Water Management– Summary of Key Outcomes

The water requirements, wastewater production, stormwater management and flooding potential have been assessed for both construction and operation of the Dalton Power Project.

The facility has a small essential water demand, comprising domestic water, utility water and firewater water. In addition it has a discretionary process water demand to improve turbine efficiency. While the Facility can run without process water, it is desirable that it be supplied to allow the turbines to operate significantly more efficiently.

Water for the Project will be sourced through a number of options. Water will be sourced from a range of sources including: tankering (by road) water to the Site; groundwater extraction; and via the augmentation of the Dalton or Gunning supply and/or from the Gunning Sewerage Treatment Plant if the water quality is suitable and sufficient water quantities are available. It is currently proposed that the site water supply may be offsite tankering to meet the essential base domestic and utility water demands, and some or all of the process water demands (depending upon the development option adopted). AGL also proposes to obtain water from on site groundwater extraction to meet the full nominated site water supply requirements. Water may also be obtained from Upper Lachlan Shire Council water supplies.

The most significant potential water demand for the Facility is process water, for supply of gas turbine inlet air evaporative cooling and, if installed, high fogging systems. Deionised water is required for the high fogging demand, and deionised water or high quality (low salinity) potable water can be used to supply the evaporative coolers, A process water treatment plant would be expected to be required on site, regardless of the water supply source, although the level of complexity would change depending upon the source(s) water quality. A potable water supply would be required for domestic purpose, as well as a utility water supply for miscellaneous plant uses. Fire fighting water requires dedicated storage tanks. Landscaping water would be sourced from rainwater, although this may need to be supplemented during flora establishment. There would be provision on site for the delivery of bulk water via tanker trucks.

Process wastewater is generated at the Facility by the process of blow down from evaporative air inlet coolers and wastewater streams arising from process water pretreatment. The specific pretreatment processes would depend on the final water supply selection and wastewater streams that may arise from the plant include: ion-exchange resin regeneration wastewater; filter backwashes; and desalination concentrate. The process water treatment plant would be designed to minimise the generation of wastewater following a cost benefit analysis. If a plant configuration is selected which includes both high fogging and evaporative cooling process water demands, then a brine concentration system may be installed to reduce the wastewater volume, and facilitate recycling of the recovered distilled water.

Process wastewater streams would be collected in evaporation ponds lined with a synthetic liner (such as high density polyethylene) and to minimise the risk of the saline wastewater escaping into the natural groundwater system. Brine would be periodically removed from the evaporation pond(s) (or potentially directly if a brine concentrator is installed) when it is nearly dry to manage the accumulation of salts in the pond. This would occur by road tanker for disposal at a licensed facility.

Clean rainwater collected from the Facility catchment area would be directed to a sedimentation pond. The outlet of the stormwater system would be designed to maximize the dispersion of these high flows and thereby minimise their potential to cause soil erosion downstream.

Surface water from potentially impacted process areas and bunded areas would discharge to the sedimentation pond via a sediment and oil trap. Bunds would only be drained (manually) after confirmation that the contents are uncontaminated. In the event of contamination, the bund contents would be educted by vacuum truck and transported offsite to a licensed disposal facility.

All construction works for the Project would be undertaken in a manner to minimise the potential for soil erosion and sedimentation. Wastewater volumes have been estimated and management strategies developed to effectively maintain zero discharge from the site except for natural surface flows.

14.1 Introduction

This chapter presents an assessment of the water requirements, wastewater production and stormwater management at the site for the Dalton Power Project. Both the construction and operation aspects have been considered.

This assessment includes:

- an assessment of the water quantity and quality impacts, with particular reference to the water needs of the Project;
- the proposed source(s) of water;
- the implementation of water saving measures;
- identification of the quantity and quality of wastewater and how this wastewater is to be disposed of; and
- the management of stormwater at the Site.

The Project area is managed by the Lachlan Catchment Management Authority and the Dalton area falls under the Lachlan River – Unregulated surface water management and the Lachlan Fold Belt groundwater management unit. **Figure 14-1** indicates the area of the Lachlan River Catchment, with the Project region shaded purple.

14.2 Existing Environment

14.2.1 Topography and Surface Water

The Site is located in the Lachlan River Catchment. The Lachlan River Catchment is shown in **Figure 14-1**, with the subject area shaded. Much of the Site is comprised of undulating hills, with areas of gently sloping plains to the south and west. A large hill is present in the south-west section of the site. The Lachlan River forms a boundary to the north and east of the Site. The western and eastern sections of the Site gently slope towards the river; however some sections of the property in these locations are quite steep.

The majority of the Site drains to the north, while the south-western portion of the Site drains to the west. There are approximately three farm dams within the site that would have historically been used for agricultural purposes.

The northern and eastern boundaries of the Site are formed by the Lachlan River with the most western and eastern sections having areas of land that slope gently towards the river and are suitable for development.

The south-western corner of the Site is characterised by a large hill which is visible from the surrounding properties but which provides some screening of a large part of the remainder of the Site.

The historic land use for the subject area and surrounds includes predominantly rural enterprises, typically sheep and cattle grazing for the wool and dairy industries. The Site currently operates as a rural land holding for sheep and cattle. The majority of the Site is cleared with remnant vegetation largely confined to banks of some watercourse and ridge lines/steep slopes. Some areas of woodland exist in the centre of the Site.

The Development Footprint, located on the larger property, is shown in **Figure 14-3**. Pre-development contours are shown on the drawing. It can be seen from this that the existing pre-developed site is situated on a ridge line which effectively splits the proposed plant footprint area into two subcatchments, therefore approximately equal volume of surface water runoff currently discharges towards the north and the south. Runoff towards the north discharges into a valley and eventually into the Lachlan River. The southern sub-catchment discharges towards the south into an existing unnamed ephemeral creek, flowing east to west. The unnamed creek is a subsidiary of Oolong Creek, aligned and flowing from the south to the north, which is a tributary of the Lachlan River, towards the north.

14.2.2 Upper Lachlan Catchment Water Quality

Water quality in the upper Lachlan catchment was reviewed by the Department of Sustainable Natural Resources in 2003 (NSW Department of Sustainable Natural Resources, June 2003a).

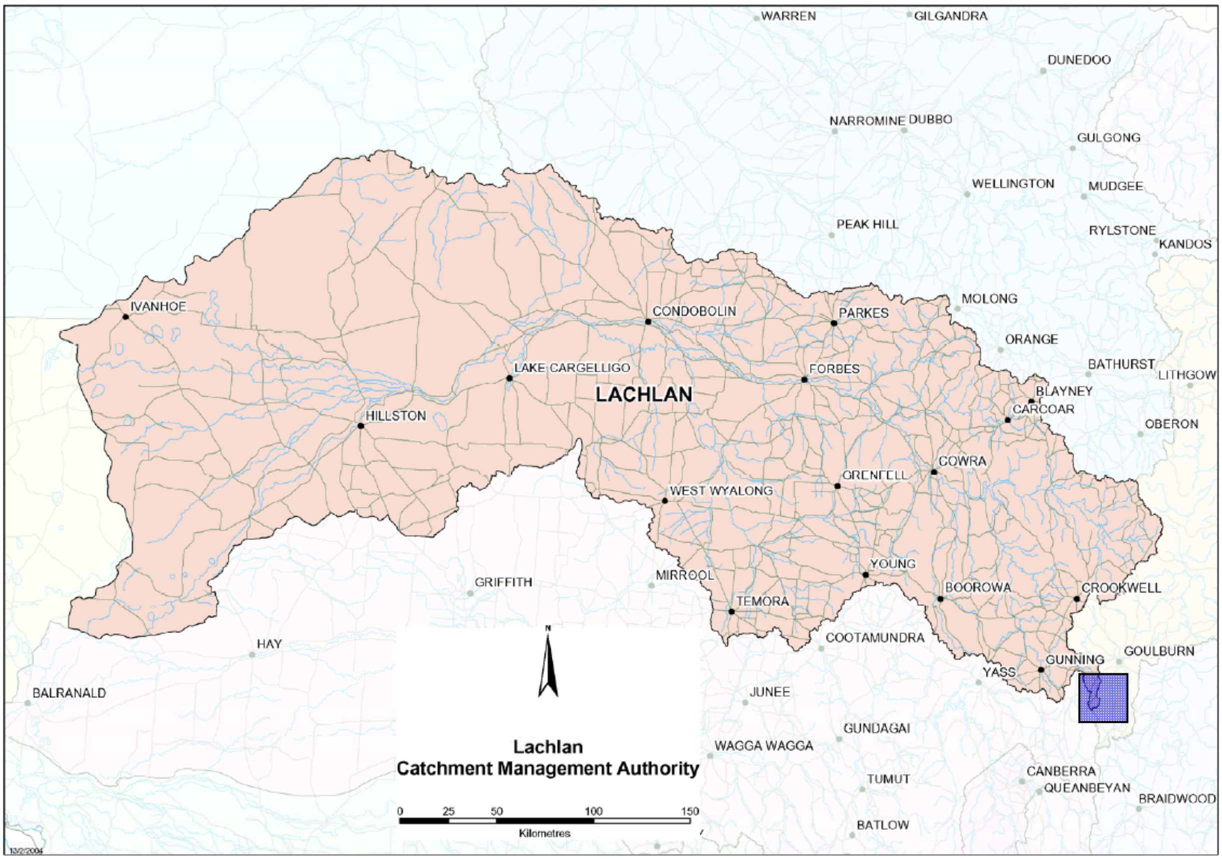
The report indicates that Upper Lachlan River waters are:

- Nutrient enriched with average phosphorus concentrations higher than ANZECC guidelines. However, median phosphorus concentrations are typically below ANZECC trigger values indicating high phosphorus concentrations under flood conditions probably correlated with suspended solids movement.
- Typically high in turbidity particularly during flood events as suspended particulate matter is transported. Turbidity readings are typically well below 50 NTU but under flood conditions turbidity can reach at least 400 NTU.
- High in median nitrogen concentrations often exceeding ANZECC guideline values.

