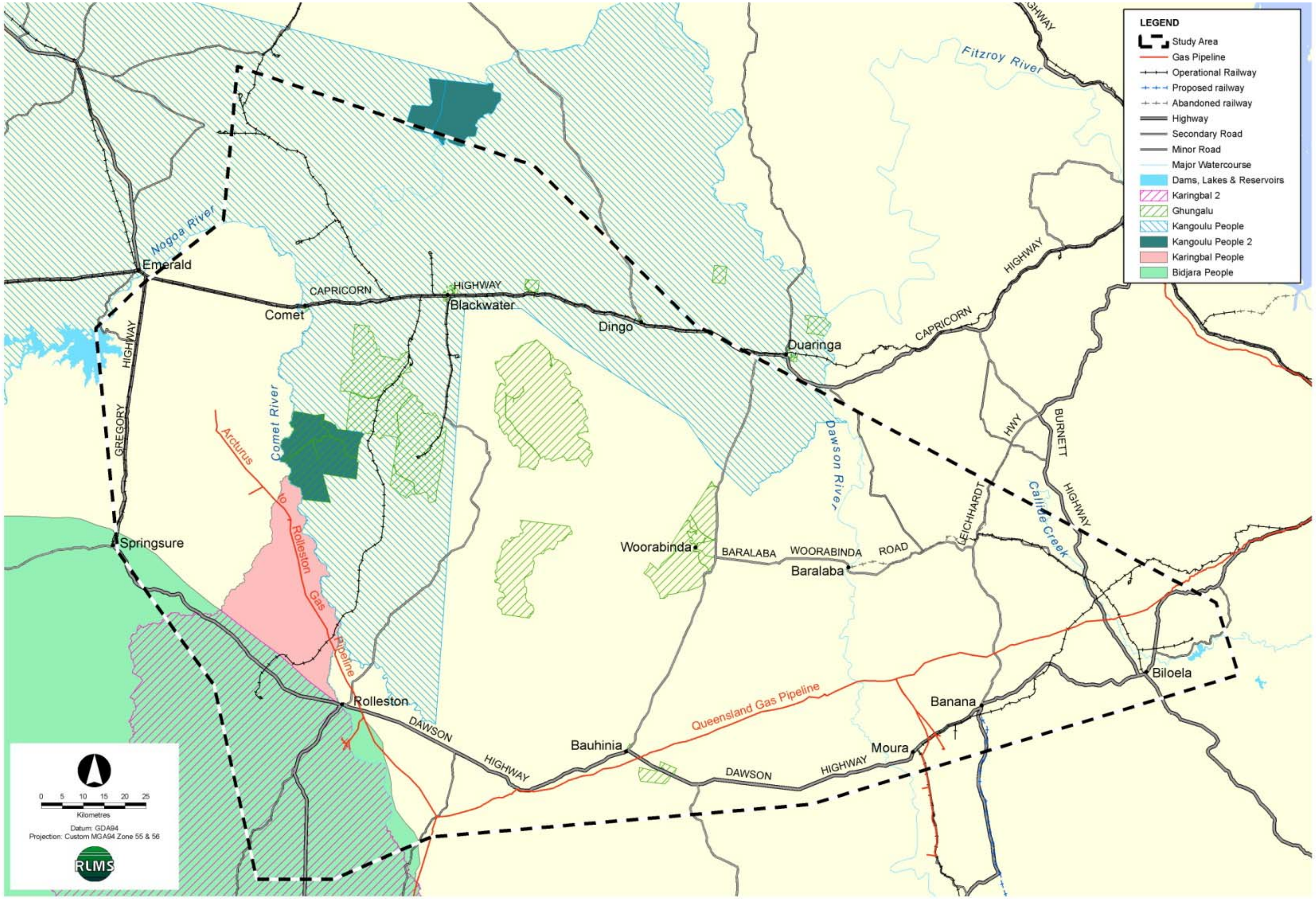


Figure 5-3 Native Title claims within the ZeroGen study area

