Mt Piper Power Station Extension

ENVIRONMENTAL ASSESSMENT

CHAPTER 3 – PROJECT DESCRIPTION

- September 2009

Contents

3. Project Description

The Director-General's requirements:

- *details of project construction, operation, decommissioning, staging and key ancillary infrastructure (e.g. ash disposal, fuel delivery and storage) under both coal fired and gas generation scenarios including identification of likely worst case development footprint;*
- *details of the extent to which existing infrastructure and facilities (including water sourcing and ash disposal) would be used for the project;*
- *identification of fuel source options for the project and feasibility of those options; and*
- *supporting maps/plans clearly identifying existing environmental features (e.g. watercourses, vegetation), infrastructure and land use (including nearby residences and any approved sensitive land use) and the siting of the project in the context of this existing environment.*

3.1 Location

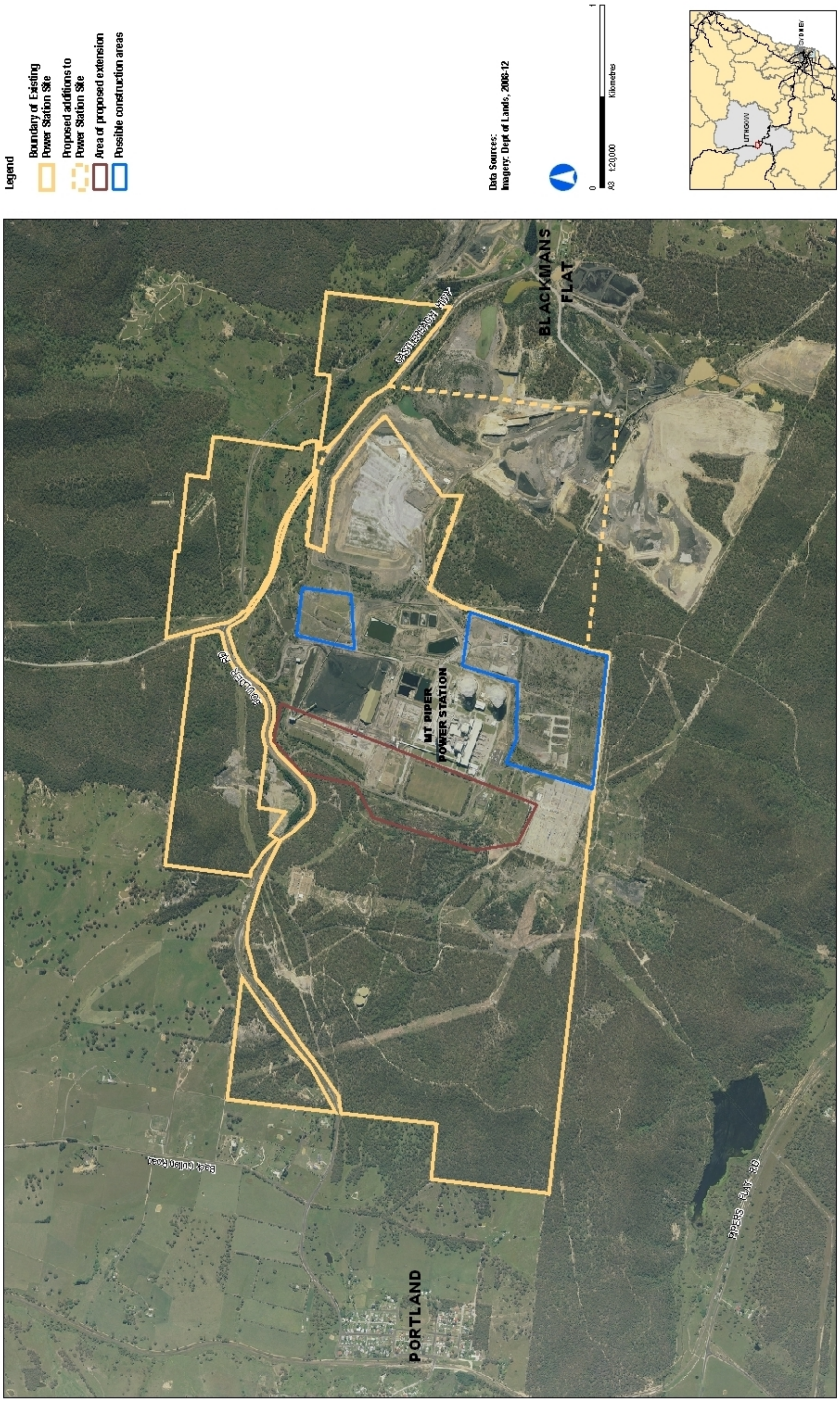
The project site is occupied by the existing Mt Piper Power Station, owned and operated by Delta Electricity. The proposed Mt Piper Extension would be located on the site, generally to the west of the existing power station in an area originally prepared in the 1980s for the installation of coal generation Units 3 and 4 which were never built.

The power station site and surrounding area, the existing Units 1 and 2 and associated infrastructure and a schematic footprint of the proposed extension are shown in **Figure 3-1**.

3.2 Overview of Existing Power Station

The existing Mt Piper Power Station was commissioned in 1992 and 1993 and has been operational since 1994. It comprises two 700 MW steam turbine generators (known as Units 1 and 2), driven by steam (subcritical[1] pressure cycle) provided from coal-fired boilers. It has an approximate average output of 9,700 GWH/year.

[1] Subcritical steam is that which occurs below the critical point of water at 22.1 MPa and 374 degrees C.



■ ***Figure 3-1 Area of proposed extension***

The coal is delivered to the power station via conveyor or truck, and is ground in pulverising mills before injection into the boiler furnace chamber in a stream of preheated air. Maximum coal consumption is approximately 250 tonnes per hour. The boiler furnace heats purified fresh water to high pressure (HP) steam which is collected in a pressure vessel (steam drum) at the top of the boiler, before it passes through a superheater stage on route to the steam turbines.

Boiler exhaust gases pass through a series of fabric filters to trap ash particles and prevent particle emissions from the boiler stack. The trapped ash particles are collected and disposed of in a designated ash storage area. The HP superheated steam is expanded through multiple stages of turbine blades on the drive shaft of the turbine, which is connected to the electric generator. The exhaust steam is cooled to water for re-use in the boiler as it passes over a series of condenser tubes, through which cooling water is circulated. The cooling water is circulated through a natural draft cooling tower giving up heat through evaporation of typically 2-3% of water. The heat is dissipated to the atmosphere as a humidified plume of warm air from the cooling towers. The generation of electricity from Units 1 and 2 requires up to 50 ML/day of water for cooling and about 0.4 ML/day for steam cycle makeup.

