Condobolin Ethanol Production Facility Water Resources Assessment Report

Final Report

for Agri Energy Limited

July 2007

0056132

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Approved by:	*Geoff Herman*
Position:	Principal Water Resource Engineer
Signed:	
Date:	*July, 2007*

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FINAL REPORT

Agri Energy Limited

Condobolin Ethanol Production Facility
Water Resources Assessment

July 2007

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1 INTRODUCTION

1.1 BACKGROUND

Agri Energy Limited (AEL) seeks project approval for the development of an ethanol production facility at Condobolin, New South Wales (NSW), under Part 3A of the *Environmental Planning and Assessment Act, 1979 (*EP&A Act). The ethanol production facility will be capable of producing 200 megalitres (ML) annually and will include several holding dams, an effluent treatment facility and an irrigation area. The irrigation area will be irrigated with process effluent as part of an effluent reuse scheme.

Environmental Resources Management Australia Pty Ltd (ERM) has been engaged by AEL to prepare an environmental assessment for the construction and operation of the ethanol production facility, inclusive of a Water Resources Assessment. This Water Resources Assessment report details the review of water resources issues and potential impacts that has been conducted as part of the environmental assessment.

1.2 SITE OVERVIEW

The site of the proposed ethanol production facility is wholly within the local government area of Lachlan. It is located along Micabil Road approximately five kilometres (km) west of Condobolin. Condobolin is situated in the Central West region of NSW, approximately 460km west of Sydney and 100km west of Parkes, as shown in *Figure 1.1*.

The site is approximately 96 hectares (ha) in area and comprises one land parcel, identified as Lot 32 on Deposited Plan 752093; Parcel ID 5804. The site comprises former agricultural cropping land and there are stands of native trees located along the property boundaries and in the southwestern corner. There are two shallow farm dams positioned near the southeast and southwest corners of the site.

A subsurface water pipeline is proposed to be constructed from an existing pumping station that is owned by Lachlan Shire Council and is located on Crown Reserve No. 98048 adjacent to the Lachlan River. The pipeline will run in a northerly direction adjacent to the east side of Gum Bend Lake, across Crown Reserve No. 98048 (which incorporates the Gum Bend Lake Recreation Reserve) and Travelling Stock Reserve 54826. It will then run along the south side of the Orange - Broken Hill Railway easement, before crossing under the rail line and entering the site. The topography along the proposed pipeline route is relatively flat. The proposed site layout and pipeline route are shown in *Figure 1.2*.

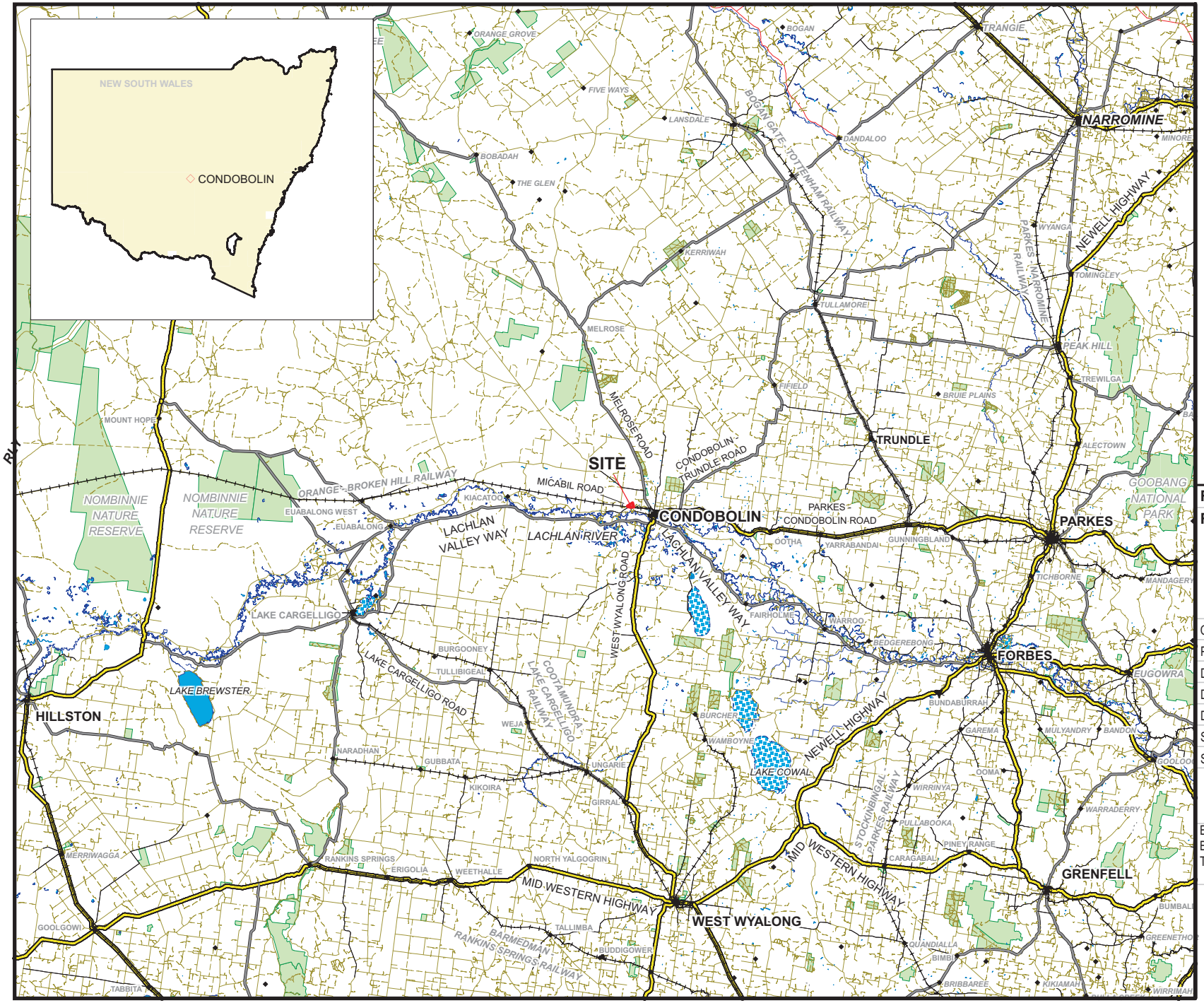

Figure 1.1

Regional Location of Site

Client:	Agri Energy Limited	
Project:	Condobolin Ethanol Production Facility	
Drawing No:	0056132_CN_SW_01	
Date:	16.02.2007	Drawing Size: A4
Drawn By:	ML	Reviewed By: -
Source:	-	
Scale:	Refer to Scale Bar	