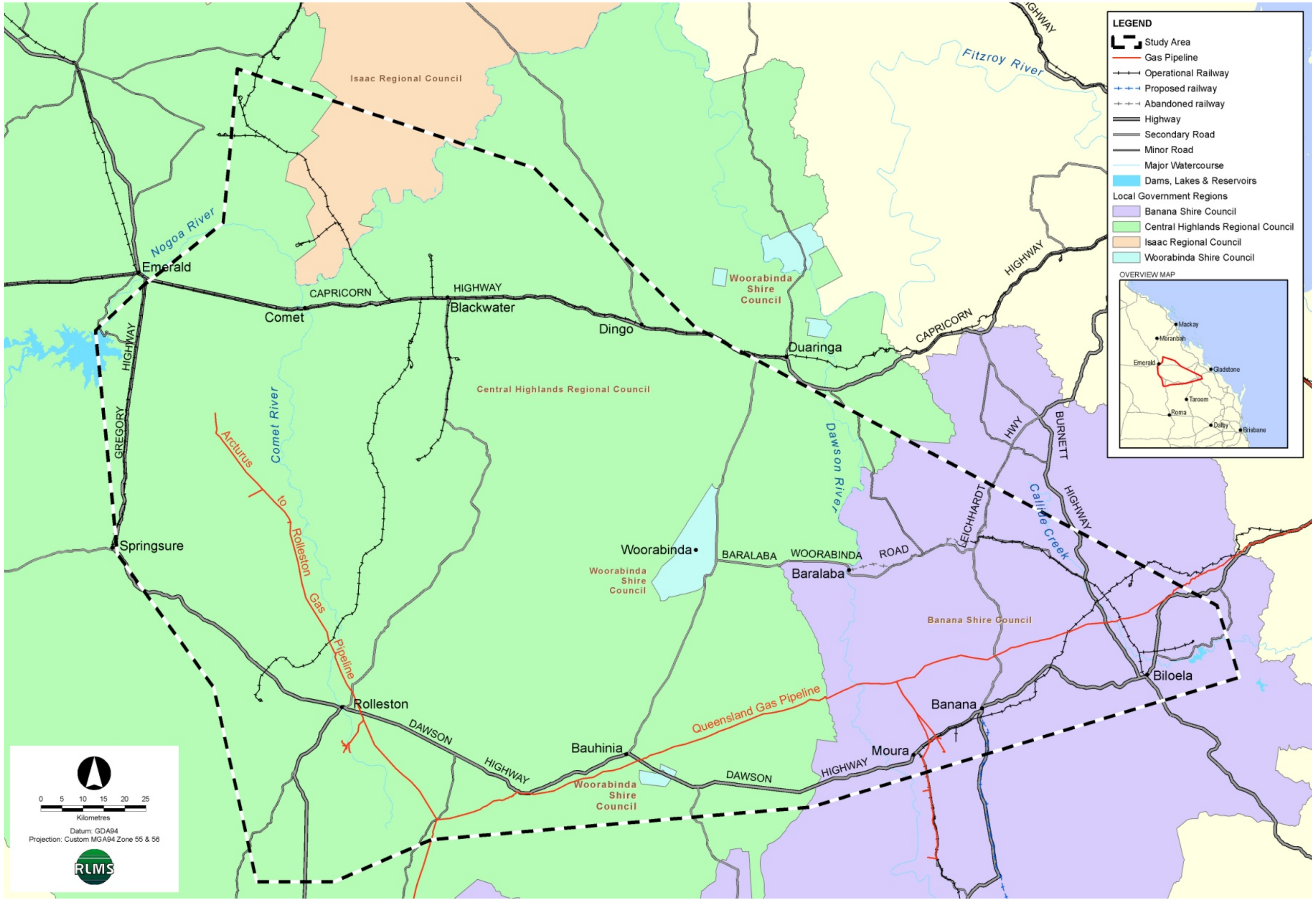


Figure 5-4 Local Authority boundaries within the ZeroGen study area