These results suggest a high potential for algal growth with phosphorus limiting conditions.

A review of river salinity in the Lachlan (NSW Department of Natural Sustainable Resources, June 2003b) indicates that waters in the upper Lachlan are considerably more saline than other areas with typical EC readings above 800 µS/cm. The NSW State of Environment Report 2004 shows that EC readings are highly seasonal with winter readings circa 400 µS/cm and summer (low flow) readings ~1000 µS/cm up to ~1200 µS/cm. This seasonal change in EC reflects the increasing dominance of groundwater flows in low flow periods.

Figure 14-1 Lachlan River Catchment



14.2.3 Groundwater

Regional Geology

The Site is located within the very upper reaches of the Lachlan catchment, which is in the north eastern corner of the Murray Basin.

Published geological maps and cross-sections describe the subsurface geology in the study area as Ordovician aged silty sandstone, micaceous siltstone, phyllite, shale and slate. The township of Gunning is flanked to the east and west by north-south trending granites comprising the Silurian aged Wyangala Batholith. The Wyangala Batholith is described as a gneissic and massive biotite and hornblende biotite granite. There are some small areas where Tertiary aged basalts and dolerites outcrop. In the vicinity of Gunning un-named Tertiary aged gravel, sand, clay, claystone and sandstone sediments outcrop (Brunker and Offenberg, 1968).

Regional Hydrogeology

The site is located within the Lachlan River Catchment and within the Lachlan Folds Belt Groundwater Management Area (GWMA). The highest yielding and most actively utilised groundwater targets in the Lachlan Catchment are located in the alluvial aquifers. GWMA's located in the catchment include:

- Lower Lachlan;
- Upper Lachlan Alluvium;
- Belubula Valley Alluvium;
- Young Granite;
- Orange Basalt; and
- Lachlan Fold Belt.

The Lower Lachlan Groundwater Management Area (GWMA) has a water management plan, which commenced in February 2008. The level of entitlement prior to the commencement of the plan exceeded the long-term annual average extraction limit (LTAAEL). The plan reduces the level of water entitlement over ten years to the LTAAEL. Licence holders have also received structural adjustment through the Achieving Sustainable Groundwater Entitlements (ASGE) scheme to alter their enterprises to the reduced level of entitlement.

The Upper Lachlan Alluvium, Belubula Valley Alluvium, Young Granite and Orange Basalt GWMAs are also areas of high groundwater use and entitlement. The Upper Lachlan Alluvium and Belubula Valley Alluvium GWMAs are high yielding aquifers. In these GWMAs the water is mainly used for the irrigation of large areas, such as crops and pasture, whereas in the Young Granite and Orange Basalt GWMAs the groundwater is used for the irrigation of cherries and apples respectively.

The Lachlan Fold Belt GWMA, in which the Dalton Power Project is located, has diverse characteristics due to the large area it covers. In this area the groundwater contributes flows to streams and is the source of spring flows. These systems support a diverse range of aquatic and terrestrial ecosystems, either directly or indirectly. They also ensure the availability of stock and domestic water for landholders.

Local Hydrogeology

The aquifer systems in the vicinity of the Site are limited to a number of basement (fractured rock aquifers) formations. There is no regional scale alluvial aquifer of any note in this portion of the catchment. The basement formations can be categorised into the following:

- Ordovician aged silty sandstone, siltstone, phyllite, shale and slate; and,
- Wyangala Batholith.

Tertiary aged basalts and dolerites and located in proximity to Gunning are unlikely to be utilisable groundwater source in the region due to their limited lateral and vertical extent.

The regional aquifers are fractured rock systems. They support a number of springs, which are registered Groundwater Dependent Ecosystems (GDE) in the area.

Groundwater yields in the aquifers are expected to be highly variable and dependent on the degree and interconnectivity of the fractures. A review of registered groundwater users reported variable yields generally ranging up to 2.5 L/s. Therefore, although typically bore yields are small they are sufficient for stock and domestic purposes.

The nature of fractured systems means that reported flow rates may be an over estimate of the long term sustainable yield given the limited storage in most basement rock systems. The exception to this can be in areas of faulting and/folding where there is extensive, open, fracture systems that are connected to recharge areas. There are a number of these types of features (targets) within the study area, and it is these that would form the basis for any investigation.

There is limited groundwater quality data from the registered groundwater bore information in the study area. Salinity maps of the region suggest that groundwater is within 1,000 and 3,500 mg/L TDS (DWR, 1987) making it suitable for agricultural, domestic and limited industrial use. Salinity concentrations in the vicinity of Gunning are reported to range up to 1,000 mg/L making it suitable for drinking from a salinity aspect (DWR, 1987). This is supported by the actual Dalton groundwater supply quality data discussed in **Section 14.4.2**.

The majority of registered bores located in proximity to the Site are registered for domestic and/or stock purposes.

14.3 Water Demand

14.3.1 Introduction

During operation of the Facility, water would be required for the following uses:

- process water; for evaporative cooling and possibly for high fogging (if a turbine using this technology is selected);
- domestic uses (drinking, toilets, wash basins, etc);
- utility water (turbine wash water, utility hoses, etc);
- fire fighting; and
- landscaping.

The main water demand for the Facility relates to turbine inlet air densification during warmer weather, by evaporative cooling, to improve turbine efficiency. One turbine option being considered also incorporates high fogging, which has the same effect of densifying the inlet air. Deionised water is required for the high fogging duty and the pretreatment processes to remove dissolved minerals from the raw water supply would generate wastewater. In addition there would be a blowdown wastewater stream from the turbine inlet air evaporative cooling system. This is described in greater detail in **Section 14.3.2**. The requirements for these uses are discussed in more detail below and presented in **Figure 14-2.**

In addition to the main process water demand, a relatively smaller amount of additional water is also required for domestic water supply, site utility water, firewater and landscape watering. These demands are discussed further in the remainder of **Section 14.3**.

Table 14-1 outlines the breakdown of indicative water requirements for specific uses within the plant, outlining indicative water requirements for nominal 750 MW (Stage 1) and 1500 MW (Stage 2) plant options on the basis of supply of the process water demands for 438 hours (5 % of the year).

As noted in **Section 2.5,** the normal operation of the plant is expected to be approximately 260 hours (3% of the year). This is the historical average for the operation hours for AGL's peaking plants. However, this has quite a wide variance. Some years it can be as low as 1% (90 hours) or as high as 5% (450 hrs). AGL is seeking the flexibility to operate the Facility for up to 15% of the year to allow for rare and extreme events. Therefore calculations for water use have been based on the reasonable peak runtime of 5% of the year.

It is important to note that the lack of availability to supply process water beyond the nominated demand (or even any) would not affect the ability of the plant to operate and supply power, merely the efficiency of that generation. Process water also has the effect of marginally reducing the carbon dioxide (CO_2) emissions per unit power generated (~2%). The only water that is essential to facilitate operation is fire water (to fill the tanks), some utility water and a domestic water supply i.e. less than 3 ML/a.

The water requirement nominated in **Table 14-1** is the demand only and the water supply requirement for the Facility would be higher and dependent upon the water supply source and the extent of wastewater treatment and recycling incorporated into the design. Different water sources would have different qualities and therefore different pretreatment requirements. There are water losses (as wastewater streams) associated with the potential pretreatment processes. Potential wastewater treatment options, such a brine concentration, have been considered, which would produce high quality recycle water stream. Water supply sources are discussed in **Section 14.4** and the overall water supply requirement for different water sources and potential pretreatment requirements is estimated in **Section 14.4.7**.

The demands nominated in **Table 14-1** are indicative only and would be refined in later stages of facility design. AGL has considered a range of options for generator cooling water. Further refinement of these options by AGL has narrowed the options to:

- E Class turbines (up to 4 per stage of development) that operate with high fogging all of the time (if water is available), and evaporative cooling in hot weather, and
- F Class turbines (up to 3 per stage of development) that use evaporative cooling only in hot weather.

If high fogging is not included, the overall water demand, as can be seen in **Table 14-1** would be substantially reduced (by about 78 %, noting also that there is one less turbine in the F-Class case). Also, if high fogging is not included, then it is possible to supply high quality (low total dissolved solids) potable water as make-up to the inlet air evaporative coolers rather than the nominated deionised water.

Table 14-1 Indicative Water Demand Requirements

Water Demands	Total Amount (ML/year)						Water Quality Requirement
	E Class Turbines with evaporative cooling and high fogging		F Class Turbines with evaporative cooling only		Minimum Demand (no evaporative cooling or high fogging demand		
	Nominal 750MW Installed Capacity (Stage 1)	Nominal 1500MW Installed Capacity (Stage 2)	Nominal 750MW Installed Capacity (Stage 1)	Nominal 1500MW Installed Capacity (Stage 2)	Nominal 750MW Installed Capacity (Stage 1)	Nominal 1500MW Installed Capacity (Stage 2)	
High fogging water (for turbine inlet air densification)	39.1	78.2	-	-	-	-	Deionised water
Evaporative cooler water (for turbine inlet air cooling)[&]	12.0	24.0	10.0	20.0	-	-	Deionised water or high quality (low TDS) potable water*
Potable water	0.2	0.3	0.2	0.3	0.2	0.3	Potable water
Gas turbine compressor wash	0.4	0.8	0.4	0.8	0.4	0.8	Potable water
Other utility water	1.0	1.5	1.0	1.5	1.0	1.5	Filtered raw water or potable water
Fire fighting system[#]	0.0	0.0	0.0	0.0	0.0	0.0	Filtered raw water or potable water
Landscaping#	0.0	0.0	0.0	0.0	0.0	0.0	Raw or potable water (depending upon dissolved solids of raw water)
Annual Water Demand	**52.7**	**104.7**	**11.6**	**22.6**	**1.6**	**2.6**	

Notes: * High quality (low total dissolved solids) potable water can be used for this demand, but if deionised water is required for high fogging and a deionised water supply would therefore be produced, it is preferable to also supply this water quality for this demand.
There is a 3 ML firewater demand to initially fill up the fire water tanks that would need to met over and above the annual demand. Topping up these tanks associate with minor firewater use e.g. equipment testing, is assumed to be met from the utility water demand. Similarly, a small amount of landscaping water might be required during establishment, but would not be an ongoing demand.
& For the high fogging case, (ie E Class generators) this assumes that the make-up will be deionised water, and for the F-Class case, that the make-up will be high quality potable water, which has an associated higher blowdown rate due to the higher make-up water TDS.