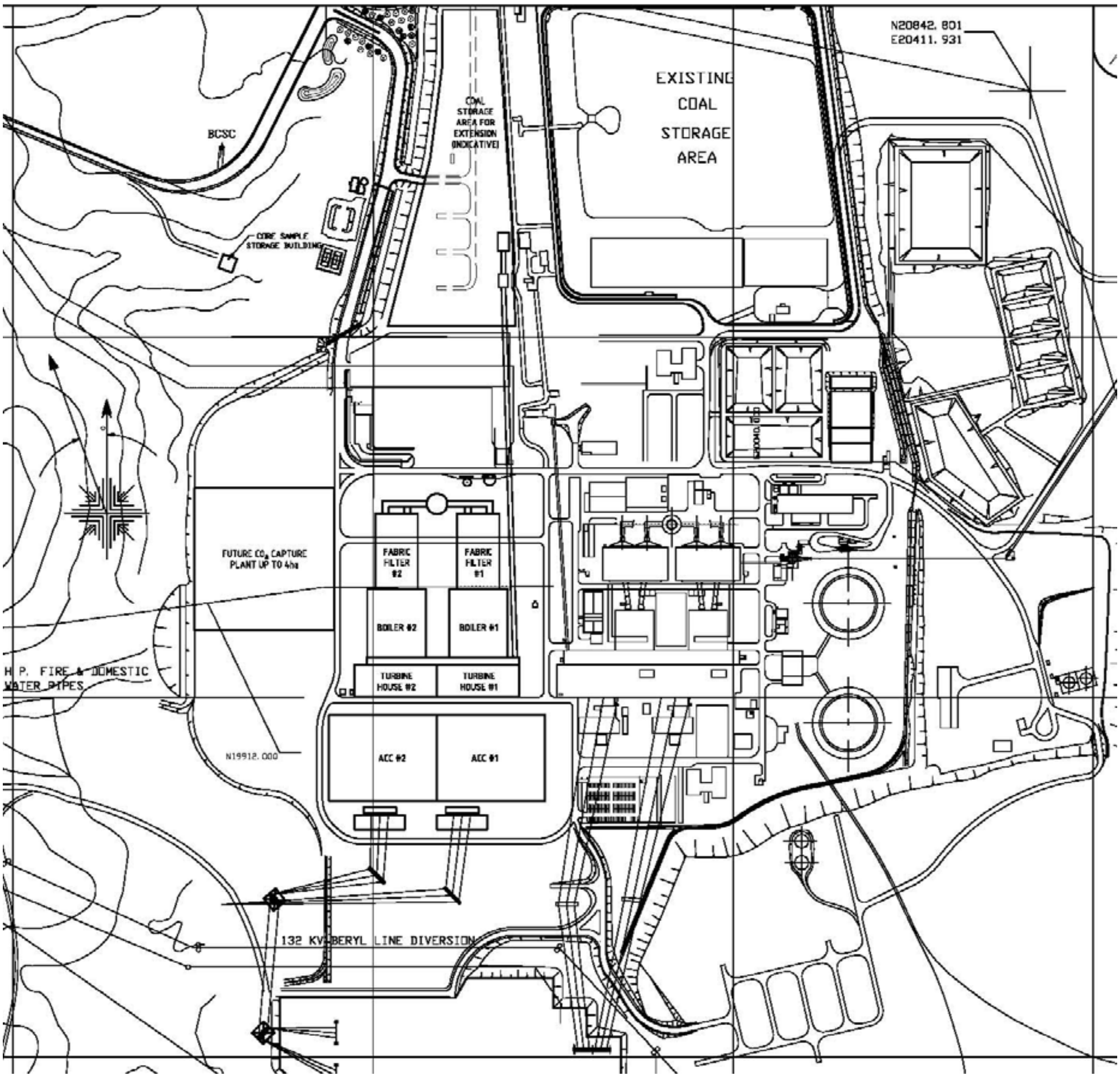
The electrical generator consists of a rotor revolving at 3,000 rpm to generate electricity (alternating current) in the stator (a series of coils grouped around the rotor). Electricity is produced in the 700 MW generators at a voltage of 23 kV. It then passes through a generator transformer where the voltage is stepped-up to 330 kV for overhead connection to TransGrid’s nearby 330 kV switchyard and thence to the electricity transmission network.

3.3 Project Description – Ultra-supercritical Coal

The project description for the coal fired alternative is based on information provided in feasibility studies by SKM (2007) and plant definition studies by Connell Wagner (2008a) and Aurecon (2009).

3.3.1 Plant layout

The Mt Piper Power Station Extension would have a generating capacity of up to 2,000 MW. A (typical) layout of the new plant is shown in **Figure 3-2**. It is indicative only at this stage and will be dependent on detailed design considerations.



■ *Figure 3-2 Coal Fired Plant Layout*

The project would typically include:

- A Turbine house area;
- Air cooled condensers (ACCs);
- Generator transformers and overhead lines;
- Boiler house and fabric filters;
- Bottom ash and fly ash handling plants;
- Fly ash conveying route to ash storage areas;
- Coal handling plant, storage area and conveyors;
- Oil separator and contaminated water pits;
- Main roadway and diversions; and
- Area allocated to the future Carbon Capture Plant.

The new plant would comprise the installation of two power generators within the benched area previously prepared for the extension. The benching would need to be extended to the west and south to fit the ACCs. This would entail cutting into existing slopes in those areas to make way for the large area required for the ACCs. Road deviations would be needed, with the diversion of services and drains in the affected areas.

The existing benched area has 3 to 7 metres of compacted fill sitting on sound rock. The existing power station structures are supported on reinforced concrete piles or pads of depths 3 to 7 metres. The power station extension foundations would be similarly constructed.

The Mt Piper Extension would be as stand alone as possible, utilising only those resources of the existing station where it is impractical to do otherwise. These resources include:

- The water supply infrastructure;
- The future Western Rail Coal Unloader and associated conveyor;
- The extension to the existing ash storage area which is the subject of separate planning application to meet the needs of the existing Units 1 & 2; and
- Waste water treatment facilities.

3.3.2 Plant operation

The Mt Piper Extension would generally operate as follows:

- The coal would be pulverised and used to fire the two new boilers. Ash would be collected and transported by conveyor or truck to the ash storage areas, and flue gas emitted to the atmosphere via a single stack, approximately 250m in height;

- The steam generated by the boilers would be routed to the high pressure turbine where some of the heat energy would be converted to mechanical energy. The steam would then return to the boiler for reheating before it flows through the intermediate pressure turbine and then to the low pressure turbine to convert more of the heat energy into mechanical energy. Steam discharged from the low pressure turbine would pass to direct dry air cooled condensers (ACCs) to be condensed to water before it is returned to the boiler by way of feed heaters, which use steam extracted from the turbines. Heat would be dissipated to the atmosphere via fan-forced air flow;
- The electrical power output of the power station would be delivered, via step-up generator transformers, to TransGrid's new 500 kV switchyard adjacent to its existing 330 kV switchyard;
- The proposed extension would also operate 24 hrs/day 7 days/week.

In general, the new plant (extension) would differ from the existing plant in two major factors:

- It would use ultra-supercritical[2] rather than subcritical technology for the boiler steam cycle, thereby increasing efficiency and minimising the level of greenhouse gas emissions from coal burning; and
- It would use ACCs, rather than evaporative cooling towers, to eliminate the consumption of water for steam condensing.

In addition to the ultra-supercritical, high efficiency plant design proposed, provision would be made for the station to be "carbon capture ready". Technology to capture CO_2 from flue gas is still under development and not proven on a commercial scale for power stations. In the trials being undertaken CO_2 is generally striped and concentrated. Captured CO_2 is compressed and dried for storage or utilisation. An area would need to be set aside for retrofitting a Post Combustion Carbon Capture (PCCC) plant, and an area of up to 4 ha has been reserved (see **Figure 3-2**) for a plant, together with a scrubber unit, wet flue gas desulphurisation (FGD) plant and auxiliary equipment. Due to the uncertainty as to the requirements and technology involved, the PCCC plant would be subject to separate approvals, when further information is available.

A more detailed description of the proposed works, and the extent to which existing infrastructure at the Mt Piper Power Station would be used for those works, is outlined below.

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[2] Supercritical steam is that which occurs above the critical point of water at 22.1 MPa and 374 degrees C. Ultra-supercritical, although not formally defined, is generally regarded as plant which operates with steam conditions above about 26 MPa and 580 degrees C. This allows more efficient consumption of coal and results in lesser CO_2 emission levels per MW produced than the existing subcritical technology used in Units 1 and 2.

3.3.3 Power Generation

Turbines and Boilers

The proposed system would comprise an ultra-supercritical conventional steam cycle. Assuming nominal steam conditions for a USC unit of 28.5 MPa and 600/620 deg C, modelling with reference to the parameters of other commercial plants in comparable climatic conditions, indicates a design efficiency of about 38.6% and an annualised efficiency approaching 39.2% for plant with ACCs and local conditions.