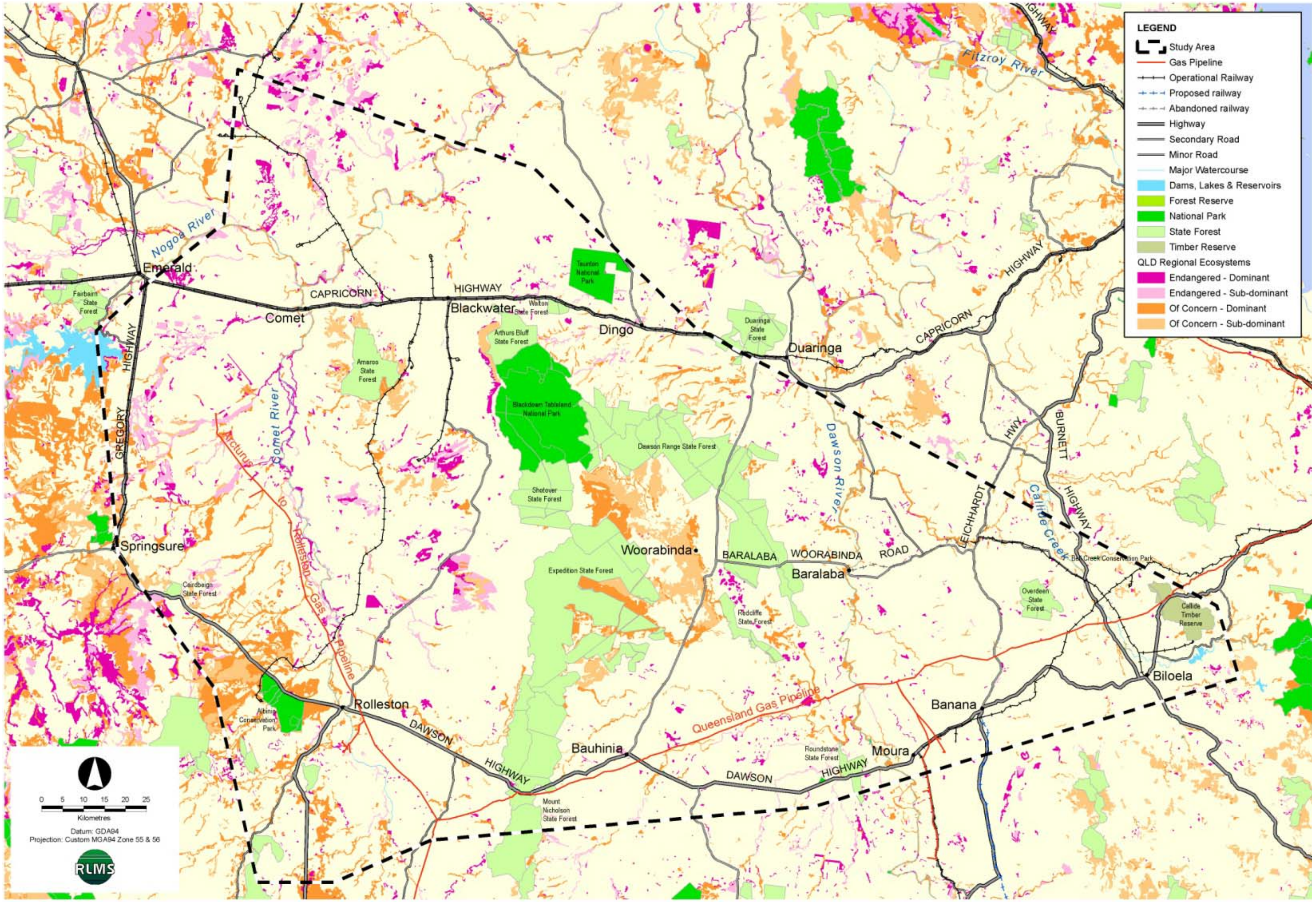


Figure 5-5 Environmental Reserves and Regional Ecosystems within the ZeroGen study area