14.3.2 Process Water Requirements

Process water is potentially required for the following:

- high fogging, for densification of gas turbine inlet air:
- evaporative cooling of the gas turbine inlet air cooling.

However, as noted above, the lack of availability to supply process water beyond the nominated demand (or even any) would not affect the ability of the plant to operate and supply power, merely the efficiency of that generation.

Inlet Air Cooling and Densification

The ambient conditions under which a gas turbine operates have a noticeable effect on the power output. At elevated inlet air temperatures, the power output decreases. The power output decreases due to the decreased air flow mass rate or density (the density of air declines as temperature increases). Conversely, the power output increases when the inlet air temperature is reduced. At inlet air temperatures of near 38°C, power output can drop to as low as 90 % of ISO-rated power for typical gas turbines.

At cooler temperatures of about 4 to 10°C, power can increase to as high as 105 % of ISO-rated power. ISO-rated power refers to the power rating of the turbine at an ambient temperature of 15 °C, relative humidity of 60% and ambient pressure at sea level.

The density of air also decreases at altitudes above sea level. Consequently, power output decreases with an increase in altitude.

The decreased power output of gas turbines at high ambient temperatures means that gas turbine performance is at its lowest at the times power is often in greatest demand and most valued (in the local context). Cooling the air entering the turbine by 4 to 10°C on a hot day, thus increasing the air density, can increase power output by approximately 1 to 3%. The decreased power resulting from high ambient air temperatures can be mitigated by inlet-air cooling, including evaporative cooling.

The density of the inlet air can also be increased by directly spraying very finely dispersed water (‘fog’) into the inlet air stream. This is referred to as ‘high fogging’.

Evaporative Cooling

Water flows over baffles and air is drawn into the gas turbine inlet through the baffles. The air is cooled by evaporation as it passes over the baffles. Evaporation of the water reduces the temperature and increases the density of the air, allowing the gas turbine to operate at a higher output. After traversing the baffles the remaining water is collected in a sump and then recycled to the top of the baffles. Water is continually added to replace the evaporated water.

As water evaporates there is an increase in the concentration of dissolved salts (total dissolved solids or TDS). To control the salt concentration and to prevent scaling of the system (precipitation of salts), some water is continually bled off or 'blown down' from the sump. The blow down rate is adjusted to keep the concentration of dissolved salts below the threshold for scaling to occur. The blow down water is proposed to be discharged to an evaporation pond.

The quality of water required for gas turbine inlet air cooling is at least high quality (low TDS) potable water. An indicative water specification for gas turbine inlet air evaporative cooler make-up water is provided in **Table 14-2**. Individual vendors have their own specifications, which are usually tied to equipment warranties. The concentration of TDS in the feed water affects the volume of blowdown required to control salt build-up in the recirculated water. For the water quality specified in **Table 14-2**, the blowdown rate might be of the order of 20 % of the feed water rate. If a lower TDS water supply is available and is used for cooling water make-up, then the blowdown rate would be reduced, potentially significantly. If deionised water is available and is supplied to the coolers, the reduction in blowdown may be very significant. For calculation of water supply requirements and wastewater generation within this assessment a blowdown rate of 5 % of the make-up has been conservatively assumed, but it may be as low as 1 to 2 %.

Table 14-2 Water Quality Criteria for Evaporative Cooling Make-up Water

Constituent	Criteria (parts per million)
Calcium Hardness ($CaCO_3$)	50-150
Total Alkalinity (as $CaCO_3$)	50-150
Chlorides	<50
Silica	<25
Iron	<0.2
Oil and Grease	<2.0
Total Dissolved Solids	<500
Suspended Solids	<5
pH	7.0-8.5

The operation of inlet air coolers is generally only required in warmer weather, typically in summer and to a lesser extent in spring and autumn. Consideration has been given to the ambient air conditions at Dalton, and an indicative operating profile, and on this basis it has been nominated that the water supply should be sufficient to meet the process water demand for 438 hours (5 % of the year). The lack of availability to supply process water beyond the nominated demand would not affect the ability of the plant to operate and supply power, merely the efficiency of that generation.

High Fogging

Inlet air densification by high fogging, if installed, would provide power generation efficiency benefits over and above inlet air cooling alone. This has benefits independent of air temperature and, if high fogging is installed, would be applied all year round. There are potential maintenance implications arising from high fogging and it is not preferred or recommended by all generator vendors, but as discussed in **Section 14.3.1**, some generator vendors are expected to include high fogging in their proposal. Consequently, we have included this in nominating the maximum overall water demand case (**Table 14-1**).

The extremely fine water droplets are entrained with the turbine inlet air and thus enter the turbine. The water therefore needs to be of extremely high quality, i.e. very low dissolved solids (TDS) concentration, referred to as deionised water, to prevent erosion and deposition of scale on the surfaces within turbines.

Ion-exchange (I-X) or electro-deionisation (EDI) would be required as one of the pretreatment processes (regardless of the supply source) if high fogging is applied.

14.3.3 Domestic Uses

Water would be required for staff facilities, including drinking water, hand washing and toilet flushing. Water for drinking must be of potable quality. It is estimated that up to 200 kL/annum would be required, which includes consideration of additional personnel being onsite during minor maintenance periods. This figure is based on 10 people normally based onsite, at about 60 L per person per day. For short periods of time during major maintenance periods (every 3 years at the most) additional staff would be based at the plant and therefore some additional domestic water may be required for that period.

14.3.4 Utility Water

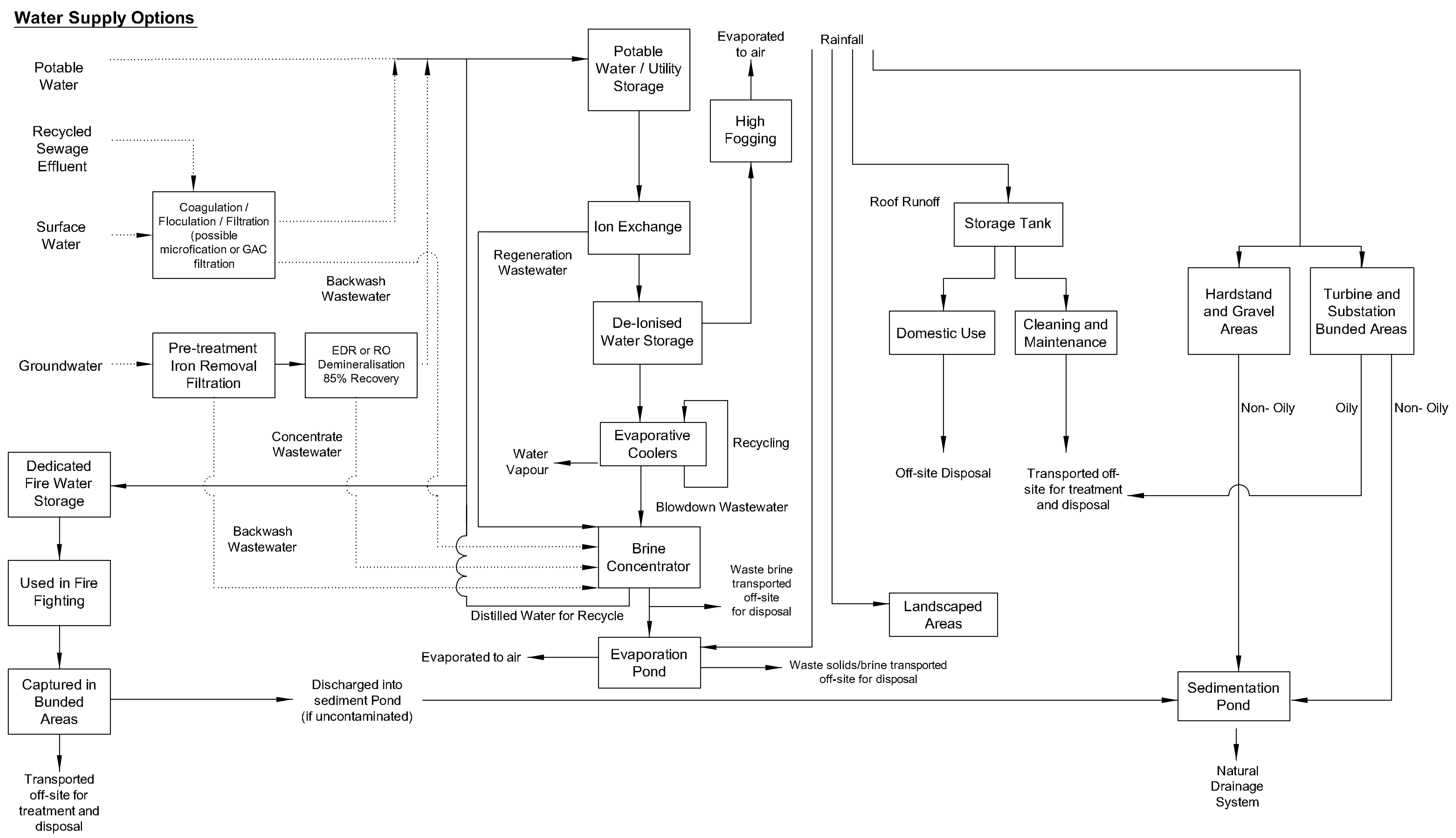
Water would be required for maintenance and cleaning of equipment. This includes water required for the periodic gas turbine compressor washing. Other utility water uses include dilution of any pretreatment dosing chemicals and supply for utility hoses for miscellaneous washing, etc. It is estimated that up to 0.8 ML/year required for gas turbine compressor wash, based on 12 washes per year at 7m^3 per wash. An additional 1.5 ML/year has been assumed for utility water supply, which includes some contingency.