The boilers would be provided with low NOx burners and combustion control to meet emission criteria. The furnace bottom ash extraction would be a dry system for improved water economy and boilers would be supplied with dual air and flue gas paths. Boiler dust emission control would use a fabric filter dust collection plant for flyash removal from the flue gas. A single twin-flued stack would be used for the two units.

Cooling Technologies

It is proposed that the two units are dry cooled using Air Cooled Condensers (ACCs). Direct ACCs pass steam from the LP (low pressure) turbine exhaust direct to the finned tube heat exchanger modules, which are each cooled by a forced draught fan.

Auxiliary cooling can employ evaporative or dry cooling circuits. Evaporative cooling for the auxiliary cooling water systems has been assumed in the estimate of the annual water needs of Mt Piper Extension.

Flyash and Furnace Conveyance and Disposal

In the existing power station, flyash is conveyed in the fly ash collection plant by means of a dense phase system to a silo for transfer to conveyors. Furnace ash and economiser grits are transferred from the boilers by submerged scraper conveyors. The furnace ash and economiser grits are then held in an open top hopper for loading into trucks for carriage to the ash repository.

A new pneumatic extraction and transportation system using dry, compressed air as the transport medium, would extract flyash from the fabric filter hoppers and transport it to the new flyash storage silo. A new flyash silo providing storage for the new plant would be provided and the silo would be equipped with a truck loading facility to allow truck transport off-site or to the disposal areas.

Approximately 20% or 150,000 tonnes per year of flyash from the existing plant is sold to Flyash Australia. This ash is transferred from the existing flyash silo to Flyash Australia's on-site plant. A bypass conveyor has been retrofitted to the flyash silo to allow the transfer of ash to trucks rather than the conveyors. A similar arrangement would be provided in the new silo should a market be found for some ash re-use.

Transportation to the ash placement area of the fly ash is by fully enclosed belt conveyors. These conveyors discharge into separate surge bins located in the ash placement area, from which the ash is discharged into a bottom dump ash trailer/truck for ash emplacement. When the conveyors are out of service ash is taken by truck to the ash placement area.

The ash placement area for the existing plant is located on the north-east side of the site and is shown in **Figure 3-3**. It is estimated that this area (known as the stage 1 ash placement area) has 6-7 million m^3 of remaining capacity. Accounting for the 150,000 tonnes per year to Flyash Australia, approximately 600,000 m^3 per annum of ash is currently placed in the ash area. The western end of the placement area is used for brine conditioned ash. The remaining area available for flyash is estimated to have approximately 5-6 years capacity, after which an alternative ash placement area will be required.

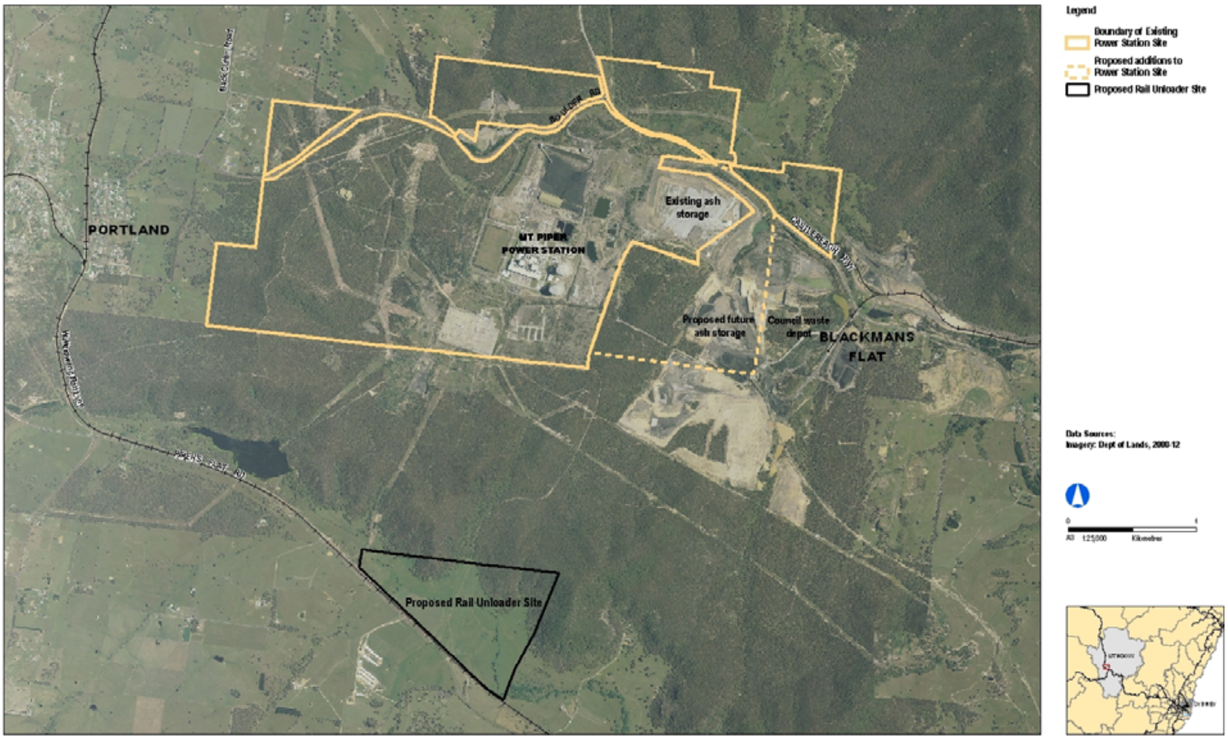
The options for future ash placement from the existing plant and for the extension project are subject to a separate study and approval process. An application will be lodged for approval for ash placement in areas to the east of the existing power station currently being mined (open cut) for coal (see **Figure 3-3**). These areas are located next to the existing ash placement areas and, if the application for ash placement were approved, these areas would provide space for the continued placement of ash from the existing power station and the new coal fired plant.

For the new plant two new suitably enclosed conveyors with flexibility for routing would run from the new fly ash silo to the future ash placement area.

3.3.4 Water Treatment and Disposal

Mt Piper Extension would be designed for "zero water discharge" status, the same status as the existing Mt Piper power station. As Mt Piper Extension would use ACCs rather than evaporative cooling, there will be no requirement for large scale blowdown water treatment plants. The relatively small volume of water that will require treatment could be treated in the Reverse Osmosis and/or brine concentrator plants at the existing Mt Piper Power Station. However, the Mt Piper Extension would require independent Contaminated Control Systems.

The existing Mt Piper Power Station operation incorporates an advanced water management system whereby all potentially contaminated water is treated and reused on site. Only clean, uncontaminated water, principally stormwater, is discharged from the site. Station and coal stack runoff water is treated in siltation ponds and discharged to Neubecks Creek via a holding pond which has an underflow weir. The discharge is monitored and licensed under Delta Electricity's Mt Piper Environment Protection Licence. A similar arrangement for storm water drainage would be designed for the Mt Piper Extension with its own licensed discharge point reflecting the different ownership.



▪ *Figure 3-3 Mt Piper Power Station*

Demineralised Water

The existing demineraliser plant is located in the water treatment plant and produces make-up to the boiler feed water systems. Demineralised water is stored in two 2 ML demin water storage tanks.

The Mt Piper Extension would require two new demineraliser trains to operate for the worst case operation (ie maximum weekly demineralised water usage of the existing units, coinciding with maximum weekly usage for the additional units). As such it would be necessary to add a third new demineraliser train as a standby to cover one of the trains being out of service for maintenance.

Reverse Osmosis and Brine Concentrator Plants

A Reverse Osmosis (RO) of capacity 6 ML per day has been installed in the existing Mt Piper Power Station to treat station cooling water. This water is taken from the Cooling Tower forebay. The use of this plant minimises the need to blow-down water directly into the blow down ponds, with water being recovered through the RO. The RO waste is then used as Brine Concentrator feed.