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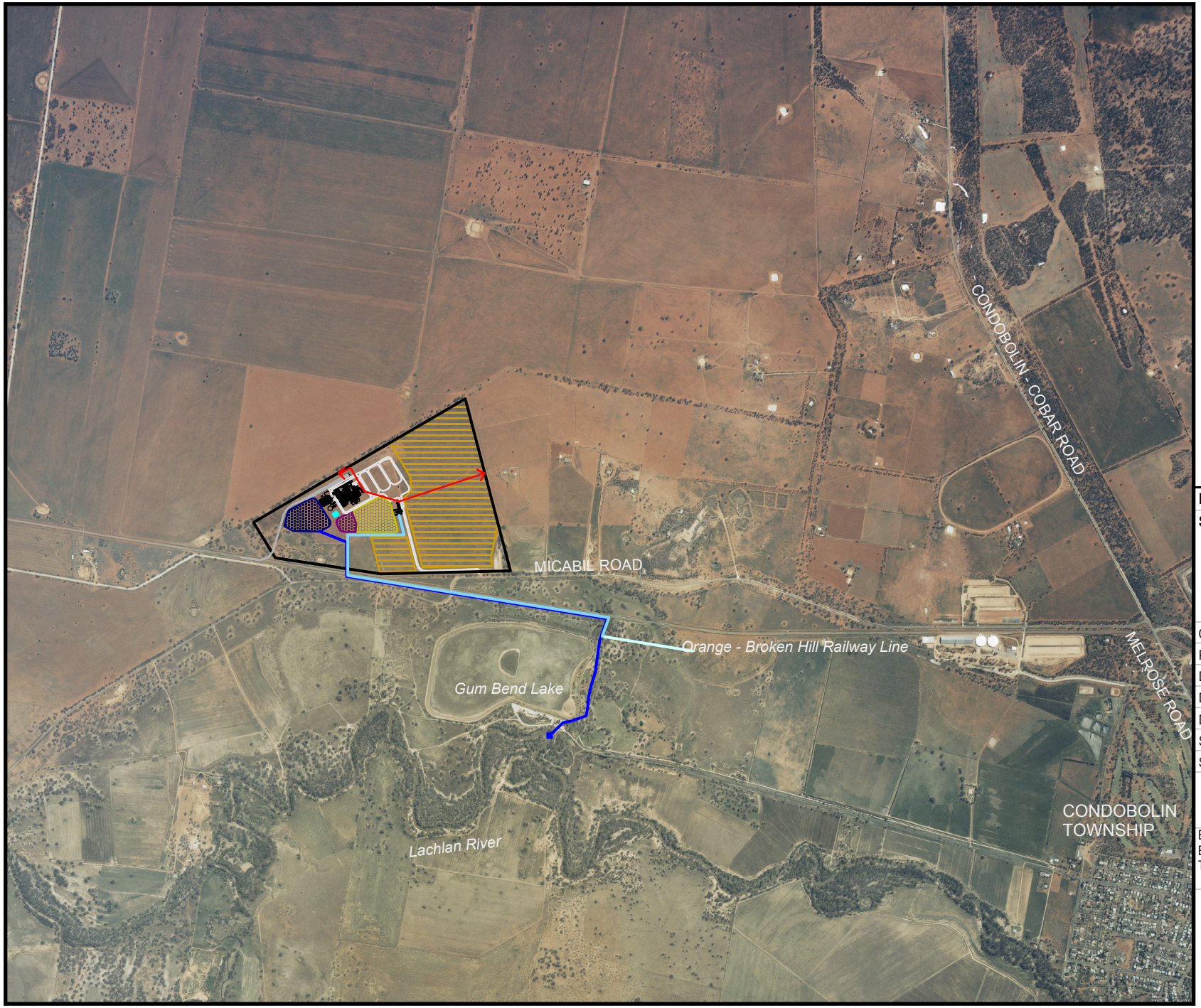

Legend

- 200Ml Raw Water Dam
- 2Ml Stormwater Dam
- 40Ml Effluent Dam
- Irrigation Area
- Salt Evaporation System
- Water Pipeline
- Site Boundary
- Potable Water Pipeline - proposed
- Potable Water Pipeline - existing
- Internal Access Road
- Future Rail Siding
- Realigned Transmission Line

Figure 1.2

Site Layout

Client:	Agri Energy Limited	
Project:	Condobolin Ethanol Production Facility	
Drawing No:	0056132_SW_GIS01	
Date:	02.07.2007	Drawing Size: A4
Drawn By:	DH	Reviewed By: -
Source:	Aerial: Department of Lands NSW Plant Design: PDF DWG No: M06075-0311	
Scale:	Refer to Scale Bar	

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1.3 ASSESSMENT OBJECTIVES

The primary objective of this water resources assessment is to assess the impacts of the proposed ethanol production facility on local and regional water resources. To focus this assessment on environmental issues of primary concern, the following specific objectives have been developed:

- To assess water management across the site. A water balance will detail water demand and consumption, water recycling and effluent reuse across the site.
- To assess any water quality impacts resulting from the proposed ethanol production facility.
- To assess impacts of the proposed development on flood behaviour in the Lachlan River and to assess the potential impacts of floods on the development itself.
- To detail mitigation and monitoring requirements to sustainably manage any potential water resources impact.

1.4 CONSULTATION

1.4.1 *Director General's Requirements*

The Director General's Requirements were issued by NSW Department of Planning (DoP) on 5 October 2006. In relation to water resources, they require:

- a water balance for the site detailing water sources, water consumption, water recycling, the quantity and quality of wastewater streams and the impact of any water releases from the site on surface and groundwater;
- proposed erosion and sediment controls (during construction) and the proposed stormwater management system (during operations); and
- an assessment of potential impacts from storage of water and wastewater and assessment of potential impacts of reusing wastewater over the proposed irrigation area.