Turbine compressor wash water needs to be reasonably high quality (potable water) but some of the other utility water uses may be able to tolerate lower quality water. However it should not be turbid and have low levels of suspended solids. Consideration would be given to potential recycling to supply some of the utility water usage e.g. use of backwash water from water treatment processes and/or rainwater harvesting.

14.3.5 Fire Fighting

Fire fighting water would be stored on site. The required raw water would be stored in two dedicated storage tanks (each tank 1500 m^3) for fire fighting use only. As there is no water supply reticulation system at the Site, the Facility requires dedicated fire storages.

In fire events approximately 1500 m^3 would be necessary for two hours fire fighting for the largest likely fire in a power station. In emergency conditions the dedicated fire storage tanks (2 x 1500 m^3) needs to be refilled in 8 hours. This water would not be required to be of potable water quality. However it would need to contain low levels of suspended solids.



Client: AGL ENERGY LIMITED	Project: DALTON POWER PROJECT	Title: INDICATIVE WATER CYCLE STAGE-1

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Designed: AR	Checked:	Date: 17/03/2011	Job No.: 43177661	Figure: 14-2	Rev. A
Drawn: AP	Approved:	Status: FINAL	File No.: WaterCycle.dwg		A4

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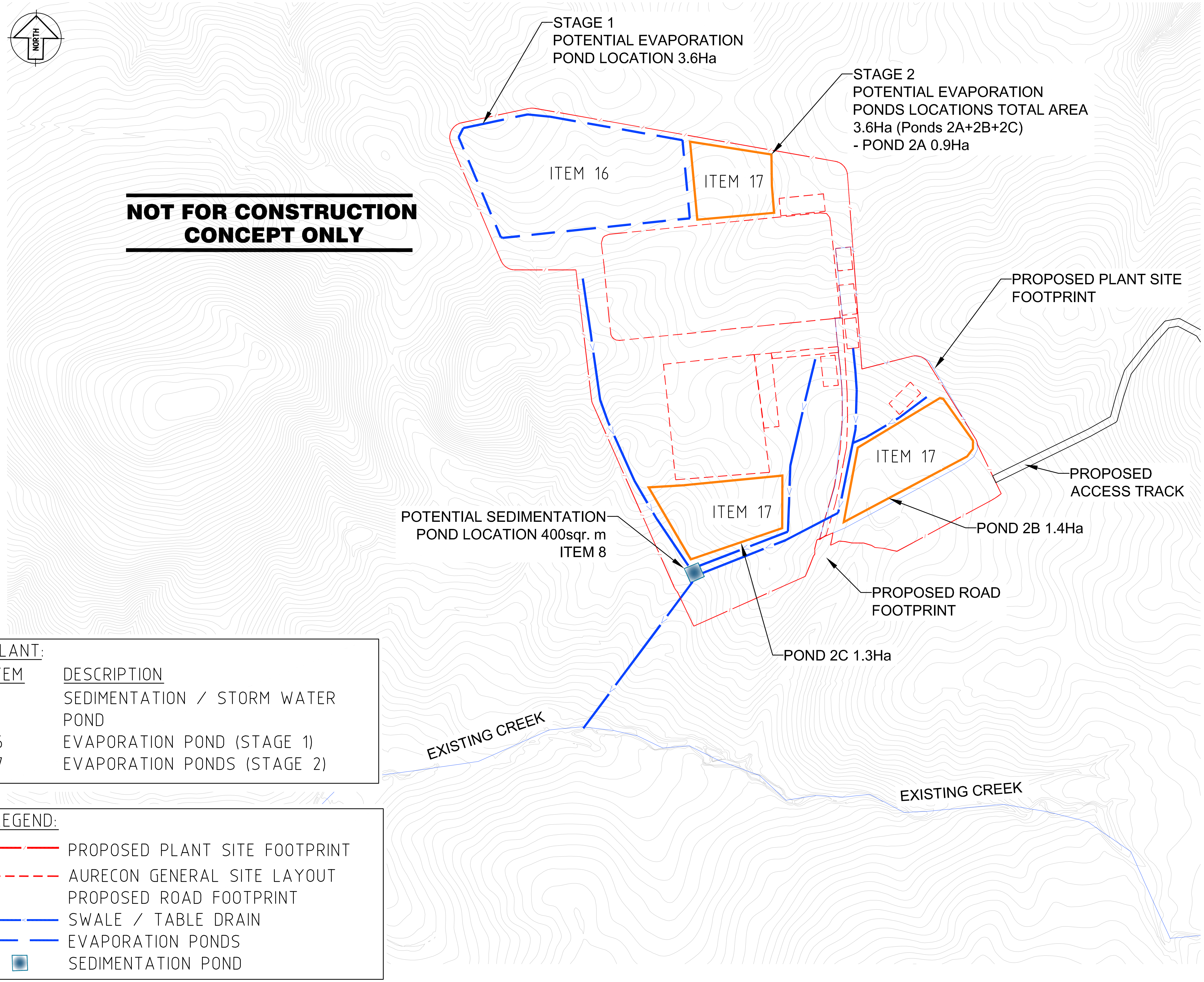

PLANT:

ITEM	DESCRIPTION
8	SEDIMENTATION / STORM WATER POND
16	EVAPORATION POND (STAGE 1)
17	EVAPORATION PONDS (STAGE 2)

LEGEND:

- PROPOSED PLANT SITE FOOTPRINT
- AURECON GENERAL SITE LAYOUT
- PROPOSED ROAD FOOTPRINT
- SWALE / TABLE DRAIN
- EVAPORATION PONDS
- SEDIMENTATION POND

Source:

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Source:

Designed: CVM	Checked: BKH	Date: 29.06.11
Drawn: CVM	Approved: RV	Status: FINAL
Job No.: 43177661	File No.4317661 STM MGMT Rev 3.dwg	

Client

AGL

Project

DALTON POWER PROJECT

Title

PROPOSED SURFACE
WATER FLOW REGIME

Figure: 14-3

Rev. A

A3

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14.3.6 Landscaping

To minimise the potential for soil erosion and enhance the local ecology, all disturbed areas would be planted at the end of the construction process in accordance with measures outlined in **Chapter 13**. In order to minimise water usage, these areas would be planted with species that are both local to the area and whose water requirements can be supplied by rainfall alone. Some supplementary irrigation water may be required during establishment.

14.4 Potential Water Sources and Water Treatment

A number of potential water sources for the Dalton Power Project have been considered. Approval is sought for each or a combination of:

- water from the existing Upper Lachlan Council water supply. This might be sourced from the:
  - Dalton potable supply;
  - Gunning potable water supply; and
  - Gunning Sewage Treatment Plant
- local groundwater (via bores (and ancillary infrastructure) located within the Development Footprint);
- delivering water to site by truck; and
- harvesting and recycling water on site, such as;
  - harvesting of stormwater runoff;
  - harvesting of roof runoff; and
  - recycling and minimisation of water used on site.

Approval is also sought for a water treatment plant on site to provide the different levels of water quality necessary for the power plant and ancillary purposes including drinking water for the site staff. It should be noted and reiterated that the Facility can operate without water, other than for domestic and utility purposes.

In addition, an option of using surface water from the Lachlan River was considered but discounted given the vulnerability of the river flow to periods of drought, and other, more dependable water source options identified.

Operationally, it is expected that one, or a combination of these sources will be used during the life of the project.

14.4.1 Upper Lachlan Council Water Supplies

There are potentially a number of sources of water from Upper Lachlan Council's existing supply scheme. These are described in the remainder of this section.

AGL has held discussions with the Upper Lachlan Shire Council (ULSC) regarding access to water from Upper Lachlan Water supplies. The ULSC, in its correspondence, indicated the following key points:

- Upper Lachlan Shire is currently planning water supply improvements for both Gunning and Dalton villages.
- It may be possible for Upper Lachlan to supply water for the operation of the power station from the proposed new Gunning water treatment plant. The plant and off river storage could be augmented to cater for a demand of the order of 100kL per day. There are a range of potential water storage options, which would have the effect of improving power station water security, including:
  - ULSC off river storage (as raw water);
  - ULSC Gunning treated water reservoir;
  - ULSC Dalton treated water reservoir; and
  - AGL onsite tanks (also necessary to reduce impacts of peaks in your demand).
- The supply may be arranged on the basis that AGL contributes to the capital expenditure involved (fixed charges) and water purchased from Council under the terms of a negotiated supply agreement (user charges).

Dalton Potable Supply

The town of Dalton is approximately 3 km from the Project site. The existing water supply system comprises a disinfected reticulated water scheme sourced from two groundwater bores. Whilst the Dalton water supply has sufficient capacity to meet the demands of the existing 80 connections, water quality is of a relatively poor standard as drinking water.

Previous water quality assessments indicate that water hardness and total dissolved solids (TDS) uniformly exceed the National Health & Medical Research Council (NH&MRC) Guideline values. The upper limit of acceptable water hardness is >200mg/L $CaCO_3$, and TDS is 500 mg/L. Water hardness and TDS are above the evaporative cooling requirement, and hence would need to be ameliorated. Average pH was found to be 8.4, which is bordering the acceptable upper pH limit for evaporative cooling.

This represents a potentially suitable source for water supply to the Project site providing water quality issues are ameliorated by treatment on site or otherwise and there is sufficient available additional capacity. As mentioned previously, ULSC is proposing to upgrade this water supply system.

As discussed in **Section 14.3**, water from this source may require treatment on site at the water treatment plant including deionising. Some of this deionised water could be shandied with the raw water to produce a lower TDS potable supply.