For the existing Mt Piper Power Station the main wastewater stream is cooling tower water blowdown[3]. This is initially treated in the RO plant, with excess cooling tower blowdown and RO reject treated in the brine concentrator plant. The brine concentrators are designed to prevent discharge of station process and drainage wastes which do not comply with discharge requirements. They are located in the existing water treatment and recovery plant building.

Brine concentrate is piped to the two brine concentrate waste ponds then used to condition flyash and placed at the western end of the stage one ash disposal area.

The Mt Piper Extension would be likely to produce some additional waste water flows. The combined effect of the existing RO plant, which reduces the total volume of waste water needed to be treated, and the storage capacity of the cooling tower blowdown ponds provides a sufficient buffer capacity should one of the brine concentrators be out of service. No additional brine concentrator would be required for the Mt Piper Extension.

Station Contaminated Water System

Contaminated water may be polluted by oil or oil products such as degreasers or detergents. The main components of the drainage system of the existing Mt piper Power Station are:

- Gravity collection system;
- Contaminated water pumping stations and associated rising mains;
- Holding pond;
- Oil-water separator tanks;
- Recovered waste oil tanks.

Potentially oil contaminated plant drainage, washdown and fouled rainwater runoff is directed via gravity pipelines to two contaminated water pumping stations in the immediate area. The contaminated water is pumped to the holding pond and gravitates, via a flow regulating float valve and weir, to the oil-water separator tanks.

There is not sufficient capacity for the oil water separator or the contaminated water pond to accommodate Mt Piper Extension. Therefore, the additional plant would require its own independent collection and separation system.

[3] The steam used to drive the steam turbine generators is condensed after passing through the steam turbines. This requires cooling water from evaporative cooling towers. Due to the evaporation in the cooling towers the dissolved salts in the cooling water supply are concentrated before being blown down and the cooling tower is topped up with fresh water.

Ponds

The existing three settling ponds form an integral part of the design of the water treatment scheme for the existing power station. All three settling ponds are available for receipt of ash washdown water and blowdown flows, demineraliser plant waste and condensate polishing plant waste. Settled water from these ponds gravitates to cooling water blowdown pond. The brine waste ponds are used to store brine produced from the Brine Concentrators. The clean water pond collects and stores brine concentrator distillate, boiler blowdown, treated sewage and bathroom effluent, harvested stormwater and clean effluent from the contaminated water system. The settling ponds and waste brine ponds currently operate without any capacity issues. The clean water pond is typically operated at 60% capacity to provide high quality cooling water makeup. It is maintained at part capacity to allow for an emergency dump from either boiler.

As the Mt Piper Extension units would use dry cooling, there will be no additional cooling water blowdown. The additional units would be likely, however, to produce additional waste water flows and there could be insufficient capacity for this in the settling ponds. The brine concentrate ponds have sufficient capacity to accommodate the likely flow and the existing clean water pond could provide for the proposed extension.

Bathroom and Sewage Effluent

All bathroom and sewage effluent at the existing Mt Piper Power Station is treated by a sewage treatment plant and the effluent is directed, via a clean water pond, to the cooling towers of the existing station where it is reused. As the existing plant has a nominal capacity for 1,000 staff, there would not be a need to augment the existing system to accommodate the additional workforce for Mt Piper Extension.

3.3.5 Fuel Oil

The existing fuel oil system at Mt Piper Power Station comprises two storage tanks, an overflow tank, a fuel treatment system and dual pipelines to the station. Mt Piper Extension would require its own fuel oil system.

3.3.6 Coal Supplies and Infrastructure

The existing Mt Piper Power Station currently consumes about 4 million tonnes per year (mtpa) Mt Piper Extension is likely to consume more than 5 mtpa. Coal required for the new units would be sourced from a competitive market and would probably be transferred via rail to the proposed coal unloader at Pipers Flat (location shown in **Figure 3-3**) and/or conveyor or private haul road from local sources. The rail unloader was approved in June 2009 (PA 06_0271) and the assessment was undertaken as a separate project, independent of the Mt Piper Extension; the requirement for a coal unloader at Pipers Flat was not dependent on the construction of new coal generation units but on the reduced availability in the future of locally mined coal.

Coal would be sent by conveyor from the railway facility to a new coal handling plant at Mt Piper Extension. The conveyor would also provide coal to the existing coal handling plant. The existing coal handling plant includes the main receiving bin, conveyors to/from the long term and live stockpiles and crusher station sizers.

The new coal handling plant would have similar facilities with a smaller long term storage area (as shown in **Figure 3-2**). Mt Piper Extension is likely to be owned by a different entity to the existing power station, and a new coal handling plant has been provided since coal is a key component in the competitive advantage of a coal-fired power station. Use of the existing coal handling plant is unlikely to be practical because of the difficulty in segregating the coals and providing access to each simultaneously if required.

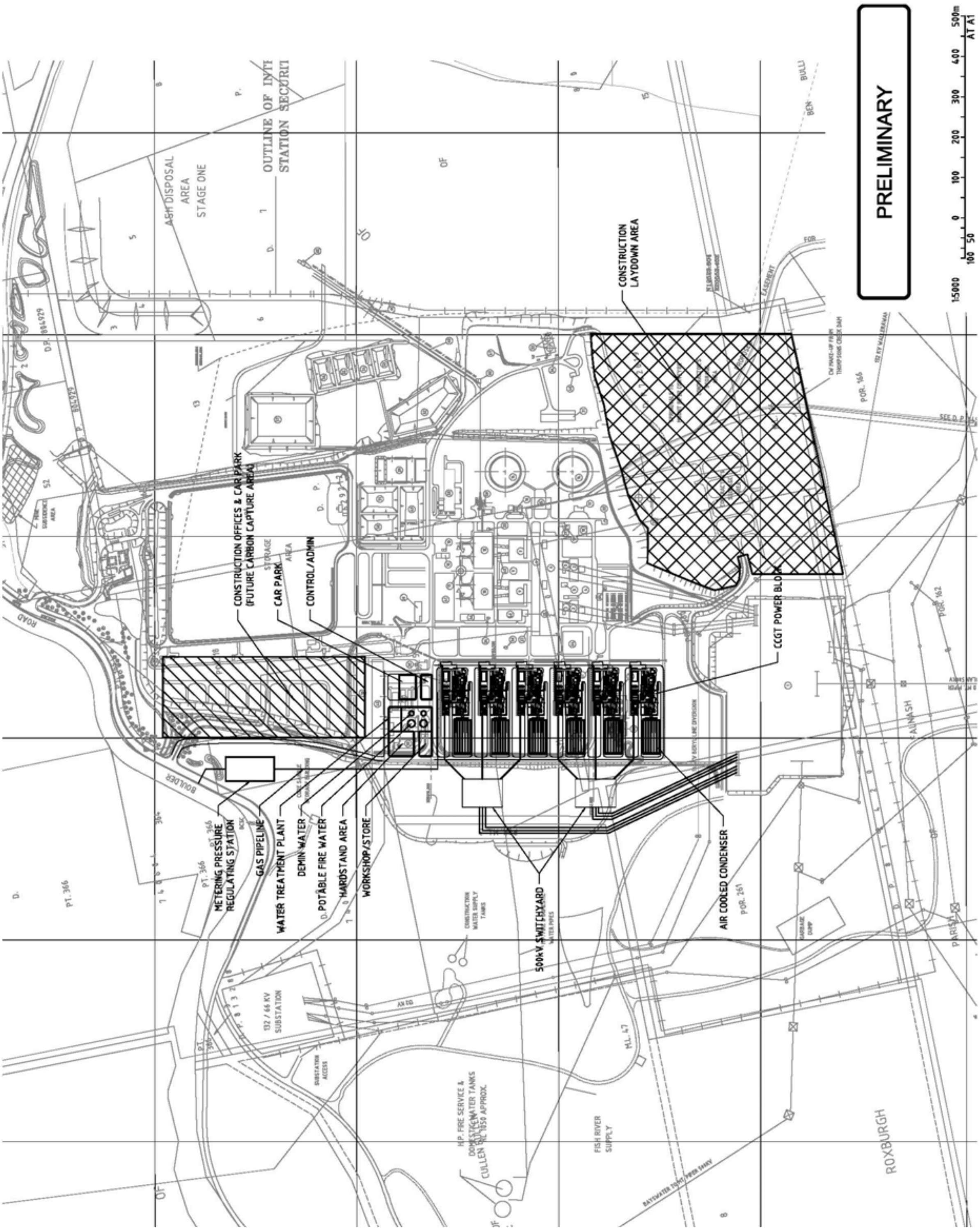
3.4 Project Description – Combined Cycle Gas Turbine (CCGT)