1.4.2 Department Of Natural Resources

In a letter dated 25 September 2006, the Department of Natural Resources (DNR) identified the following requirements in regards to this water resources assessment:

- Details of effluent and waste management - including details of the proposed effluent management system, details of all methods to reuse and recycle waste streams, details of quality of effluent and assessment of soil salt and nutrient balances associated with irrigation, details of detention or evaporation basins, details of stormwater management;

- Details of water supply - including an approximate water budget, water use requirements, proposed water source, requirements for pumping stations and water supply pipelines;

- Details of soil and water management – including details of sediment and erosion control measures; and

- An assessment of flooding characteristics due to the proximity of the site to the Lachlan River.

1.4.3 Department Of Environment And Conservation

In a letter dated 18 September 2006, the Department Environment and Conservation (DEC) identified the following requirements in regards to this water resources assessment:

- An assessment of impacts on water quantity and quality – with goals for the project being to ensure that there is no pollution of surface or ground waters; that wastewaters are managed and beneficially reused where practical; and that the project is acceptable in relation to the River Flow Objectives and Water Quality Objectives for the Lachlan River catchment; and

- Demonstration that the proposed reuse of wastewater for irrigation is sustainable.

1.4.4 Department Of Primary Industries

In a letter dated 25 September 2006, the Department of Primary Industries (DPI) identified the following requirements in regards to this water resources assessment:

- Details of the proposed water use and wastewater management system for the site are to be provided, including details of effluent quality and effluent suitability for reuse via irrigation; and
- An irrigation plan should be prepared for the proposed effluent reuse.

1.4.5 Australian Rail Track Corporation

In a letter dated 26 September 2006, the Australian Rail Track Corporation (ARTC) indicated that runoff or stormwater discharge from the proposed development entering the rail corridor would be unacceptable.

1.5 REPORT STRUCTURE

This report has been structured as follows:

Chapter 1 provides an introduction, outlining the project and objective and context of this report;

Chapter 2 provides a description of the existing water resources environment at and surrounding the site;

Chapter 3 provides details of the proposed site water management system;

Chapter 4 provides an assessment of potential water resources impacts associated with the proposed ethanol production facility including salt and nutrient balances;

Chapter 5 presents mitigation options and monitoring requirements to ensure potential impacts are reduced; and

Chapter 6 provides a statement of commitments for the proposed development in regards to water resources.

2 EXISTING ENVIRONMENT

2.1 RAINFALL AND EVAPORATION

The nearest long term rainfall gauging station is operated by the Bureau of Meteorology (BoM) and is located at Condobolin Agricultural Research (BoM Station 050052), approximately 12km to the east of the site. The average annual rainfall at this station, based on data collected between 1954 and 2006 is 461mm.

Evaporation data is also recorded at this station. The average annual evaporation at this station, based on data collected between 1973 and 2006 is 1869mm.

Monthly variations in average rainfall and evaporation are shown in *Figure 2.1* below.

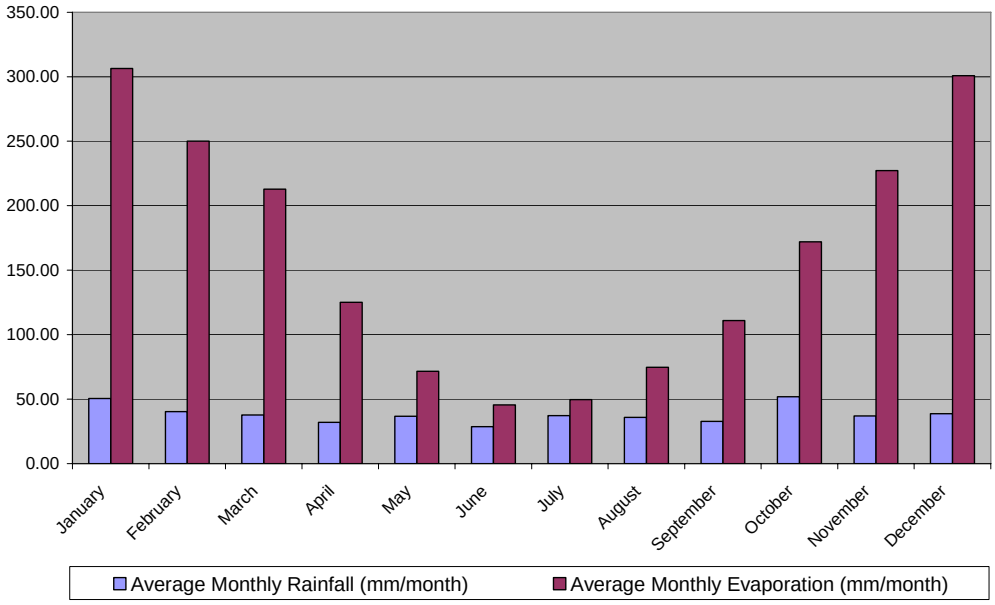


Figure 2.1 Average Monthly Rainfall and Evaporation

2.2 GEOLOGY, SOILS AND LANDFORM

Information from the *Condobolin 8331-1 & IV 1:50 000 Topographic Series Sheet (1st Edition),* identifies that the average site level is approximately 188 metres above the Australian Height Datum (AHD). The topography is relatively flat varying in level from RL186.5 mAHD near the southwest corner to RL192.0 mAHD near the northwest corner at an average gradient of 0.4%. The immediate surrounding local topography generally falls towards the southwest.

According to the *Condobolin 1:100 000 Geological Series Sheet 8331 (1st Edition)*, the geological unit at the site is Cza, which comprises Tertiary inactive alluvial plains. Mineral deposits of gold, aggregate and sand have been recorded in the locality.

As identified in the *Lachlan Shire Council State of Environment Report 2004*, the predominate soil types found in the area include red earth, brown soils, lithosols (gravely soils), clays and yellow and red solodic soils, along drainage lines. The makeup of this soil landscape in the region means that soil has generally low chemical fertility. The combination of gravel, lithosols and clay means that the there may be high erosion hazard and there may be a high potential rate of infiltration of water, especially in drier periods. The Condobolin area may be affected by dry land salinity.