Gunning Potable Water Supply (via existing Lachlan River Offtake)

The Gunning water supply is sourced directly from the Lachlan River, and Upper Lachlan Council has an existing entitlement of approximately 200 ML/year. The Gunning supply is chlorinated and pumped via a 3.5 km rising main to a 909 kL service reservoir located on the outskirts of the village. Connection to the Gunning water supply was investigated. However, this supply is currently understood to have limitations in terms of water quality and security of supply. However, as previously mentioned, it is understood that plans are underway to augment the village water supply via construction of a water treatment plant and off-stream water storage water facility. These works are expected to be constructed in 2010/11.

Gunning is also known to have hard water. Use of this supply would require treatment online at the water treatment plant to address the water hardness issue.

Gunning Sewage Treatment Plant

Another potential source of water is recycled water from the Sewage Treatment Plant at Gunning. The Gunning sewage treatment plant has a maximum capacity of 250 kL/day (91 ML/year), with approximately half of this water being utilised. If the water quality is suitable and sufficient water quantities are available, this is a viable source to supply a reasonable portion of the overall raw water requirement for process and utility water. While the quality of reuse water is not known, it would require further treatment particularly in relation to the levels of Total Dissolved Solids (salts).

Depending upon the quality, the pretreatment system would likely comprise an appropriate prefiltration system (options including gravity sand filter, multimedia pressure filter, micro-filter or other membrane filter), that would incorporate coagulant and flocculant dosing. This would be followed by ion-exchange (probably with an activated carbon prefilter) or EDI for production of deionised process water.

14.4.2 Direct Lachlan River Off take

A direct take of water from the upper Lachlan River is possible but would require securing a water entitlement from the water market as well as the installation of diversion infrastructure. Given the location of the Site on the catchment boundary, the catchment area upstream of the intake point may not be able to supply water sufficient to meet the water demand without the creation of storage.

Available upper Lachlan River surface water quality data is provided in **Section 14.2.2**. Pretreatment requirements for surface water supplied directly from the Lachlan River would be similar to that discussed in **Section 14.4.1**. This option is presently not being pursued.

14.4.3 Groundwater

Approval is sought to extract and use groundwater for the Dalton Power Project.

Groundwater resources available within the project area, including quality, were discussed in **Section 4.2.3**. The following provides an assessment of the potential bore yields and potential extraction arrangements together with the necessary licencing and infrastructure requirements.

Extraction Arrangements

The Project site is outside the water sharing plan areas under the Water Management Act 2000 and consequently the Water Act 1912 applies.

Licensed extraction of groundwater is administered under the NSW Office of Water. In December 2008, two orders were made which embargo certain new applications for groundwater licences under Part 5 of the Water Act.

The first Order under section 113A of the Water Act gazetted on 19 December 2008 does not apply to the Project site.

However, the second Order also made under 113A of the Water Act and gazetted on 22 December 2008 does apply to the Project site.

Whilst the order is an embargo and operates to prevent any applications for new Part 5 water licences with a water allocation, the embargo does not prevent an application for a licence for a bore to produce water that has been obtained through the transfer of a water allocation.

AGL will therefore be required to:

- purchase a groundwater allocation from an existing licence holder and apply to the Office of Water for the transfer of that allocation to AGL; and
- apply for a Part 5 bore licence to receive the transferred allocation.

In addition, AGL will be required to have purchased the groundwater allocation from an existing licence holder from within the Lachlan Fold Belt GWMA.

AGL proposes to obtain a permanent transfer and has contacted a number of water brokers and has identified numerous water licences with suitable extraction amounts that are for sale. AGL is confident that the purchase of water allocation for the site for the required volume is achievable.

Groundwater Infrastructure

AGL proposes to establish up to approximately six bores within the Development Footprint. In addition, and to convey the water, AGL proposes to construct and operate:

- water pipelines to connect the bores to the site and infrastructure;
- water treatment plant;
- electrical power to the bores, pumps and supporting infrastructure; and
- install header tanks; pumping apparatus and associated infrastructure.

Groundwater Pre-Treatment

The specified TDS of the groundwater is up to 3,500 mg/L making it unsuitable for direct use for any of the nominated water supply categories. Pre-treatment by oxidation (aeration) and filtration and then desalination by reverse osmosis (RO) or electro-dialysis reversal (ERD) were considered for this application. A minimum desalination water recovery of 85 % has been assumed in later estimations of water supply requirements and wastewater streams (and 90 % where a brine concentrator may be applied)

A purified (desalinated) groundwater stream is likely to be of suitable quality for cooling water make-up supply and as potable water following chlorination (or alternate disinfection).

The production of process water for high fogging would require the further deionisation of the desalination water, by ion-exchange or EDI. If the extracted groundwater TDS was at the lower range, then it is likely that that initial desalination could be avoided and the water could be directly deionised. Direct deionisation of water at the upper end of the TDS range is possible, but may be less desirable from an operating cost perspective. In estimating the total site water requirement from a groundwater source (refer to **Section 14.4.7**), a supply TDS of 3500mg/L has been assumed, with initial filtration, desalination followed by deionisation.

Conclusions

The desktop assessment of groundwater as a source of water for the Dalton Power Project concluded the following:

- the primary regional aquifers in the area are basement formation fractured rock systems, with no alluvial aquifer systems in the near vicinity;
- yields from the basement aquifers are highly variable, but reported values are generally less than 2.5 L/sec, and sustainable yields for long term extraction may be much lower than this.;
- groundwater salinity is expected to be within the range of 1,000 (or marginally lower) to 3,500 mg/L (TDS); and
- the site is within the Lachlan Fold Belt GWMA.

14.4.4 Water Delivery by Tanker

Provision has been made in the design for the Project to accept bulk water deliveries by truck, should this be required. Furthermore, it is important to note that the Facility, once operational, can operate without water other than domestic water and a small amount of utility water.

The water delivery option is considered from sources identified above or another source beyond the immediate region.

All of the base site water demand (< 3 ML/a) and all, or a portion, of the projected process water demand, depending upon the development option adopted, could be sustainably supplied by tankering water.

For the purposes of the traffic assessment (refer **Chapter 11**), a maximum of 12.5 ML per annum and no more than 10 truck deliveries per day for each of stage1 and stage 2 of the project (25 ML per annum in total) is assumed. Assuming a standard road tanker of 20 kL, up to approximately 400 kL/d, or 20 truck deliveries per day, could be supplied to the site in any single day. This equates to 40 vehicle movements per day of which it is assumed that 10 % of these movements would occur during the AM peak hour. For the purposes of the traffic assessment, it is assumed that the reminder of water supply is provided by on-site groundwater or via the augmentation of the Dalton or Gunning supply.

Feed tankage would to need be provided to accommodate variable demand. The impact of these deliveries on the traffic network is considered further in **Chapter 11** and **Appendix F**.

Pretreatment requirements for a tankered potable water supply are discussed in **Section 14.4.1**.

14.4.5 Harvested and Recycled Water

Stormwater Runoff Harvesting

Water harvesting of stormwater runoff from on site (and potentially off-site where water flows onto the site) is a potential source of water as the potential site yield (up 80 ML/a in a 90%ile wet year) is sufficiently high to supply some of the Project's water supply requirements. Pretreatment requirements would be similar to those discussed for the Lachlan River water in **Section 14.4.1** and **Section 14.4.2**.

This option is not considered further as the proposed stormwater management system described in **Section 14.6** has been developed to approximately maintain the pre-existing flow regime.

Roof Runoff Harvesting

There would be a number of rooves at the site including administration and control building, workshop and store, security building, generator and transformer buildings and parts of the turbines themselves, some or all of these areas could be connected to rainwater tanks. Rainwater would be of suitable quality for non-potable domestic uses (showers, toilet flushing) and laundry, for the required maintenance activities, for a raw water supply for process water (requiring pretreatment like all of the other potential supply options), and for plant establishment irrigation. The yield would be relatively small compared to the overall site requirements and roof runoff could be harvested to supplement other supplies.

The rainwater collection system would be properly maintained in order to ensure that water entering and stored in these tanks remains of good quality. A first flush system would be installed to ensure water most likely to be contaminated by particles settled on roofs does not enter the tank.

Roof runoff harvesting would be implemented for the Project.

Wastewater Desalination

As discussed in **Section 14.5**, if high fogging is implemented, it is likely that a brine concentrator would be installed to reduce wastewater generation and recycle the recovered distilled water. An explanation of brine concentration technology is provided in **Section 14.3.5**. A brine concentrator may also be considered for an inlet air evaporative cooling only arrangement. Most of the wastewater that is fed to a brine concentrator is recovered as a very high quality distilled water. It would be of suitable quality for direct use in evaporative cooler make-up, but may require further deionisation for high fogging water supply.

Water Use Minimisation and Recycling

- As the selection of the primary site water supply has not yet been determined, the water demand quality and quantity is also not yet confirmed. The detailed selection and design of the water storage and treatment system would be the responsibility of the successful tenderer to construct the plant. There are a wide range of options for reducing water consumption in pretreatment processes, and for recycling (with and without further treatment) wastewater streams. The specific potential wastewater streams are discussed in **Section 14.5**.

14.4.6 Summary of Water Supply Sources

A summary of the water supply options, previously discussed in **Section 14.4.1** to **Section 14.14.5**, is presented in **Table 14-3**.