The Mt Piper Power Station Extension CCGT would consist of up to six gas-fired combined cycle blocks with a total net capacity of nominally 2,000MW. The new units would employ combined cycle gas turbine technology as this is the most efficient power generation cycle commercially available for this size of plant. As with the coal fired option, air cooled condensers (ACCs) would be used to condense the steam leaving the steam turbines to minimise water usage. The proposed works would be located generally to the west of the existing power station on the site originally designated in the design and earthworks for the installation of coal fired generation Units 3 and 4. A site layout showing the existing plant and a schematic layout of the proposed Combined Cycle Gas Turbine (CCGT) Blocks is shown in **Figure 3-4**.

3.4.1 General Combined Cycle Plant Description

A combined cycle plant utilises the commonly used Rankine (fossil fired boiler plant) and Brayton (gas turbine plant) thermodynamic cycles together in a single cycle. The simplest configuration consists of a gas turbine (GT), a heat recovery steam generator (HRSG) and a condensing steam turbine (ST).

Natural gas is fired in the gas turbine which drives a generator producing power. The hot exhaust gases from the gas turbine are ducted into the HRSG to produce steam (replacing the conventional fossil fuel fired boiler). The steam is expanded through the steam turbine driving a generator to produce additional power. Steam is raised at three pressures and there is normally a reheat section in the steam cycle wherein steam leaving the high pressure steam turbine is reheated and mixed with intermediate pressure steam generated in the heat recovery steam generator. Low pressure steam would be mixed with the steam leaving the intermediate pressure steam turbine section.



■ ***Figure 3-4 CCGT Plant layout***

The expanded steam is all condensed as in a normal Rankine cycle and returned to the heat recovery steam generator as feedwater, thus making a closed loop water cycle. The gases leaving the heat recovery steam generator are exhausted to the atmosphere. Fabric filters are not required because there is no flyash to collect from the combustion of gas.

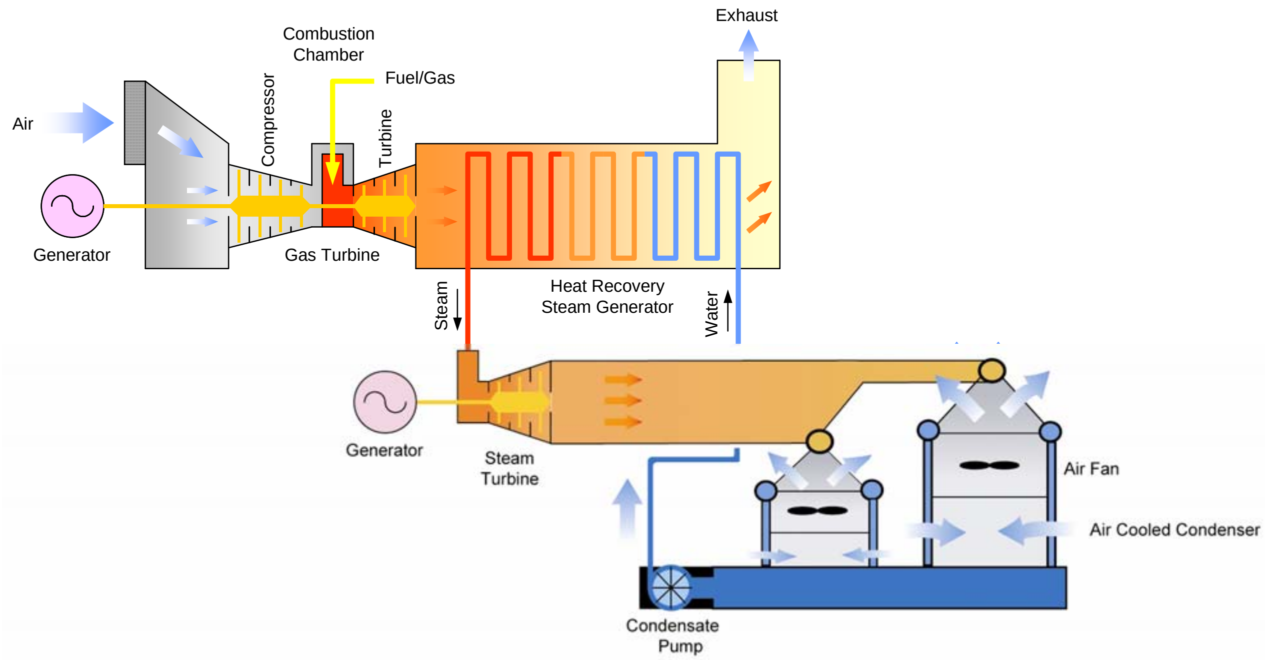
The air, fuel, water and steam cycles can be integrated to greater or lesser extents (eg fuel pre-heating, steam generation using cooling air extracted from the compressor, steam cooling of gas turbine blades). The final design would normally depend on the equipment supplier's approach.

Approximately two thirds of the cycle power is generated by the gas turbine and the remaining one third by the steam turbine. This ratio varies slightly, however, with plant selection and the mode of operation.

Typical installed efficiencies range between 50 to 55% Higher Heating Value (HHV) at standard design conditions. The simple combined cycle configuration above is described as 1 x 1 x 1, i.e. there is one GT, one HRSG and one ST. Other configurations are possible, the most common alternative being 2 x 2 x 1.

A process overview of a combined cycle plant with an air cooled condenser and 1 x 1 x 1 configuration is shown in Plate 1 below.

- **Plate 1 Process overview for CCGT with dry cooling**



3.4.2 Unit Sizes and Available Plant

Combined cycle plant sizes are set by gas turbine sizes, which are limited to the standard sizes available from the original equipment manufacturers. There is a small variation from the steam cycle optimisation, which is driven by fuel efficiency rather than size requirements. In general new plant unit sizes are increasing over time and the actual size and capacity of the plant will depend on their commercial availability at the time of tender.

There are four main manufacturers for large heavy industrial gas turbines: Alstom, General Electric (GE), Mitsubishi Heavy Industries (MHI) and Siemens. The performance of the various plant options available in the size range under consideration here is summarised in **Table 3-1**.

- **Table 3-1 ISO Ratings for Available Plant**

GT Model	GT26	9 FB	701 F	4000F	9H	701 G	8000H
Supplier	Alstom	GE	MHI	Siemens	GE	MHI	Siemens
Nominal Capacity	424	413	416	416	520	498	530
Nominal Efficiency (HHV)	53.0%	52.7%	53.6%	53.0%	54.5%	53.9%	54.5%

Data from Gas Turbine World 2007/08 and Siemens, assuming one gas turbine/HRSG/steam turbine and at 15°C, sea level and 60% relative humidity and wet cooling.