Geotechnical investigations undertaken by GTS (2007) indicate that the natural silty clay material over the site extends to at least 1.2m below the surface. Below this the soil particles become coarser, with the subsoil not considered suitable for dam construction (GTS, 2007).

Chemical analysis of the soil at the site has also been undertaken by GTS (2007). Soils were analysed for pH, cation exchange capacity (CEC) and Exchangeable Sodium. Emerson aggregate tests (EAT) were also completed as part of the geotechnical investigation (GTS, 2007). Comparison of the laboratory results of this assessment to *Table 2.2* of the *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004) shows that overall the soil chemistry poses moderate limitations to the site for use for irrigation. In summary, the chemical analysis of the soil indicated;

- The Emerson number was found to be 2, indicating that soil has some potential to slake and disperse. Addition of gypsum, lime or organic matter can improve structural stability.

- Soil pH was in the range 7.4 – 9.3. Plants generally grow best and are able to maximise the availability of nutrients when soil pH is between 6 and 7.5.

- Sodic properties at some locations, which may cause soils to disperse following irrigation. If soils in the root zone have sodic properties, dolomite or gypsum can be applied to reduce sodicity.

- The soils samples analysed typically had a high cation exchange capacity (CEC) (>15). Soils with a high CEC generally have the potential to be more fertile than soils with a lower CEC as they have a greater capacity to hold exchangeable cations such as potassium, calcium, magnesium and hydrogen and are less susceptible to nutrient loss by leaching.

- Parameters such as soil salinity, saturated hydraulic conductivity, available water capacity, phosphorous sorption, depth to water table and depth to bedrock are currently unknown.

An analysis of GTS field observations and soil chemistry data conducted by Agsol (2007) (refer *Annex A*) concluded that surface soils are generally suitable for cultivation and are underlain by sodic subsoils which are moderately saline. These limitations are considered to be manageable.

2.3 *REGIONAL DRAINAGE*

Condobolin is located within the Lachlan River Catchment, which covers an area of approximately 84,700 square kilometres above its confluence with the Darling River. The Lachlan River is approximately 1,450 kilometres long, rising near Gunning and terminating in the Great Cumbung Swamp near Oxley. The Lachlan River is a significant regional water resource and supplies the Greater Lachlan Shire.

The site is located approximately 5km to the west of Condobolin and approximately 830m to the north of the Lachlan River. The Lachlan River has a catchment area of approximately 25,200 square kilometers upstream of Condobolin. Between the Lachlan River and the site lies Gum Bend Lake. Gum Bend Lake is a small artificial waterway created for boating, swimming and water skiing, surrounded by 40 ha of landscaped grounds for recreational purposes.

2.4 *LOCAL DRAINAGE*

Because the site and immediate surrounding local topography is relatively flat, surface drainage towards the Lachlan River is not well defined. Site runoff is captured by the two shallow farm dams, one positioned in the southeast corner and the other in the southwest corner of the site. Overflows from these dams must cross both the rail line and Micabil Road to cross flat low lying land before reaching the Lachlan River approximately 830m south of the site. It is possible for minor overland flows to enter the site from higher ground extending up to 500m to the east.

2.5 *FLOODING*

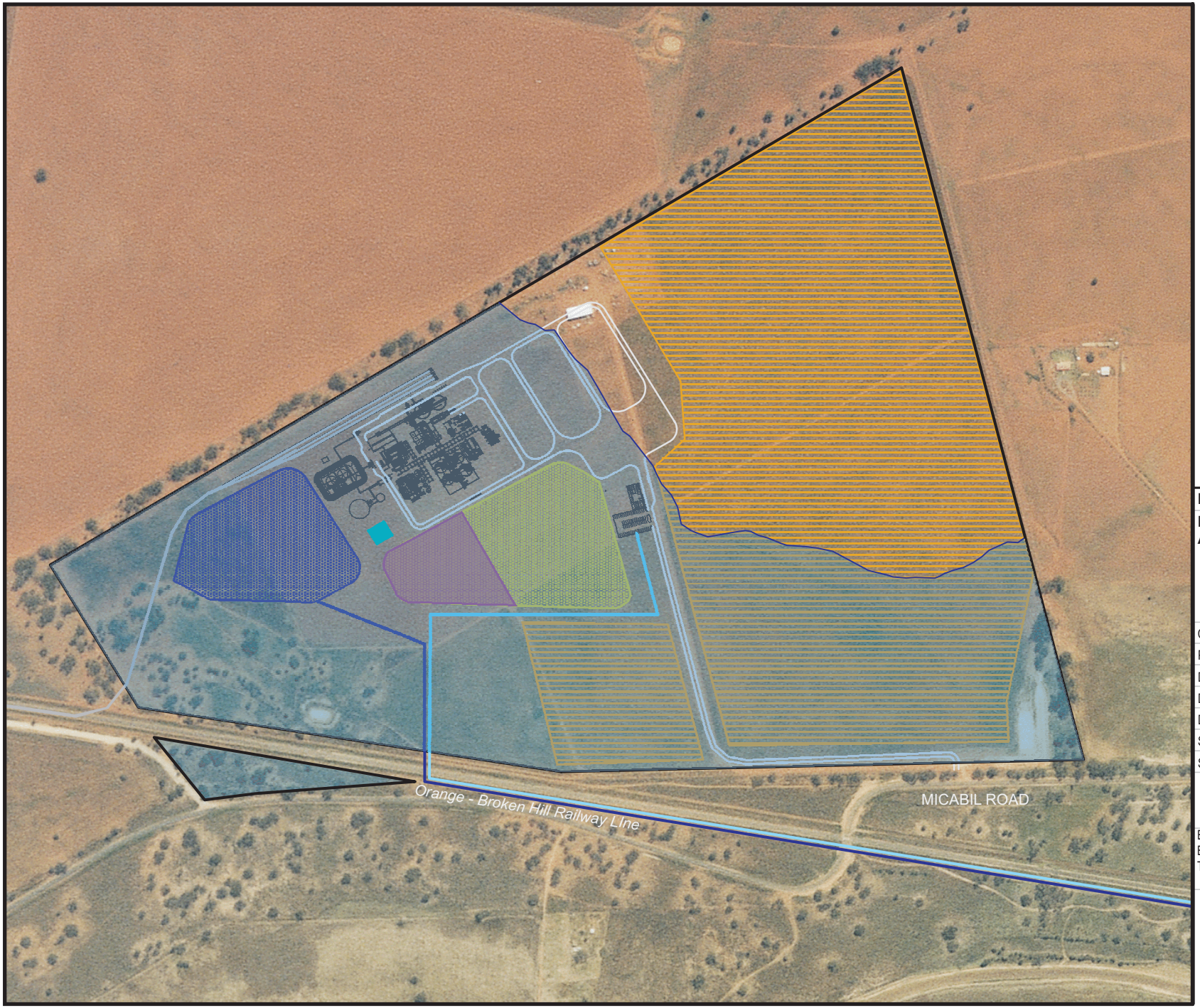
Definitive flood levels are not available for the site. Both DNR and Lachlan Shire Council were contacted to obtain details of flood information available in the area.