Table 14-3 Summary of Water Supply Sources

Water Supply Options	Advantages	Disadvantages	Conclusion
Dalton potable water supply (groundwater)	Existing water supply in reasonable proximity to site. Water supply system is proposed to be upgraded.	Likely to be insufficient excess capacity to be the main water supply for the site, although this may change with proposed ULSC upgrades. Marginal water quality as a potable water supply without further treatment (though fine for further treatment to process water)	Option as a supplementary supply but unlikely to be sufficiently available excess capacity to be the main supply, although this may change with proposed ULSC upgrades.
Gunning potable water supply (Lachlan River offtake)	Council extraction entitlement held, which is well in excess of site needs. Water supply system is proposed to be upgraded.	Source is 15 km from the site (if piping). There is a suggestion that there is potential water supply constraints associated with the available water from the river.	Option as a primary water supply source.
Gunning treated sewage effluent (recycle water)	Initial indications are that there may of the order of 40ML of excess effluent, which is sufficient for all of or a reasonable proportion of site needs.	Source is 15 km from the site (if piping). Recycled water quality is not yet clear, but there is likely to be a higher pretreatment requirement. Microbiological quality risks would need to be managed.	Option as a supplementary water supply source.
Direct Lachlan River offtake	River in reasonable proximity to the site.	Suggestions that the supply may be seasonally constrained. Entitlement would need to be acquired. Diversion infrastructure required. Marginal water quality as a potable water supply without further treatment (though fine for further treatment to process water)	Not currently proposed.

Water Supply Options	Advantages	Disadvantages	Conclusion
Groundwater extraction	Groundwater is available in the area. Although, relatively, local aquifers are not high yielding it is reasonably possible that the sufficient groundwater supply could be acquired from a number of bores on or nearby the site.	Entitlement would need to be acquired within the existing cap. Further investigations, including drilling, would be required to locate extraction bores, with no guarantee of success. Groundwater TDS may be higher than other potential supplies.	Option as primary water supply source.
Tankered water (from sources identified above or another source beyond the immediate region)	Water can be sourced and is a guaranteed supply	Base domestic and utility water demands readily met by tankering. Relatively large overall water demand, including process water, to supply by tankering . Therefore large number of trips per year and potentially relatively expensive.	Option as primary water supply source.
Roof runoff harvesting	Reasonably good quality water.	Yield small relative to over water demand	This would be implemented as part of the design to provide supplementary water.
Stormwater runoff harvesting	Available onsite.	Could impact on downstream waterways, which has not been assessed. Objective to retain post development hydrology as close as possible to pre-development.	Not currently proposed.

For the purposes of this Environmental Assessment, it is currently proposed that the initial site water supply may be offsite tankering to meet the essential base domestic and utility water demands, and some or all of the process water demands (depending upon the development option adopted). During operation, other water sources such as on-site groundwater extraction and/or Upper Lachlan Shire Council water supplies may be used to meet the full nominated site water supply requirements.

14.4.7 Overall Water Supply Requirement

As discussed previously, the overall water supply requirement to meet the water demands nominated in **Table 14-1** is a function of the pretreatment requirements of the water supply, and of any wastewater treatment and recycling proposed. The potential levels of pretreatment for different supply options is summarised in **Table 14-4.**

Table 14-4 Summary of Potential Pretreatment Requirements for Water Supply Sources

Indicative Pretreatment Requirement	Water Supply Source			
	Groundwater	Surface Water	Recycled Sewage Effluent	Potable Water
Prefiltration - multimedia pressure filters - gravity sand filters - membrane filters - cartridge filters Possibly after pre-aeration/oxidations and/or coagulant and flocculant dosing	✓	✓	✓ (high level of prefiltration)	
Desalination - reverse osmosis (RO) - elecro-dialysis reversal (EDR)	✓	Possible but unlikely	Possible but unlikely	
Deionisation (for process water supply only) - ion-exchange - electro-deionisation (EDI)	✓	✓	✓	✓

Each of the potential pretreatment processes has an associated wastewater stream. The water supply would therefore need to accommodate these losses to meet the Facility demands nominated in **Table 14-1**. **Table 14-5** presents an indicative total site water supply requirement to meet the demand, accounting for pretreatment losses for nominal 750 MW Power Station Capacity (Stage 1) and nominal 1500 MW Power Station Capacity (Stage 2). Indicative pretreatment requirements for a high fogging and evaporative cooling or evaporative cooling only option assuming a groundwater supply are set out in **Table 14-5**. Due its relatively higher salinity, groundwater has the highest pretreatment requirement and compared to the other options is expected to result in a marginally higher overall water supply requirement. This has therefore been presented as the conservative option.

Table 14-5 Overall Site Water Supply Requirements Assuming Groundwater Water Supply Source

Water Supply Requirement	Assumptions	Groundwater Supply Requirement (ML/a)			
		Stage 1		Stage 2	
		E Class - High Fogging and Evaporative Cooling	F Class - Evaporative Cooling Only	E Class - High Fogging and Evaporative Cooling	F Class - Evaporative Cooling Only
Prefiltration backwash	Assumed 10% backwash loss	4.8	1.4	9.6	2.7
Desalination concentrate	Assumed 90% recovery for high fogging case and 85% recovery for evaporative cooling only case	4.8	2.0	9.6	4.0

Water Supply Requirement	Assumptions	Groundwater Supply Requirement (ML/a)			
		Stage 1		Stage 2	
		E Class - High Fogging and Evaporative Cooling	F Class - Evaporative Cooling Only	E Class - High Fogging and Evaporative Cooling	F Class - Evaporative Cooling Only
Deionisation plant backwash and regeneration wastewater	Activated carbon prefilter back wash, and ion-exchange resin regeneration – total 6% of feed, and 8% and 10% in the surface water and sewage effluent cases respectively. Deionisation assumed for high fogging option only.	3.1	-	6.2	-
Inlet air evaporative cooling water system blowdown	Assumed 5% of make-up for high fogging option and 20% for evaporative cooling only option.	0.6	2.0	1.2	4.0
Total wastewater streams		13.3	5.4	26.3	10.7
Brine concentrator distilled water recycle	Brine concentrator assumed for high fogging case only	-12.5	-	-25.0	-
Site water demand (corrected to only account for the net evaporative cooling water demand)		52.1	9.6	104.2	18.6
Total water supply requirement		**52.9**	**15.0**	**105.8**	**29.3**

The water supply assumptions and estimates presented in **Tables 14-5** assume no significant implementation of the potential minimisation and recycling measures discussed in **Section 14.4.5**, other than the significant measure of recycling of brine concentrator distillate in the high fogging option (E-Class), which decreases the supply requirement by up to ~30%. They are also only estimates based on stated assumption and the actual supply requirement may vary from this, higher or lower. The overall water supply requirement then, depending upon the water source or combination of sources, (Table 14-4), over and above the nominated demand (Table 14-1), varies from up to 30% for groundwater supply (case presented in Table 14-5) to about 0 % for the potable water supply case (or possibly even marginally less than demand in the potable water supply case where a brine concentrator is employed).

The overall water supply requirement is likely to be in the order of up to:

- **2 to 3 ML / annum** minimum water demand
- **10 to 20 ML / annum** overall for Stage 1 and **20 to 40 ML / annum** overall for Stage 2 for the F-Class case (evap cooling only)

- **50 to 70 ML / annum** overall for Stage 1 and **100 to 140 ML / annum** overall for Stage 2 for the E-Class case (evap cooling and high fogging)

14.5 Wastewater Generation and Management

14.5.1 Introduction

In order to minimize the environmental impact, the proposed water management plan aims to supply the water requirement of the power station, reduce the release of potential pollutants to the natural environment and reuse the water following a cost benefit analysis.

The runoff storm water drains are discharged to a storm water pond for attenuation and treatment prior to release to the environment. Process areas, including bunds, would be directed to the stormwater pond via an oil / sediment interceptor after confirmation that the water is uncontaminated. In the event that this water is identified to be impacted e.g. oil spill, it would be collected by an eductor truck for offsite disposal.

Wastewater from the Facility would be generated by the following operations:

- wastewater from evaporative cooler operation (referred to as blow down water);
- wastewater from water pretreatment operation including:
  - prefiltration backwash wastewater;
  - desalination system concentrate (high TDS reject steam); and
  - ion-exchange plant regeneration wastewater (and activated carbon prefilter backwash, or EDI concentrate.
- wastewater from maintenance activities;
- domestic wastewater;
- spills; and
- stormwater collected in bunded areas.

These sources are discussed in further detail below.

14.5.2 Process Wastewater

As discussed previously, process wastewater would be generated from water supply pretreatment operations and gas turbine inlet air evaporative cooling blowdown. An indicative estimate of the wastewater volumes for various water supply options is presented in **Table 14-5**. These estimates do not assume the significant implementation of potential minimisation measures discussed in **Section 14.3.5** and are therefore considered to be reasonably conservative. The estimated wastewater generation quantities are:

- Stage 1: ranging from approximately **0.2 ML/annum** for a potable water supply case with a brine concentrator (fogging) compared to **5.4 ML/ annum** for a high TDS groundwater supply case for evaporative cooling.
- Stage 2: ranging from approximately **0.4 ML/ annum** to **10.7 ML/ annum** respectively.

Process wastewaters, which are characterised by high TDS would be discharged directly to an evaporation pond for volume reduction and periodic offsite tanker disposal, or via a brine concentrator. The wastewater evaporation pond is discussed in **Section 14.5.4**.

14.5.3 Brine Concentrator

In the water supply and demand scenario for a high fogging option, the potential wastewater volume would be such that evaporation ponds alone as the primary wastewater concentration method becomes less attractive. In this context, based on preliminary assumptions of treatment technologies and wastewater volumes, a brine concentrator may be required to concentrate the wastewater and recover water for recycle. The concentrated brine would either be directly tankered offsite or discharged to an evaporation pond.

The wastewater streams that would likely be fed to a brine concentrator are as follows:

- Inlet air evaporative cooler blowdown;
- Ion exchange regeneration and backwash wastewater;
- RO/EDI desalination concentrate; and
- Filter backwash water.

As there is not a continuous source of waste heat on site, an electrically powered brine concentrator would be required. The normal technology employed in this type of plant is a mechanical vapour compression (or vapour compression distillation) brine concentrator. This uses a compressor to apply a vacuum to the system, which reduces the boiling point of water within. Water is ‘boiled’ off and condensed to produce distilled water, and salt that was present in the water fed to the unit is concentrated to produce a brine wastewater. A falling film type system is often used, which can help control scaling on the heat transfer surfaces. The brine is concentrated to an indicative 200,000 to 250,000 mg/L TDS. Although it is possible to concentrate beyond this, some of the salt minerals start to precipitate, which can impact on the design, operational and maintenance requirements of the concentrator.