Actual output at the site would be lower than these values for a number of reasons, principally:

- The site is 940m above sea level. Air density reduces with elevation and so the gas turbine output reduces with the lower mass flow possible at this higher elevation; there is minimal impact on plant efficiency;
- The steam cycle would use air cooling. This means the pressure in the low pressure end of the steam cycle will be higher than it would be with wet cooling. This would reduce the capacity of the steam turbines. Gross efficiency is reduced due to the lower steam cycle capacity. Also, air cooled condensers tend to use a relatively large amount of auxiliary power, reducing net power output further.

The plant may be upgraded to some extent over the plant life increasing output and efficiency. For this assessment we have assumed the nominal capacity of 2,000MW would be delivered by one of the plant types and combinations listed in **Table 3-2**.

Table 3-2 Estimated Site Based Performance

GT Model	GT26	9 FB	701 F	4000F	9H	701 G
Supplier	Alstom	GE	MHI	Siemens	GE	MHI
Number of Units	6	6	5	6	5	5
Nominal Net Capacity (MW)	2,193	2,283	1,997	2,171	2,164	2,142
Net Efficiency (%, HHV)	51.5%	51.8%	51.3%	51.6%	52.9%	52.4%
Net Heat Rate (kJ/kWh, HHV)	6,990	6,940	7,020	6,980	6,810	6,880

Data from GTPro model, assuming multiple blocks of one gas turbine/HRSG/steam turbine and at 15°C, 940m, 70% relative humidity and an ACC.

From hour to hour, output and efficiency will vary as ambient temperature, humidity and pressure fluctuate. **Table 3-3** summarises expected performance for a plant based on the GE 9FB operating at the design temperature and at the extremes of ambient conditions.

Table 3-3 Estimated Performance at Extremes of Ambient Temperature

Temp/RH		15°C/70%	-5°C/95%	35°C/20%
Gross Power	[MW]	2,332	2,431	2,133
Net Power	[MW]	2,283	2,387	2,086
Gross Heat Rate	[kJ/kWh, HHV]	6,800	6,880	7,140
Net Heat Rate	[kJ/kWh, HHV]	6,940	7,000	7,300

Data from GTPro model, 15°C and 35°C conditions assume evaporative cooler is in service.

Part load efficiency will be lower than efficiency at base load. Because of its relatively larger output, the GE 9FB design tends to have the largest envelope of requirements and produce the greatest impact. Data used for this study is generally based on a plant incorporating this design.

3.4.3 Plant layout

For this study it is assumed the combined cycle units would be built as single shaft blocks. This is the preferred design for this type of plant. The gas turbine and steam turbine drive a common generator, normally located between the two prime movers. This design delivers the lowest cost power and is the standard offering from the manufacturers.

Alternatives are possible – most commonly where the steam from more than one gas turbine/HRSG train is sent to a single steam turbine. For a 2,000MW plant at Mt Piper, the most likely alternative options are:

- Three blocks, each with 2 gas turbines, 2 HRSGs and a single steam turbine;
- Two blocks, each with 3 gas turbines, 3 HRSGs and a single steam turbine.

The turbines and generators would be located in turbine halls. The HRSGs, ACCs and step-up transformers would be located outdoors. Balance of plant equipment would generally be located in weather proof enclosures.

The new plant would comprise the installation of up to six units in the benched area previously prepared for the extension during the construction of Units 1 and 2. As for the coal fired option, this would require:

- The benching to be extended to the west and south, by cutting into existing slopes in those areas; and
- Road deviations, with the diversion of services and drains in the affected areas.

The existing benched area has 3 to 7 metres of compacted fill sitting on sound rock. The existing power station structures are supported on reinforced concrete piles or pads of depths 3 to 7 metres. It is expected that the foundations for the gas fired power station extension would be similarly constructed.

The extension could be built to utilise some existing infrastructure or to be completely stand alone. This assessment assumes the new plant will be largely stand alone, with minimal sharing of services between the existing and new plants. Any shared services would likely be limited to:

- Domestic sewage;
- Access.

It is also possible that liquid wastes would be sent to the existing plant for disposal or for use within that plant in order to reduce demand associated with the existing coal fired power station.

3.4.4 Water Treatment and Disposal

As noted in Section 3.3.4 the existing Mt Piper Power Station operation has a water management system whereby all potentially contaminated water is treated and reused on site and only clean, uncontaminated water is discharged to Neubecks Creek via a holding pond which has an underflow weir. The discharge is monitored and licensed under Delta Electricity's Mt Piper Environment Protection Licence. A similar arrangement for storm water drainage would be designed for the Mt Piper Extension with its own licensed discharge point reflecting the different ownership.

Wastewater from the proposed CCGT alternative would be routinely handled with on-site treatment and neutralisation and any resultant effluent reused on site, disposed of to the existing power station or collected and disposed of by a licensed contractor. Alternatively, these waste streams could be sent directly to the existing wastewater treatment plant for treatment, as outlined in the coal fired option.

The expected volume is low, in the order of 25t/h, and could probably be used to offset raw water demand at the existing plant. If installed, blowdown from the gas turbine inlet air evaporative cooler (estimated to be approximately 20t/h at 35°C and 20% relative humidity) would not need on-site treatment and could be used to offset cooling water demands at the existing coal fired power station. Based on the operating regime described, 80ML per year of blow down may be available from this source.

Water wash wastes will be collected separately and disposed of by a licensed contractor. Oily wastes will be collected and the oil removed in a Class 1 (in accordance with EN 858) (5ppm) separator with the resultant effluent either reused or disposed of to the existing plant.

Clean storm water will be reused where possible, and where not, disposed of via the storm water system and the new licensed discharge at Neubecks Creek.

As for the coal fired option, all bathroom and sewage effluent would be sent to the existing sewage treatment plant.

3.4.5 Gas Supply Infrastructure

It will be necessary to provide gas to the site to run the gas turbines. The availability of gas for potential gas turbine operations in NSW was reviewed by Wood MacKenzie (2007) as part of the Owen Review. Wood MacKenzie stated that the total gas resource of Eastern Australia as of July 2007 was 13,980 PJ, equating to approximately 23 years of production at 2007 levels. The Gippsland Basin was the most significant region (6,859 PJ), with coal seam gas (CSG) in South East Queensland up to 4,000 PJ. By contrast the Cooper Basin has 1,213 PJ of gas reserves and production is in decline. Wood MacKenzie also identified "Additional Potential" reserve additions for the CSG of up to 8,578 PJ.

It is necessary to build a new gas pipeline to the site from the gas sources or pipelines already connected to those sources. The exact location and description of the pipeline and approvals processes are not considered here, but to demonstrate it is feasible we have assumed that the pipeline would off-take from the existing Sydney Moombah 864 mm Pipeline at Young and follow in the same easement as the existing Young to Lithgow 168 mm pipeline via Cowra and Blayney, leaving the existing easement west of Lithgow to travel along road easements such as Castlereagh Highway to the Mt Piper site.

The existing Young to Lithgow pipeline is not adequate for the gas required at Mt Piper Extension. A new pipeline would be at least 457mm diameter and would be required to deliver approximately 133PJ per annum to Mt Piper for the CCGT plant operating at a 95% capacity factor. A Meter Pressure Regulating Station (MPRS) would be required comprising dry gas filtering, metering, water bath heating to maintain regulated outlet temperature, pressure regulation to 3-5MPa, pressure and temperature measurements, remote isolation valve, control hut to accommodate the communications, computing and auxiliary equipment, pipeline blowdown vent and remote control and monitoring.

Nominal demand would depend on the actual plant chosen. Day to day demands would fluctuate as ambient conditions change. **Table 3-6** summarises expected demand, depending on ambient conditions.