Lachlan Shire Council reported that they have recently initiated a flood plain study of the area, but that at present no flood levels or other site specific information was available. Council were able to provide some information which indicated that the highest flood level recorded at Condobolin was during a flood in August 1990 (*pers comms*, Barrie Toms, 24 October 2006).

DNR have almost completed a Floodplain Risk Management Study for the section of the Lachlan River upstream of Condoblin to Jemalong Gap, approximately 80km southeast of Condobolin. The study is to be placed on public exhibition later this year, along with the associated floodplain management plan for the area. DNR were able to provide excerpts of information from the Draft Lachlan River Jemalong Gap to Condobolin Floodplain Risk Management Study to assist in assessment of flood levels at the site.

As part of the Floodplain Risk Management Study, a flood frequency analysis was undertaken for the Lachlan River at Condobolin. The analysis was based on data recorded over a 107 year period, however 22 years of data was missing from this record. Large floods occurred in the Lachlan River in September 1952 and July 1956, both within the period of missing record for the frequency analysis. Data from the DNR PINNEENA database indicated that peak levels recorded at a discontinued gauging station (412034 – Lachlan River at Condobolin Weir) during September 1952 and July 1956 were similar to peak levels recorded at the gauging station where the flood frequency analysis was conducted (412006 – Lachlan River at Condobolin Bridge) during the August 1990 event. Based on the frequency curve developed for the Floodplain Risk Management Study at Gauge 412006, it is estimated that these events approximate the 100 year Average Recurrence Interval (ARI) flood event at Condobolin.

Based on data from the DNR PINNEENA database, the flood gradient recorded on the 30th September 1986 between Gauge 412006, Lachlan River at Condobolin Bridge and Gauge 412119, Lachlan River at West Condobolin Weir was estimated at 0.022%. The site for the proposed ethanol facility is located between these two gauges. Using this gradient and the flood level recorded at Condobolin Bridge during the August 1990 event, it is estimated that the 100 year ARI flood level at the site is approximately 188.4 m AHD. This level is depicted on *Figure 2.2* and indicates the area of the site that would be inundated during a 100 year ARI event.



Legend

- 200Ml Raw Water Dam
- 2Ml Stormwater Dam
- 40Ml Effluent Dam
- Irrigation Area
- Salt Evaporation System
- Water Pipeline
- Potable Water Pipeline - proposed
- Site Boundary
- Internal Access Road
- Future Rail Siding
- Estimated 100yr ARI Flood Extent
- Estimated 100yr ARI Flood Affected Area of Site

Figure 2.2

Estimate of 100yr ARI Flood Extent Across Site

Client:	Agri Energy Limited	
Project:	Condobolin Ethanol Production Facility	
Drawing No:	0056132_CN_SW_04	
Date:	29/06/2007	Drawing Size: A4
Drawn By:	GC	Reviewed By: -
Source:	Aerial: Department of Lands NSW Plant Design: PDF DWG No: M06075-0311	
Scale:	Refer to Scale Bar	

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2.6 *GROUNDWATER RESOURCES*

Data supplied in the ACT Commissioner of the Environment (2004) *Upper Lachlan State of the Environment Report* indicated the following in relation to groundwater in the Lachlan region:

- groundwater within the Lachlan River catchment is suitable for some domestic, agricultural and limited industrial uses, although some groundwater from low yield systems is suitable for drinking;

- the low to moderate groundwater vulnerability rating for upland areas in the Lachlan basin suggest that future landuse changes or development should undertake groundwater investigations;

- groundwater pumping from the Lachlan subsystem impacts on flows in the streams in areas with a direct hydraulic connection between the aquifer and the watercourses;

- water management planning in the Lachlan catchment generally needs to consider both the surface water and groundwater resources as a single resource; and

- virtually no data is available for groundwater quality in the Lachlan groundwater subsystems or associated Central West Highlands areas of the Lachlan catchment. Local groundwater flow systems associated with highland areas with fractured rock landscapes have a high salinity hazard, while there was potential for inflow of saline groundwater in the Lachlan subsystem from adjacent highland areas.

The DNR groundwater licence database has records from 12 bores within approximately five kilometres of the site. To characterise the local groundwater resource, details of the shallowest water bearing zone for each of these bores, as derived from the drill log records are summarised in *Table 2.1*. The shallowest water bearing zone was characterised as it is considered the most likely to be impacted by operation of an effluent irrigation scheme. The full work summaries for each of these bores, including details of deeper water bearing zones, and a map showing the location of the bores are included in *Annex B*.