5.1 Urban Areas

The study area includes parts of the Dawson, Comet and Mackenzie Rivers and Callide Creek catchments. Townships within or adjacent to the study area include:

- Banana;
- Baralaba;
- Bauhinia;
- Biloela;
- Blackwater;
- Capella;
- Comet;
- Dingo;
- Duaringa;
- Emerald;
- Moura;
- Rolleston;
- Springsure;
- Tieri; and
- Woorabinda.

The principal towns are Emerald (population 11,000), Blackwater (population 4,800), Biloela (population 6,400) and Moura (population 2,000). These towns act as service centres for the respective surrounding districts servicing agricultural, mining, commercial, industrial and residential needs.

5.2 Major road network

The study area includes major highways and a network of minor roads. The major highways include:

- Dawson Highway (generally travels in an east-west direction along the southern boundary of the study area);
- Capricorn Highway (generally travels in an east-west direction along the northern boundary of the study area);
- Burnett Highway (generally follows a north- south direction); and
- Leichardt Highway (generally follows a north- south direction).

5.3 Native Title Claimants

Large parts of the study area are covered by Native Title Claims refer Figure 5-3. Native Title Parties are being consulted during the development of the ZeroGen project. Native Title claimants include:

- Karingbal 2;
- Ghungalu;
- Kangoulu People;
- Kangoulu People 2;
- Karingbal People; and
- Bidjara People.

Additionally other local representative groups, such as Yumba Burrin Cultural Heritage Association will be consulted in relation to the ZeroGen project.

5.4 Aboriginal and European Cultural Heritage

A number of Aboriginal Cultural Heritage sites exist within the study area. Known sites include sites in the Comet River, Rolleston and Callide areas. It is considered highly probable that currently unknown areas will be located during EIS investigations, field studies and construction activities. ZeroGen will conduct surveys during the EIS study period and treat sites in accordance with the requirements of the *Aboriginal and Cultural Heritage Act 2003*.

In addition to the Aboriginal Cultural Heritage there are known European Cultural Heritage sites within the study area. Two of these are on the Register of the National Estate, including:

- Kilbirnie Homestead (north of Biloela); and
- Greycliffe Homestead (north-east of Banana).

It is considered highly probable that currently unknown areas will be located during detailed site studies. Artefacts and sites discovered will be treated with due consideration in accordance with legislative principles.

5.5 Local Authority areas

The ZeroGen commercial scale plant study area overlies four Local Authority areas (refer Figure 5-4) including:

- Banana Shire Council;
- Central Highlands Regional Council;
- Isaac Regional Council; and
- Woorabinda Shire Council.

The ZeroGen IGCC plant and associated pipelines may cross one or more local authority boundaries.

5.6 Environmental Reserves

There are a number of National Parks, Conservation Areas, State Forests and Nature Refuges within the study area (refer

Figure 5-5) including:

- Blackdown Tableland National Park
- Albinia National Park
- Taunton National Park
- Ghungalu Conservation Park
- Bell Creek Conservation Park
- Roundstone State Forest
- Mount Nicholson State Forest
- Expedition State Forest
- Cardbeign State Forest
- Shotover State Forest
- Dawson Range State Forest
- Redcliffe State Forest
- Overdeen State Forest
- Amaroo State Forest
- Arthurs Bluff State forest
- Walton State Forest

Some of the areas listed above are also on the Register of the National Estate. There are 123 regional ecosystems within the study area. Fifty-five of these are identified as "No Concern at Present" 41 as "Of concern" and 27 as "Endangered".