- **Table 3-6 Estimated Gas Demand ***

Temp/RH		15°C/70%	-5°C/95%	35°C/20%
Gross Power	[MW]	2,332	2,431	2,339
Net Power	[MW]	2,283	2,387	2,290
Gross Heat Rate, HHV	[kJ/kWh]	6,800	6,880	6,820
Net Heat Rate, HHV	[kJ/kWh]	6,940	7,000	6,970
Gas required, HHV	[TJ/h]	16.0	16.9	16.1

**The power levels are from a GE9FB and are higher than the nominal 2000 MW proposed for this development, representing a worst case demand requirement*

At the site, it is likely to be necessary to construct a gas reception area. In addition to safety related equipment, the gas reception area would include gas metering, gas heating and gas pressure regulation. This equipment would all be accommodated in a dedicated, fenced area.

3.5 Carbon Capture

Although approval is not being sought for a Carbon Capture Plant, as indicated in both options an area has been allocated for the construction of this technology when practicable. Technology to capture CO_2 from flue gas is still under development and not proven on a large scale for commercial operation. The plants could be retrofitted with carbon capture technology. Space would need to be provided for the CO_2 capture equipment (scrubbers, CO_2 compressors), additional infrastructure including cooling water and electrical systems, pipework and tie-ins to existing equipment.

For pre-combustion capture the gas fuel is reformed (with steam alone or a steam/O_2 mixture) to give a mixture rich in H_2 and CO_2. In systems with solid or liquid fuels, these are gasified (with air, O_2 and/or steam) to give a synthesis gas 'syngas' which is shifted to again give a gas rich in CO_2 and H_2. The CO_2 is then separated from the H_2, typically using a physical or mixed solvent system or membranes. The CO_2 is then dried, compressed and sent for storage, whilst the hydrogen-rich gas passes to a gas turbine or fuel cell to generate power.

The Oxyfuel combustion technology involves replacement of combustion air with a mixture of CO_2 rich flue gas recycle and oxygen for combustion. An air separation unit is required to supply a stream of near pure oxygen into the flue gas recycle for the combustion process. A major part of flue gas has to be recycled back to the boiler plant. The resulting flue gas from an Oxyfuel boiler is predominantly CO_2 and water. The CO_2 rich flue gas needs to be cleaned and dried prior to compression for storage.

The most widely considered technology for post-combustion capture involves the use of chemical solvents – typically a form of amine - which react with the CO_2 in the flue gas from a normal combustion process and is subsequently regenerated at a higher temperature, producing a purified CO_2 stream suitable for compression and storage. Other capture technologies, based on flue-gas refrigeration or the use of other capture solvents such as chilled aqueous ammonia are also under development. For amine-based systems, the flue gas needs to be pre-treated to reduce acid gas (NO_2 and SO_2) concentrations to extremely low levels to prevent these reacting irreversibly with the solvents, then cooled either in a heat exchanger or by direct contact with the amine in a scrubber column. The CO_2 -rich solvent is then passed to a stripping column where it is heated in a reboiler to drive off the CO_2 and the amine is recirculated.

For the proposed extension of Mt Piper Power Station it is likely that only Post-Combustion Capture technology is applicable. Although Post-Combustion Capture technology is commercially proven at industrial scale, its integration with coal fired power plant, CO_2 transport and geological storage is in the early stages of development.

3.6 Water Supply and Requirements

The water supply to the existing Units 1 and 2 at Mt Piper is derived from two main sources:

- Fish River water supply system; and
- Coxs River water supply system.

Fish River Supply

The Fish River water is supplied to two 25 ML HP fire and domestic water tanks located on the hill on the western side of the existing power station. The HP fire and domestic water tanks supply water under gravity to the HP and LP fire and domestic water systems. The major uses of the water are to:

- Feed the demineraliser plant for boiler makeup. Although the original design of Units 1 and 2 was for the demineraliser trains to be supplied from the Fish River system, the demineraliser trains are now supplied with higher quality product water (distillate) from the brine concentrators;

- Supply fire service and domestic water. HP fire and domestic water is distributed throughout the existing station by the HP fire and domestic water ring main. The existing power station requires a minimum tank water storage of 17 ML for fire fighting to be maintained at all times. The tanks are typically maintained at capacity, with levels run down during the day and topped up during the night. The current domestic water usage is estimated to be less than 4 ML per year;
- Provide supplementary makeup to the cooling towers; and
- Provide emergency makeup to the cooling towers.

Coxs River Supply

The Coxs River water system comprises Lake Lyell, Lake Wallace, Thompsons Creek Reservoir and various interconnecting pipelines. The Coxs River water is used for:

- Cooling tower make-up for the existing Mt Piper Power Station;
- Washdown water system; and
- Cooling tower make-up for the nearby Wallerawang Power Station.

Springvale-Delta Water Transfer Scheme

In 2006 the “Springvale-Delta Water Transfer Scheme” was implemented in which mine water from Springvale Colliery is redirected via pipeline to Wallerawang Power Station for reuse. The water is transferred from the Springvale Colliery on the Newnes Plateau to Wallerawang Power Station. This system has a design capacity of 30 ML per day and has achieved a reliable transfer rate of 5,500 ML/year (up to 15 ML per day) since commissioning. The scheme reduces the uptake of water from the Coxs River by Wallerawang Power Station, therefore increasing the amount of water available for uptake by Mt Piper Power Station by approximately 15ML per day or 5,500 ML/year.

Water Requirements for Coal Option

The average water usage for the existing Mt Piper Power Station is about 14,150 ML/year or 1,265 ML per month, most of which is cooling tower make-up water derived from the Coxs River system. Up to 20 ML per month is derived from rainwater.

The new coal option with air cooling would not require significant makeup water but would use about 1016 ML/year, primarily to replace losses due to steam and water leakage in the boiler-turbine circuit, as well as to provide for ashing systems (147 ML) and boiler wash downs (341 ML) and auxiliary cooling (300 ML).

Water Requirements for CCGT

For the new CCGT water would be required for:

- Domestic purposes;
- Fire fighting;
- Maintenance, washdowns, compressor washing etc;
- Make-up to the water steam cycle;
- Evaporative coolers (auxillary), if fitted to the gas turbines, to increase output on hot days;
- fogging systems (or equivalent), if fitted to the gas turbines, to increase gas turbine output on the hottest days;
- spray assist to the air cooled condenser to try to maintain a low steam turbine back pressure during the hottest days.

Annual water demand has been estimated (see **Table 3-4**) based on historical temperature and relative humidity data for Mt Piper and the following assumed operating regime:

- Capacity Factor of 95%;
- Evaporative cooler in service at temperatures above 15°C – approximately 2900 hours per annum;
- 150 hours of fogging per annum;
- 20 hours of ACC cooling assistance per annum.

Raw water would be treated on-site to demineralise it before use in the water steam cycle and elsewhere, depending on the plant design.

The CCGT option with air cooling would use about 460 ML/year, primarily for demineralised plant feed and evaporative cooling. Domestic use would be similar to that estimated for the coal fired option (4 ML/year), giving a total water usage for Mt Piper Extension using CCGT of about 465 ML/year.

Table 3-4 Annual Water Demand Estimate

Water Usage	Units	Quantity
Demineralised water		
Steam Cycle Makeup	[ML/y]	200
Fogging	[ML/y]	11
ACC Cooling	[ML/y]	60
Total Demineralised Water	[ML/y]	271
Raw water		
Demineralised plant feed	[ML/y]	300
Evaporative cooling	[ML/y]	160
Total Raw Water	[ML/y]	460

3.7 Power Transmission

Mt Piper Power Station Units 1 and 2 are connected into the national grid at the nearby 330 kV Mt Piper switchyard owned and operated by TransGrid, the local Transmission Network Services Provider. The original planning for the Mt Piper Power Station was based on Units 3 and 4 being connected to a new 500 kV switchyard, adjacent to the existing Mt Piper switchyard, in conjunction with major associated 500 kV transmission system upgrade works at Banaby (near Marulan), Mt Piper and Bayswater (known as the Western 500 kV) and ultimately a 500 kV ring main around Greater Sydney.