Table 2.1 Details of Shallowest Water Bearing Zone at Bores within 5km of the Site

Bore ID	Date of Record	Shallowest Water Bearing Zone				
		From (m)	To (m)	Depth (m)	SWL (m)	Salinity
GW021165	01-11-1965	7.0	8.2	1.2	5.7	Unknown
GW021222	01-11-1965	No Water Bearing Zone Details Found				
GW021223	01-12-1965	No Water Bearing Zone Details Found				
GW021224	01-12-1965	11.5	12.4	0.9	8.2	Unknown
GW021228	01-11-1965	8.5	10.3	1.8	6.0	0-500ppm
GW026645	01-01-1967	No Water Bearing Zone Details Found				
GW050914[1]	*01-02-1980*	*33.2*	*36.9*	*3.7*	*28.4*	*Unknown*
GW057307	01-12-1982	10.0	10.0	0.0	10.0	Unknown
GW059353	01-11-1982	6.0	16.0	10.0	6.0	Good
GW060298	01-11-1982	9.7	14.4	4.7	7.9	Good
GW700209	16-12-1995	6.0	6.2	0.2	5.0	Unknown
GW702628[1]	*26-05-2005*	*21.0*	*24.0*	*3.0*	*7.3*	*2500mg/L*

1. The shallowest water bearing zone at GW050914 and GW702628 is intercepted more than 9.5m deeper than at other bores and is not considered to be part of the local shallow aquifer system.

The DNR groundwater licence database indicates that groundwater from bores in the vicinity of the site is used for irrigation, domestic and stock watering purposes. The database also has salinity data for the shallowest water bearing zone from two bores within five kilometres of the site. This data is from 1965 at one bore, and so is potentially outdated, however suggests that shallow groundwater in this area is potentially of potable water quality (i.e. <1000mg/L TDS).

Records from the recorded bore on the site (GW021222) and the two bores within 2.5km of the site (GW021223 and GW021224) were used to better characterise groundwater beneath the site. Of the records from these bores, only that from GW021224 had appropriate data to indicate the presence of a shallow water bearing zone. This zone was recorded between 11.5 and 12.4m below the ground surface, with a standing water level of 8.2m below the ground surface.

Historical drill log records from these three bores and the additional nine boreholes within five kilometres of the site (refer *Annex B*) indicate that:

- there are up to three water bearing zones, with the shallowest intercepted at between six and 16 metres below the ground surface;
- the standing water level in the shallow aquifer system in the vicinity of the site is variable and is reported to range from five to ten metres below the ground surface.

The standing water levels within the shallow water bearing unit are above the top of the water bearing lithology which is indicative of semi-confined aquifer conditions. This is consistent with the lithological logs for the bores in the area, which suggest the presence of a low permeability clay layer above the water bearing unit.

The pits excavated by GTS on the site ranged in depth from 3.3 to 4.3m. No groundwater was encountered within these pits (GTS, 2007).

2.7 RETICULATED WATER SUPPLY

No reticulated water supply is currently connected to the site. Condobolin does have a reticulated water supply to which AEL will be able to connect for site potable water.

2.8 SEWER SERVICES

No sewerage services are currently available at the site. The proposed facility will manage all wastewater on site.

3 SITE WATER MANAGEMENT

3.1 OVERVIEW

Three dams will be constructed on site as follows:

- *2ML stormwater dam* – located adjacent to the production buildings to hold and evaporate runoff from the buildings and hard surface areas. This water will also be available for irrigation or to supplement the raw water supply;

- *40ML effluent dam* - located south of the production buildings to store process wastewater from the facility, for pumping to the irrigation area; and

- *200ML raw water dam* – located immediately west of the production buildings to store water pumped from the Lachlan River and supply all plant raw water needs.

A significant aspect of the proposed ethanol facility is that the majority of effluent produced by the facility will be treated and recycled back through the production process. The remainder of the effluent will be pumped to the effluent dam for reuse by irrigation, and a small stream of high salt effluent will be diverted and treated via a salt evaporation system. There are no proposed discharges of effluent from the site. Reuse of water within the facility will also ensure demand from external raw water sources will be minimised.

A water balance for the proposed facility has been prepared detailing water requirements through various processes within the plant, expected effluent volumes, and losses due to evaporation. This water balance is presented in the form of a water flow diagram in *Figure 3.1*. Further details of site water management are provided in the sections below.

3.2 CATCHMENT OBJECTIVES

Water quality objectives for the Lachlan River catchment have been published by the NSW DEC (http://www.environment.nsw.gov.au/ieo/Lachlan). These objectives identify the desired beneficial use of the waterways and also provide numerical water quality guidelines to enable the objectives to be achieved. These guideline concentrations are for a range of physical, chemical and biological parameters.

Based on the DEC's classification of the waterways in the vicinity of Condobolin, water quality objectives are to protect of water quality for:

- aquatic ecosystems;
- visual amenity;
- primary and secondary contact recreation;
- livestock, irrigation and homestead water supply;
- drinking water, to be treated via disinfection process;
- drinking water – groundwater; and
- aquatic foods.

Numerical limits for protection of these waterway values are also provided in the ANZECC (2000) Water Quality Guidelines. The limits, termed 'trigger values' are provided for a large range of toxicants and physio-chemical parameters. The relevant trigger values for Condobolin are those for lowland rivers and streams in south-eastern Australia.

The DEC's Lachlan River catchment objectives also provide river flow objectives. These objectives are to:

- protect pools in dry times;
- protect natural low flows;
- protect important rises in water level;
- maintain wetland and floodplain inundation;
- manage groundwater for ecosystems; and
- minimise effects of weirs and other structures.