Furthermore, four threatened ecological communities, 33 threatened species and 16 threatened migratory species are expected to be present in the area. These species and communities are identified as matters of national environmental significance within the meaning of the *Environmental Protection Biodiversity and Conservation Act 1999*. ZeroGen will be seeking designation as a "controlled action" within the meaning of this Act.

5.7 Site Selection Studies

ZeroGen will undertake a number of studies to determine an appropriate location for the power plant including:

- Engineering studies to assist with the design and development of the IGCC technology, such as size and quantity of raw materials (such as coal requirements and design quality, plant size, start up fuels). ZeroGen is embedding a number of philosophies in the prefeasibility stage, such as cleaner production and emissions reductions to reduce the resource intensity or potential impact through plant design.
- Constraints studies to develop the most appropriate location for the IGCC plant, considering transport logistics, pipeline and transmission lines, water supply and avoidance of environmental or social constraints.
- Screening level studies to examine potential issues related to risk and safety, for example screening level studies to consider the impact of IGCC plumes on Civil Aviation Safety in the vicinity of airports.
- Trial Coal Burns at gasifier test facilities in Japan to establish engineering confidence in the suitability of selected coals and to gather emissions data associated with the plant.
- Baseline environmental studies to collect data to support an assessment of environmental values, such as meteorological data for air quality modelling, climatic studies to understand climatic variability, noise surveys and ecological surveys.
- Cultural Heritage studies to determine known areas of cultural heritage for consideration in siting and corridor studies.
- Resource studies such as water availability and sources within the study area that may reliably provide process water for the IGCC, coal supply and transport (such as conveyors or rail sidings).
- Corridor studies to determine potential corridors for transport of gas/water/CO_2 and power transmission lines.

These studies will inform the site selection process and provide base level information for the feasibility study into the ZeroGen Project. In addition to the prefeasibility studies indicated above ZeroGen proposes to conduct detailed studies during the development of the EIS including:

- Detailed engineering design producing detailed process drawings and designs of the power station, including mass flow rates, equipment sizing, civil engineering facilities, plant layouts, stack parameters and related factors.
- Geological/geomorphical investigations to establish civil engineering basis of structures and to investigate soil properties for impact assessment
- Flora/Fauna surveys over the IGCC plant sites and pipeline/transmission line corridors and sequestration area to identify areas of conservation significance, rare and endangered species present in the area, ecosystem identification and to inform impact mitigation and rehabilitation opportunities.

- Cultural and social assessment including native title and cultural heritage surveys and social impact assessment associated with the development and the employment opportunities from construction and operational phases of the ZeroGen Project.
- Economic analysis of the influence of the ZeroGen Project on local, state and national economy.
- Hazard and risk associated with the construction and operation of the IGCC, pipeline and transmission lines and the sequestration area.
- Surface and groundwater impacts including stream crossings, water chemistry and flows
- Noise impact assessment including detailed baseline studies, impact modelling and mitigation as necessary at the IGCC plant and possibly at the sequestration field if there is a requirement for infrastructure installations.
- Air quality impacts from construction and operations, including modelling and prediction of ground level concentrations for relevant parameters including greenhouse gas emissions.
- Transport assessments including frequency of movements of transport vehicle during construction and operations and heavy lift items.
- Reservoir modelling and injection trials to inform the project about the suitability of the Northern Denison Trough to safely and economically store the requisite quantity of CO_2.
- Environmental management programs to develop strategies for ongoing management of the environmental aspects and impacts from the ZeroGen Project covering construction activities, operational and decommissioning phases.

These studies will combine prefeasibility studies, desktop, and preliminary field investigations which have provided high level baseline information about the project with detailed field and engineering studies to properly characterise and assess the influence of the project on matters of local, state and national interest.

5.8 Community Consultation

ZeroGen is committed to open and transparent community consultation throughout the project. ZeroGen has already undertaken substantial consultation about the project including briefings with government, non-government organisations, indigenous groups, research and development organisations, industry groups, local communities, landholders and the general public. ZeroGen has established a website which can be accessed by the community to provide feedback or raise issues for consideration and response.