14.5.4 Wastewater Evaporation Pond

Process wastewater streams would likely be discharged to an evaporation pond. In the case of the E-Class with a brine concentrator, the estimate volume is relatively small (~770 kL/a) and may be directly tankered off site for disposal at an appropriately licensed facility. Nevertheless, it has been assumed that it will be discharged to an evaporation pond for planning purposes.

It is envisaged that an evaporation pond would be constructed for Stage 1 and additional pond(s) would be constructed to accommodate the additional wastewater load for Stage 2. The indicative pond size and indicative location for Stages 1 and 2 are shown in **Figure 14-3**.

The performance of an evaporation pond is a function of climatic conditions and the wastewater salinity and can therefore vary significantly from year to year. Increasing wastewater salinity has the effect of reducing evaporation rates, which needs to be accounted for in design. The pond also needs to be sized to accommodate the maximum volume of water generated but also to accommodate the generation pattern. More of the wastewater would be expected to be generated in summer when inlet air cooling is typically in greater demand.

The evaporation ponds have been indicatively sized based on a simple water balance. The balance was conducted over a 10 year period assuming wastewater discharge of approximately 0.8 ML/a (refer to **Table 14-5**) of brine concentrate, distributed in accordance with an assumed operational pattern. The balance assumed average climatic conditions (evaporation and rainfall) in all years except for a 90%ile wet year assumed in year two (but could accommodate two wet years and the rest average years in a 10 year period). A relationship between salinity and evaporation rate was incorporated to account for this factor. The indicative sizing is provided in **Table 14-6** and shown in **Figure 14-3**.

Table 14-6 Evaporation Pond Indicative Sizing

Evaporation Pond	Evaporative surface area (m^2) (approx.)	Depth (m) (approx.) (excluding freeboard capacity)	Capacity (ML) (excluding freeboard capacity)
Stage 1	36,000	1.00	36
Stage 2	36,000	1.00	36

The pond sizing is very indicative and would be finalised when Project design is verified. A pond of an indicative 3.6 ha might be required for the E-Class high fogging brine concentrator option for Stage 1, but the evaporative cooling only case(F-Class), with an indicative 5.4 ML/a (i.e. approximately seven times more than the brine concentrator discharge volume) wastewater discharge has an estimated evaporation pond requirement of only 2.4 ha, illustrating the impact of the reduced evaporation rate for much higher salinity water. The evaporative area required for Stage 2 may need to be provided by more than one pond, as shown in **Figure 14-3**, however the water balance assessment determined that the evaporation ponds for Stage 1 and 2 could be accommodated within the Facility footprint.

The evaporation pond would at times contain water with high to very high salinity, as it approaches periodic drying out. The water balance modelling also indicated that dissolved solids / salt build up in the pond would be able to be readily controlled with the annual disposal by tanker (to a licensed facility) of a relatively small volume of wastewater in late summer/early autumn, when the volume in the pond is low and TDS concentration is high. It is anticipated that the annual removal of evaporation pond wastewater would not need to commence for some years after commencement of operation. In the case of brine concentrator discharge, direct disposal of brine would also be considered.

The drying behaviour of the pond is very dependant upon the climatic conditions considered on an annualised basis. Based on the initial modelling, the pond may be dry for a period of one or two months, usually at the end of summer, at least four a times in a decade, depending upon the climatic conditions.

A pond liner would be required to avoid contamination of surface water, soil and groundwater. A composite pond liner is proposed. The liner may consist of a High Density Polyethylene (HDPE) geomembrane placed over 1 m of compacted clay, to achieve a minimum combined permeability of $1x10^{-9}$. This is a preferred choice over a solitary clay liner, to minimise the potential for cracking of the clay liner and to define the boundary between sediment and liner, thus assisting cleaning of sediments. The final liner design would be considered in further design stages, understanding however that it would meet the regulatory permeability requirements. It is expected that the in-situ materials or site-won fill would be structurally adequate for construction of evaporation ponds. However, a synthetic liner (such as high density polyethylene) and an appropriate clay layer would be used to minimise the risk of the saline blow down water and chemical drains escaping into the natural groundwater system. The option for a protective soil layer would be considered at the detailed design phase.

The pond would be designed to have at least a 1 m freeboard above pond top water level.

Roofed areas of plant and the workshop would also be bunded to ensure that any spills or fire water would not escape into the compound area. Stormwater should not enter these areas. Any liquid contained in these bunds is likely to be contaminated and would be disposed of off-site.

14.6 Stormwater Management

The proposed development alters the rate of progress of water through the cycle, resulting in hydrological and water quality effects. The most effective forms of stormwater management aim to address this disruption during the detailed design phase by minimising impervious area on site. This is to match the pre-development level of runoff to post-development level as closely as possible. Where this is not possible, stormwater effects could be managed by constructed mitigative methods such as stormwater detention ponds and water quality treatment devices such as swales, rain gardens and other low impact devices. These considerations have been applied in developing a conceptual stormwater management regime. This would need to be reviewed as part of detailed plant design.

The pre-development hydrology of the Site is discussed in **Section 14.2.1**. There is effectively a northern and southern catchment, which can be discerned from the contours shown in **Figure 14-3**. The Northern catchment ultimately discharges to the Lachlan River via existing drainage lines, and the southern catchment discharges to the creek to the south of the site, shown in **Figure 14-3**. This creek ultimately discharges to the Lachlan River. The area of the larger Dalton property on which the Facility is located that drains to the Lachlan River would be left as cleared grazing land or revegetated with species indigenous to the area and therefore there would be effectively no change in the quantity of stormwater.

14.6.1 Stormwater Pre-Development

Pre-development peak inflow estimates to the site for the 10 and 100 year ARI (Average Recurrence Interval) storm events were calculated using the Statistical Rational Method recommended in Australian Rainfall and Runoff. These flows are shown in **Table 14-7**.

Table 14-7 Pre-Development Catchment Areas and Design Inflows

Catchment	Area (ha)	Design Inflows	
		Q10 (m^3/s)	Q100 (m^3/s)
North	7.06	0.289	0.635
South	17.43	0.713	1.766
Road	5.16	0.211	0.464

The Facility would alter the quantity and quality of the pre-development stormwater runoff through the introduction of a power station, hardstand areas and associated access roads. All of these developments may affect the quantity, flow paths and timing of stormwater runoff during a rainfall event.

Based on the current site plan (**Figure 14-3**), the Facility site sub-catchment areas would be modified relative to the pre-development sub-catchments areas. As such, a larger sub-catchment discharges towards the south and a smaller sub-catchment discharges towards the north (the northern catchment area has effectively been reduced by the evaporation ponds). Therefore the annual volume of surface water run-off towards each of the receiving surface water bodies would be modified from predevelopment, as shown in **Table 14-8**. The estimated annual surface water run-off were estimated pre and post development applying the MUSIC model, based on 90 percentile rainfall (wet year).

Table 14-8 Pre and Post Development Site Catchment Yields

Stage	Direction to Receiving Surface Water	Estimated Annual Flow (ML)	Catchment Area (ha)	Catchment Area (Ha) Contributing to Discharge
Pre-Development	Northern	42.2	12.25	12.25
	Southern	42.2	12.25	12.25
	Total	84.4	25.0	25.0
Developed and Treated - Stage 1	Northern	13.4	7.06	3.46
	Southern	66.4	17.44	17.44
	Total	79.8	24.5	20.9
Developed and Treated - Stage 2	Northern	11.3	7.06	2.51
	Southern	60.4	17.44	14.74
	Total	71.7	24.5	17.3

The overall site discharge in the scenario modelled was reduced by up to about 15 % (84.4 ML/a predevelopment compared to 71.7 ML/a post-Stage 2 development).

14.6.2 Stormwater Post-Development

Approximately 25 ha of land would be disturbed in order to construct the compound, access roads, gas and water pipelines, and electricity supply. Rainfall on these disturbed sites may cause soil erosion and runoff may contain high levels of sediments which could then enter natural waterways.

To minimise potential effects to the receiving environment site stormwater treatment measures have been identified in order to achieve stormwater quantity and quality objectives, based on NSW Stormwater Quality Guideline and Best Stormwater Management Practices.

The following stormwater management practice is proposed for the Project:

- Swale/Table drains:
  - Divert catchment runoff around the site areas and into the sediment pond.
  - Divert and treat runoff from the power station hardstands into the sediment pond.
  - Treat runoff from the access road via swales.
- Sedimentation Pond:
  - Treat runoff from the disturbed site areas

An increase in runoff has been estimated based on multiple surface types. The peak stormwater runoff from the constructed site was modelled based on change in surface type from pre to post development (end Stage 2) and the associated footprint area of these surfaces, as summarised in **Table 14-9**.

Table 14-9 Development Catchment Type and Area

Surface Type	Area (ha)
Concrete	4.34
Gravel	2.14
Road	2.91
Roof	5.41
Main Access Road	5.16
Evaporation Ponds	7.25

Post-development peak flow estimates, without treatment, to the site for 10 and 100 year ARI were calculated using the Statistical Rational Method recommended in Australian Rainfall and Runoff. These flows are shown in **Table14-10**.

Table 14-10 Developed Catchment Areas and Design Inflows (Stage 2)

Catchment	Area (Ha)	Q10 (m^3/s)	Q100 (m^3/s)
North	7.06	0.103	0.226
South	17.43	1.116	2.421
Road	5.16	0.211	0.464

Sedimentation Pond

Sediment ponds are used to retain coarse sediments from runoff and are important for protecting downstream elements from becoming overloaded or smothered with sediments. They operate by reducing flow velocities and encouraging sediments to settle out of the incoming water stormwater.