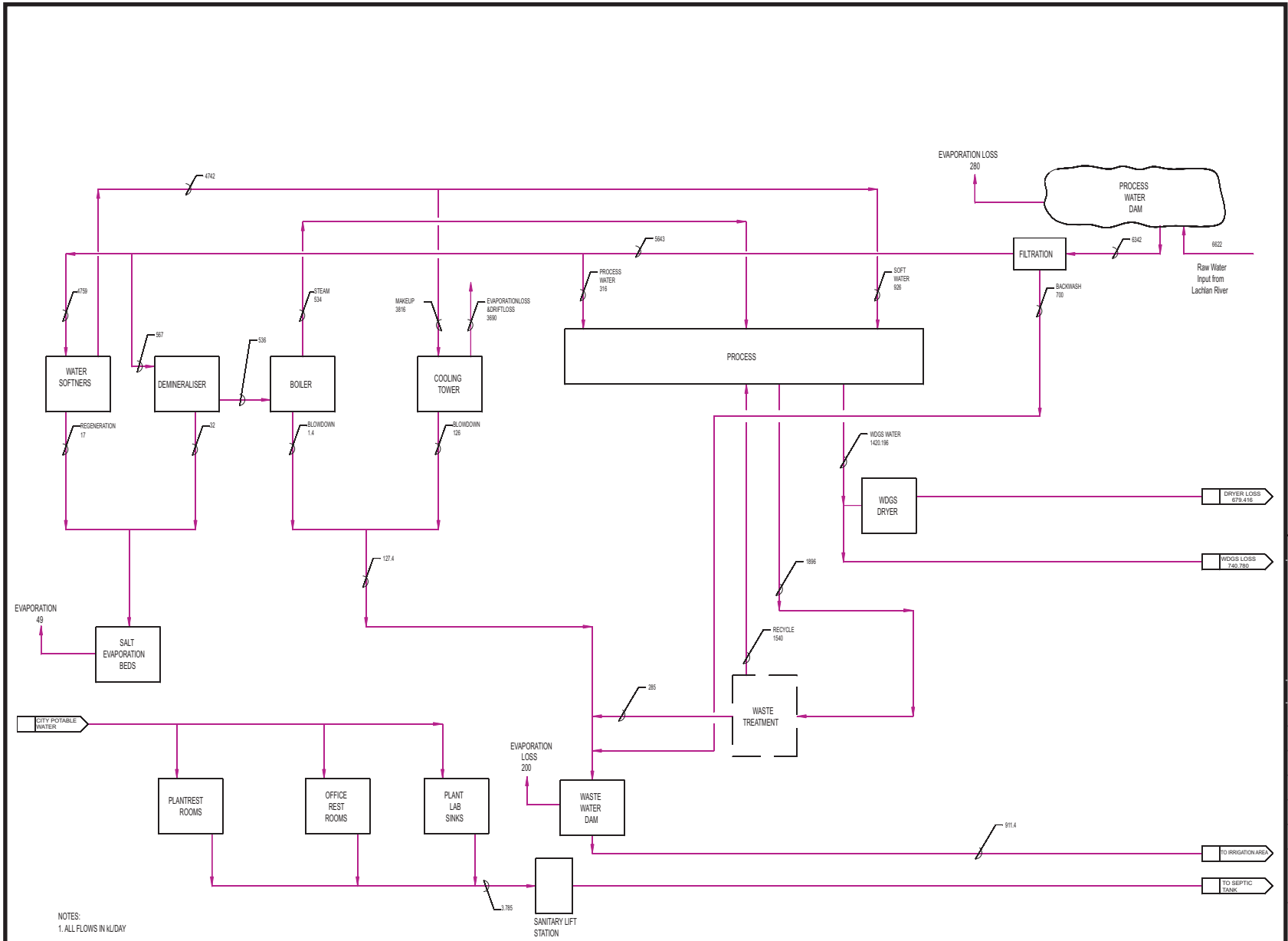

Figure 3.1

Water Flow Diagram

Client:	Agri Energy Limited	
Project:	Condobolin Ethanol Production Facility	
Drawing No:	0056132_CN_SW_03	
Date:	25/06/2007	Drawing size: A4
Drawn by:	GC	Reviewed by: -
Source:	-	
Scale:	N/A	

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3.3 WATER SUPPLY

3.3.1 Ethanol Production Process

Water is a key input to the ethanol production process. It is predicted that the facility will require 6622 kL of raw water pumped from the Lachlan River per day, of which the plant will receive approximately 5642 kL of water per day after evaporation and filtration losses are taken into account. Of this plant water, 1540 kL of water will be provided per day by treatment and recycling of process water, as part of the proposed water management system for the plant. Raw water for use in the production process will be pumped from the Lachlan River via a 'high security' water licence sought from DNR under the *Water Act 1912* and in accordance with the *Water Sharing Plan for the Lachlan Regulated River Water Source 2003*. The high security water licence will ensure an adequate supply of water for the production process.

It is predicted that on average 6622 kL per day of raw water will be required to be pumped to the raw water dam to ensure adequate supply for the process and allow for backwash from the raw water treatment facility as well as evaporation losses from the raw water dam. This figure is based on the average daily evaporation rate as recorded at BoM Station 050052. Based on the average daily winter evaporation and the average daily summer evaporation, the raw water demand is expected to vary from 6422 kL/day to 6859 kL/day, respectively, throughout the year.

The proposal includes construction of a 200ML raw water storage dam on the site to store raw water for the plant. This sizing provides a contingency for up to 30 days supply (based on average daily evaporation rates). The dam is proposed to be 5m deep to minimise evaporation loss. This dam will be recharged from the Lachlan River via a subsurface pipeline to be installed from the existing pumping station at the Lachlan River.

Water will be pumped from the raw water dam to a raw water treatment facility prior to being pumped to the plant. Raw water will undergo the following treatment steps prior to use in the plant:

- filtration to remove suspended material;
- softening, using a zeolite softener, or similar, to remove calcium and magnesium hardness (the zeolite softener will be regenerated with salt); and
- de-mineralisation using reverse osmosis or a mixed resin bed.

3.3.2 *Ancillary Facilities*

Ancillary facilities which will require water include:

- plant rest rooms;
- office rest rooms; and
- plant lab sinks.

Potable water will be supplied by connecting the site to the main Condobolin reticulated water supply. It is expected that these facilities will use an average of 3.8 kL of potable water per day.

3.4 *WATER RECYCLING*

Effluent generated the ethanol production process will be separated into two waste streams with the majority pumped to a secondary anaerobic digestion treatment system included within the plant and a small amount diverted to a salt evaporation system adjacent to the plant.

The first stream, an estimated 1896 kL per day of effluent will be generated and treated within the secondary treatment system. Of this effluent, 1540 kL per day (approximately 80%) will be recycled back to the process with the remainder being pumped to the effluent dam for reuse on the proposed irrigation area.

The anaerobic digestion treatment system will treat the water to the quality outlined in *Table 3.1.* The limits shown in this table provide the acceptable water quality for water used in the production process.