ZeroGen has conducted public information sessions at a number of townships over extended periods of time to increase awareness of the project and potential issues. Community liaison groups were established by ZeroGen at a number of locations between Stanwell township and Springsure.

ZeroGen proposes to continue the practice of community briefings and hosting public meetings throughout the development of the commercial-scale project. Once the site of the IGCC plant has been determined, a site-specific Community Liaison Group will be established with individual members of the community, landholders, local government and state government invited to participate and meet regularly with the project team

It is ZeroGen's intention to:

- inform all stakeholders about all aspects of the project;
- understand community issues or concerns about the project;
- explain the EIS process and encourage community input; and
- address wherever possible, any concerns raised during the approvals process.

6 Project Approvals

ZeroGen is seeking designation of the project as a "Significant Project" under the SDPWO.

A number of permits and licences will be required for the commercial-scale plant prior to construction and/or operation including:

- Generating Authority pursuant to the *Electricity Act 1994;*
- Pipeline Licenses under the *Petroleum and Gas (Production and Safety) Act 2004;*
- Development Approvals for the conduct of Environmentally Relevant Activities as Scheduled in the *Environmental Protection Act 1994* (EP Act) and the *Environmental Protection Regulations 1998;*
- Approvals for water crossings under the *Water Act 2000;*
- Development Approvals for material change of use under the *Integrated Planning Act 1997* (or the recently passed but as yet uncommenced) *Sustainable Planning Act 2009;*
- Storage tenements and approvals under the GGSA and related environmental authorities under Chapter 5A of the EP Act;
- EPBC approvals as necessary; and
- Registrations with the National Electricity Market via the *National Electricity (South Australia) Act 1996.*

Other legislation that may apply to the project includes:

- *Clean Coal Technology Agreement Act 2007;*
- *Native Title Queensland Act 1993;*
- *Aboriginal Cultural Heritage Act 2003;*
- *Petroleum and Gas Regulations 2004*; and
- Greenhouse Gas Storage Regulations (currently being drafted but expected to be in force by late 2009 or early 2010).

Additionally the planning schemes for the relevant local authority or local authorities may provide guidance on the development approval or compliance conditions attached to the project.

The project has completed a screening level study on the potential impacts of a site on an airport as per the Civil Aviation Safety Authority (CASA) guidelines. If this site proceeds then an approval may be necessary from CASA.

7 Conclusions

ZeroGen is developing a proposal to construct and operate a commercial-scale IGCC plant with carbon capture and sequestration of carbon dioxide in Central Queensland. The plant will integrate the gasification of coal with the capture, transport and storage of carbon dioxide and the reduction of other emissions.

ZeroGen supports Queensland Government climate change initiatives and, when constructed, will assist with the ongoing use of black coal within an economy in transition to a low carbon future. The plant will be constructed in central Queensland and will support ongoing economic activity and employment opportunities in the local and regional communities.

ZeroGen has attracted international interest in its activities, reflecting the importance of this project in commercialising the use of low emissions coal-fired generation.

ZeroGen has conducted a range of studies throughout the area to develop an understanding of the background environmental values and factors which will assist in the development and characterisation of the receiving environment. Included in these studies are ongoing investigations into the suitability of the Northern Denison Trough to safely store at least 60 million tonnes of carbon dioxideat a rate of 2 -3 million tonnes per annum over the life of the Project.

A range of other studies will be completed during the feasibility study period including the development of an EIS examining the potential effects on the station on the receiving environment, the social and cultural community values and the broader economy.

ZeroGen will ensure Queensland, its coal industry and MHI are recognised as world leaders in the next generation of power generation, decoupling coal-fired electric power generation and the emissions of related gases and provide Australia and the world with a clear avenue to a low carbon future. The ZeroGen project will provide low emissions, dependable, competitive energy in an active carbon market that will also ensure the continued mining, export and use of Australian black coal.

8 Bibliography

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