TransGrid is currently completing the construction of the 500 kV switchyard at Mt Piper and the Western 500 kV system and it is due in service during 2010. Either the coal or gas fired options for the Mt Piper Extension would connect to the 500 kV switchyard. In the case of the coal fired option, the generator transformer yards of the new units would each connect via overhead 500 kV lines to breaker-and-half bays in the 500 kV switchyard.

For the gas-fired option, the five or six gas turbines would be grouped into two sets of transformer yards with a generator transformer for each CCGT and then connect via overhead 500 kV lines to the breaker-and-half bays in the 500 kV switchyard. Alternatively, all the generator transformers could be located in the one transformer yard with two 500 kV overhead lines connecting to the 500 kV switchyard.

The connection point under the National Electricity Rule (NER) for each coal fired unit or group of CCGTs would be the droppers from the landing spans of the overhead lines at the 500 kV switchyard.

Transmission capacity studies indicate that with the Western 500 kV system in place, at times there may be network constraints with 2,000 MW of generation from Mt Piper Extension connected to the grid as proposed, especially following a trip of a critical network circuit. TransGrid has indicated in its 2009 Annual Planning Report that the proposed 500 kV line from Banaby to western Sydney would be likely to be built should Mt Piper Extension proceed. With this line built there should be no transmission network constraints on the output of Mt Piper Extension. Completion of the 500 kV ring main (i.e. completion of both south and north 500 kV legs) would further improve the situation, especially with regard to marginal loss factors.

3.8 Employment

It is expected that the new plant would require about 50 full-time personnel for its operation, the final number dependent on whether it was coal or gas fired and the outsourcing strategy of the owner or operator.

3.9 Construction

Construction management was addressed in the two recent project studies (Connell Wagner 2008b; SKM 2009) and these studies provided the basic information for the details on project construction.

3.9.1 Staging and Programme

The overall construction works for the Mt Piper Power Station Extension are expected to take about 4 to 5 years for the coal fired option, assuming the two units were constructed concurrently, with the first unit ready after 4 to 4.5 years, leading the second unit by about 6-9 months. These estimates are indicative only and dependent on a number of factors including supply and demand for key components and the contract strategy of the owner.

The (up to 6) CCGT unit blocks would also be built concurrently, with a time lag for delivery. The first unit would be ready for operation between 30-36 months after commencement, with each subsequent block being ready approximately 3 months later. If the station is built in blocks based on 2 or 3 gas turbines per steam turbine, then the first block would take longer to be ready for commercial operation and a greater lag between blocks would be expected. Again, these estimates are indicative only. The main construction and commissioning activities for either option include:

- Site establishment and preparation for construction;
- Civil works including earthworks, building and plant foundations;
- Erection of plant and equipment;
- Energisation of electrical plant;
- Commissioning and testing of major plant;
- Removal of temporary containment facilities; and

- Completion of remediation and landscaping works.

3.9.2 Construction Workforce

It is expected that a peak workforce of about 950 people would be required.

For the coal fired plant it is anticipated that typically the workforce numbers build up to a peak after 2 years as boiler and turbine erection is being finalised, erection work is still proceeding on the balance of the plant and a range of commissioning works are under way. The peak numbers would be maintained for about 8-10 months, and would then fall away.

For a gas fired plant based on a single combined cycle block, the workforce numbers build up to a peak after approximately 18 to 24 months as the erection of the main equipment is being finalised and cold commissioning is commencing. The peak would last for approximately three months. For a plant with six blocks, the “peak” could be prolonged for up to two years as construction and commissioning crews move from one block to the next.

Although some jobs would be sourced locally, it is anticipated that an influx of about 750 people from outside the Central west region would be required during the peak construction period. While some contractor’s staff and some construction workers may be accommodated in existing housing locally or in Bathurst, the majority (possibly up to 80%) would need to be accommodated in purpose-built hostels. The social and environmental impacts of this increase in construction workers are addressed in Chapter 14.

3.9.3 Construction Hours

Construction activities would be undertaken during standard daytime construction hours, as follows:

- 7am and 6pm Monday to Friday;
- 7am to 1pm on Saturday if inaudible off site, otherwise 8am to 1pm; and
- No work audible off site on Sundays or public holidays.

It is recognised that a number of construction and commissioning activities need to be undertaken at times when there are minimal personnel on site for safety reasons. This may include time critical activities such as joint cutting in concrete hardstand areas and delivery of bulky items or wide loads during off peak hours to minimise disruption.

Any construction and commissioning outside of these normal working hours would require prior approval from relevant Authorities. Local residents would be informed of the timing and duration prior to any works.

3.9.4 Construction Traffic

Construction traffic would be generated by the delivery of materials and equipment and up to 950 persons travelling to and from the site daily.

There are a number of heavy plant items which would be required for the proposed extension, including inner stators and generator transformers. The exact dimensions and weights would not be known until suppliers have been selected and design completed.

Several transportation options may be available for the movement of heavy equipment to site, including rail, road or a combination of both. When constructing Mt Piper Units 1 and 2 the heavy equipment was transported from Sydney to Wallerawang via rail, where it was unloaded and transported the remaining distance to the site by road. This process may possibly be repeated for the proposed extension, but the following studies would be required:

- The suitability of the existing railway for the types of loads and wagons which would be required;
- The structural limitations to the existing railway and structures;
- Disturbance to other railway users;
- Consideration of available wagon types and load support options; and
- Availability and impacts associated with unloading sites at Wallerawang.

Alternatively, heavy equipment may be transported to the site from Port Botany, Port Kembla or Newcastle by road. The transport of "oversize" or "overmass" vehicles would depend on the suitability of the existing roads, structural capacity of the existing roads and structures, disturbance to communities along the route and changes to traffic conditions which may affect safety. A detailed study would need to be undertaken to define the best route options and load limitations which would apply.

In addition to the transportation of heavy plant there would be on-going deliveries of construction materials, equipment and plant to the site. The types of vehicle movements would vary over the construction period as the works progress from earthworks and major civil works to steelwork erection and installation of equipment.

As noted above construction workforce would peak at about 950 over the construction period, with a significant proportion of these accommodated in hostels in the vicinity of the project site. It is anticipated that contractors would organise transport to and from the site using shuttle buses and car pooling.

Given the equipment transport requirements and the use of mass transport arrangements for staff, it is likely that construction traffic could be up to 1,000 vehicle movements per day.

3.9.5 Site Facilities

The construction of the new units would need to be separated from the operational activities associated with units 1 and 2. Notional construction areas would be contained on the existing site as shown in **Figure 3-1.**

It is likely that the area required for lay down would be up to 300,000 m^2 depending on whether coal or gas fired, the construction strategy and the timing between units. Additional areas may be required for lay down associated with the ACCs, although this would need to be reviewed once delivery arrangements are determined. The areas shown in **Figure 3-1** provide unrestricted lay down area plus a further area where usage may be restricted by vegetation, wet weather access or location.

3.9.6 Site Access

A dedicated access route to the construction area would be required and it is likely that the existing access road becomes the construction access road. The current access road to the existing power station administration and operating area runs through the proposed construction area for Mt Piper Extension. The existing Visitors Centre and gatehouse would be likely to require relocation. Consequently, the main access road would need to be re-routed and divided to give access to the existing power station and Mt Piper Extension. This new access would allow for existing operating traffic to be separate from construction traffic.

At least two option exist to achieve this; one involving a diversion from the existing access off Boulder Road just after the entrance, another involving access to the existing station directly from Castlereagh Highway south of Boulder Road, but north of the existing ash placement area. Access to the Transgrid 330 kV and 500 kV switchyards would also need to be provided.