Initial assessment estimates the sediment pond volume as 800 kL, 20 m long x 20 m wide x 2 m deep. The permanent pool volume in the sediment pond is 200 kL, which would capture and store settled-out sediments, which periodically would be removed during pond maintenance (normally once per 10 years). The average detention time for the pond would be 48 hours to achieve 85 % removal of suspended solids, some nutrients and metals. The proposed location of the pond is shown in **Figure 14-3**. This pond would discharge to the creek located to the south of the site.

Bunded Transmission Pad

To contain any potential leaks or spillages the bunded area is proposed in accordance with *AS 1940-2004 The storage and handling of flammable and combustible liquids*. The transmission pad would retain 100 % of the oil volume on site, in the incident of a spill, and to have additional capacity to contain incident rainfall for a 100 yr ARI event. In order to achieve this standard requirement, the bunded area has been modelled to retain the 100 year ARI, which would require a minimum bund height around the transmission area footprint of 500 mm, which includes an allowance of 150 mm freeboard. This includes two hours of the peak storm event.

It is expected that the bunded area would have a positive influence on the treatment performance of the sediment pond as it would reduce the peak flow leaving the concrete based sub-catchment.

Bund drainage (manual) would be confirmed clean and pass through an oil/sediment trap prior to discharge to the stormwater system.

Swales Drains

Vegetated swales are also proposed to convey stormwater in lieu of pipes and provide a desirable buffer between receiving waters (e.g. creek or wetland) and impervious areas of a catchment. They use overland flows and mild slopes to slowly convey water downstream. The interaction with vegetation promotes an even distribution and slowing of flows thus encouraging coarse sediments to be retained.

14.6.3 Construction Period

All construction works would be undertaken in a manner to minimise the potential for soil erosion and sedimentation and in accordance with the measures outlined in the *Managing Urban Stormwater – Soils and Construction Volume 1 (*NSW Department of Housing, 2004*)* (commonly referred to as the Blue Book guidelines*)*. Areas which are disturbed would be managed with appropriate erosion and sedimentation control devices installed and maintained in line with the Blue Book guidelines. This may include limiting slope length, the installation of sediment filters and the construction of a sedimentation basin downstream of the plant area. These devices would remain in place until the surface is restored. These devices would also capture any gross pollutants. All works would be designed to minimise the potential for problems associated with salinity.

Containment bunds would be constructed with provision for collection of any spilt material. Waste collection areas would be designated. Appropriate bunding would be installed and appropriated containers would be provided. Waste disposal and collection would be properly undertaken. All vehicle and equipment maintenance would be undertaken offsite. Any vehicle washing on-site would be restricted to specific bunded areas.

Staff facilities would be provided and installed and maintained so that pollutants, including wash water, are not conveyed from the site in stormwater.

During the construction period water may be required for dust suppression. This would be sourced from the existing dams on the site or imported if required.

14.7 Flooding

14.7.1 Potential Impacts

The proposed power station site is located in the upper Lachlan River catchment on a subcatchment boundary between two first order unnamed creeks. The site is undulating and at a significant elevation (~575mAHD) compared with the nearby creeks.

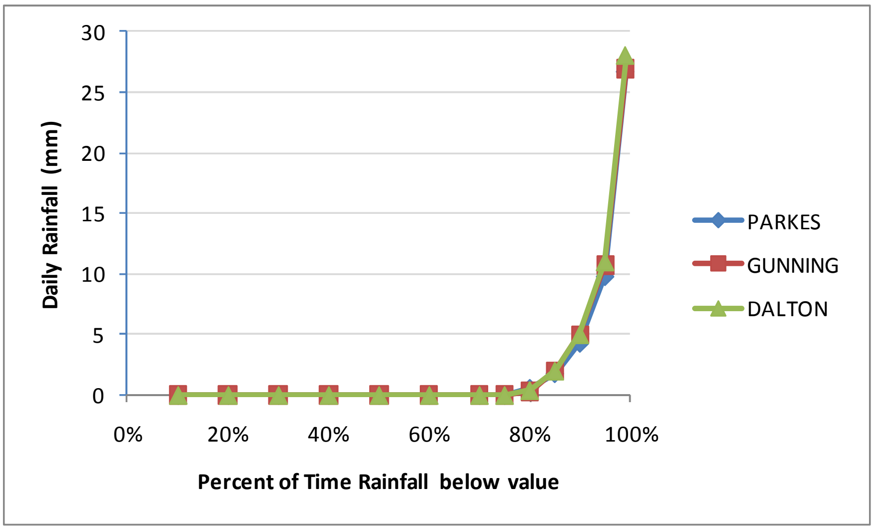
The distance from the southern boundary of the proposed site to the southern creek is ~200m and the site lies at an elevation of ~+15m above that creek. The catchment area of the creek adjacent to the power station site is small at approximately 1.8km^2.

The northern creek rises immediately adjacent to the northern boundary of the proposed power station site falling away sharply to a well defined creek line at an elevation substantially more than 15m below the proposed power station elevation.

No flood studies have been undertaken for the Lachlan River in this area. All flood studies have been undertaken downstream of the site, and are unsuitable for use in this instance.

Rainfall data from Parkes was used to consider the potential for flood inundation. Data from this site has a longer record than Dalton P.O. records. The long term daily rainfall frequency and magnitude from records at Parkes, Gunning and Dalton is similar, although the recorded maximum daily rainfall total for Parkes (149.9 mm) is higher than Gunning (137.2mm) and Parkes (112mm) (comparison provided in Figure 14-4). Adoption of Parkes rainfall is therefore considered conservative for an initial assessment of flood inundation.

Figure 14-4 Comparison of Rainfall Data



Based on the above information it was concluded that peak flows through the southern creek are very unlikely to encroach on the power station site for any event less than at least the 100 year Average Recurrence Interval flood.

Furthermore, due to the topography and location of the northern creek relative to the proposed power stations site, no flooding is expected to occur from the north even the most extreme storm event.

14.7.2 Mitigation Measures

The issue of flooding from the Lachlan River would be considered in the detailed design phase. This would require hydrologic and hydraulic studies to be undertaken and implementation of any mitigation measures to address potential local flooding from the Lachlan River.

14.8 Summary of Mitigation Measures

Table 14-11 presents a summary of mitigation measures related to water management

Table 14-11 Summary of Mitigation Measures

Mitigation Measure	Implementation of mitigation measure		
	Design	Construction	Operation
Soil Erosion			
All construction works would be undertaken in a manner to minimise the potential for soil erosion and sedimentation. Sediment and erosion control measures would be detailed in the CEMP.		✓	
At a minimum the measures outlined in the *Managing Urban Stormwater – Vol 1 Soils and Construction* would be implemented. Measures may include: • limiting slope length, • installation of sediment filters and • the construction of a sedimentation basin downstream of the plant area.		✓	
Soil erosion and sedimentation devices would remain in place until the surface is restored. These devices would also capture any gross pollutants.		✓	
Disturbed areas would be quickly revegetated or covered with a non-erodable surface following construction.		✓	
Spills and site management			
All possible pollutant materials would be stored well clear of site boundaries and stormwater drainage lines and stored in a designated covered area.		✓	✓
Appropriately bunded areas would be included for storage of fuels, oils and chemicals.			✓
Waste collection areas would be designated.	✓	✓	✓
Waste disposal and collection would be undertaken in an appropriate manner.			✓
All major vehicle and equipment maintenance would be undertaken offsite.		✓	✓
Any vehicle washing on-site would be restricted to specific bunded areas.		✓	✓
Staff facilities would be provided, installed and maintained so that pollutants, including wash water are not conveyed from the site in stormwater.		✓	✓
Water for dust suppression would be sourced from the existing dams on the site or imported if required.		✓	✓
Surface water			
Roof runoff would be reused at site and no contaminated effluent would be discharged into waterways.	✓		✓
Water management strategies developed and implemented to maintain zero water discharge from the power plant site except for natural surface flows. Some wastewater may be tankered offsite for disposal at a licensed facility.	✓	✓	✓

Mitigation Measure	Implementation of mitigation measure		
	Design	Construction	Operation
Water from the power plant site would be directed through a sedimentation pond designed to remove any oil and minimise suspended solids to an acceptable level prior to discharge from the Site. Process areas would also pass through an oil/sediment trap prior to entering the stormwater system.	✓		✓
The outlet of the power plant site's stormwater system would be designed to maximize the dispersion of these high flows and spread the flow out over a wider area and thereby minimize their potential to cause soil erosion downstream.	✓		✓
Wastewater Treatment			
Blow down water and other process wastewater would be collected in evaporation ponds lined with a synthetic liner (such as high density polyethylene) and clay to minimise the risk of the saline waste water escaping into the natural groundwater system.	✓		✓
Adequate pond freeboard would be provided to prevent overtopping eg by wave action.	✓		✓
Waste solids, sludge/brine would be removed from site and disposed of by a licensed contractor		✓	✓
Undertake hydrologic and hydraulic studies and implement mitigation measures if required to address local flooding.	✓		
Domestic wastewater would be treated by a zero discharge proprietary treatment system or stored and disposed of offsite by a licensed contractor.	✓	✓	✓
Following confirmation of water supply source(s) and arrangements during the detailed design of the water treatment system, the following would be investigated and implemented following a cost benefit analysis of the following: • Assessment and potential implementation of inlet filter (if any) backwash recycling system; • Maximising recovery of product water in any desalination systems; • Ensuring appropriate pretreatment prior to a deionisation plant to ensure minimal loss of efficiency due to poor feed water quality (physical fouling, ion-exchange resins 'poisoning' due to organics contamination, etc); • Assessment and potential recycling of the evaporative cooling system blowdown (side stream purification and return to the cooling water system or blending with the desalination/deionisation plant feed water possibly after filtration and/or other pretreatment); and • Assessment of a zero liquid discharge option whereby all wastewater streams are thermally desalinated to produce only a solid salt residue, with recovered distillate recycled. This would be an extension of a brine concentrator option, whereby a crystalliser or dryer would further treat a brine to recover solid salt.	✓		✓
Further environmental assessment would be required should AGL seek to supply water to for the Project by water pipeline.	✓		✓