Table 3.1 Water Quality Limits for Recycle Stream

Parameter	Unit	Value
Total Germs	No./mL	Less than 100
E Coli	No./mL	Nil
Coliform Bacteria	No./mL	Nil
Hydrogen Sulfide	mg/L	Nil
Chemical Oxygen Demand	mg/L	Less than 100
Biochemical Oxygen Demand	mg/L	Less than 30
Total Suspended Solids	mg/L	Less than 100
pH	pH units	7.5-9.0
Total Dissolved Solids	mg/L	Less than 500
Odour		Odourless

1. Source: Praj Industries Ltd, Revision 06S012-4-BEF 908

3.5 EFFLUENT MANAGEMENT

3.5.1 Irrigation of Effluent

The majority of wastewater from the production process will be stored in an effluent dam prior to reuse by irrigation. The effluent to be used for irrigation includes:

- backwash from the raw water treatment process (approximately 700 kL/day);
- the stream from the secondary anaerobic digestion treatment system which is not recycled (approximately 356 kL/day); and
- blowdown from the cooling tower and the boiler (approximately 127 kL/day).

It is proposed that a 40 Ml effluent dam will be located to the south of the production buildings to store process effluent from the facility. The surface area of the effluent dam will be maximised to maximise evaporation losses and reduce requirements for disposal of effluent through irrigation. The dam is proposed to be approximately 6ha in area and 0.7m deep.

Agsol (2007) noted that maximising evaporation from the effluent dam would increase the low salinity of the effluent and that shallow dams are prone to algae growth, which can clog irrigation equipment and impact on effluent quality. These factors should also be taken into account during final dam design. Agsol (2007) suggested that to manage potential salinity and nutrient accumulation, final dam configuration could be a combination of deep and shallow sections to be used as appropriate during irrigation and non-irrigation periods.

A detailed assessment of the required size of this dam has been undertaken as part of the water balance (refer to *Section 4.2.2*), which indicates that 40ML will be adequate to store effluent during wet periods, thus minimising potential for uncontrolled discharges.

From the effluent dam, water will be pumped to an irrigation area with a crop such as barley or lucerne. Lucerne has a high requirement for water and can use 7-10 ML/ha of irrigation water over a full irrigation season, in addition to normal rainfall (Bourchier, 1998). Lucerne has medium salt tolerance and a high nutrient uptake while barley has a high salt tolerance and a moderate nutrient uptake (DEC, 2004). A minimum area of approximately 55ha has been set aside on the site for irrigation.

3.5.2 Salt Evaporation System

Approximately 49kL of effluent per day will be generated from the regeneration streams of the water softener unit and the membrane treatment. This separate waste stream will be diverted to a salt evaporation system adjacent to the proposed ethanol production plant and the irrigation water storage pond. Effluent from the softening and demineralising processes of the facility will be produced with water quality parameters as shown in ***Table 3.2***, notably with a high concentration of salts (EC 30,000-32,000 µS/cm).

Table 3.2 ***Water Quality Parameters of High Concentration Effluent Stream***

Parameter	Unit	Value
pH	-	7 - 9
Electrical Conductivity	mS / cm	30000-32,000
Total Dissolved Solids	ppm	19672.9
Total Suspended Solids	ppm	0.0
Turbidity	NTU	0.3
Total Hardness as CaCO3	ppm	4200.4
Total Alkalinity as CaCO3	ppm	3259.0
Calcium as Ca2+	ppm	5623.9
Magnesium as Mg2+	ppm	789.5
Chlorides as Cl-	ppm	14189.3
Active Chlorine as Cl2	ppm	0.0
Total Iron	ppm	208.5
Total Manganese	ppm	9.7
Silica as SiO2 (reactive)	ppm	1122.5
Silica as SiO2 (filter sand)	ppm	0.7
Sodium as Na+	ppm	9364.8
Potassium as K+	ppm	362.1
Sulphates as SO42-	ppm	5552
Nitrates/Nitrites (NO3 - NO2)	ppm	833
Fluorides as F-	ppm	666
E Coli	no/ml	640
Total Coliform Bacteria	no/ml	8376
Total Phosphorus as P	ppm	0.06
Boron as B	ppm	3.9
BOD 5	ppm	0
COD	ppm	4528.7
Total Nitrogen (Kjeldahl)	ppm	90.6
Ammonia as NH4+	ppm	517.6

Source: Agri Energy Limited (2007)

Conceptually, based on an annual evaporation rate of 1869mm and an annual rainfall of 461mm at Condobolin, and applying an efficiency factor of 85%, the salt bed system will require a total net surface area of 14,904m^2 (120m x 120m). Overall dimensions of the entire system would be approximately 160m x 110m, including bunds, separated into a series of evaporation cells (six) with net surface areas of 50m x 50m. These cells will have an operating range of 0.5m in depth plus flood storage buffer and will be used on a rotational basis for complete drying and recovery of salt.

A perimeter containment bund would be conservatively designed to be either 300mm freeboard above the 100yr flood level, or 500mm freeboard above the critical 100yr rainfall event, whichever is higher. This level will be determined at the detailed design stage during the preparation of the site EMP. During extreme rainfall events, overflow will flow over low partition walls and into adjoining cells. The entire system would be clay lined to prevent seepage into surrounding soils, while an assessment of bund wall condition and groundwater monitoring will be carried out downstream of the system as part of the site EMP.

The annual salt (NaCl) production of the proposed evaporation system will equate to 420 tonnes (9365ppm Na^+ and 14190ppm Cl^-), which will be harvested and stored in high density concrete bins within a small undercover storage area. The salt will then either be sold or offered for commercial purposes.

3.5.3 Sewerage

Sewage from these facilities will be collected and treated and disposed of through an on-site septic system. It is expected that these facilities will create an average of 3.8 kL of sewage per day.

3.6 STORMWATER MANAGEMENT

The basic stormwater management requirements are described below. A more detailed stormwater management plan will be developed to provide concept design and sizes of stormwater drainage elements in future. Existing drainage paths from the site will be maintained. This plan will include the following basic requirements:

- Stormwater runoff from all roofs and hard surface areas will be directed towards a 2Ml stormwater dam adjacent to the production buildings. This water will be disposed of via evaporation, and there will also be a pump installed in the stormwater dam to enable use of this water for irrigation, or to supplement the raw water dam (the quality is expected to be satisfactory for ethanol production). The pump will enable draw down of water levels (by pumping to the raw water dam) to below the designated top water level within a 48 hour period after rain so there will be no intentional discharges. The dam will also serve as emergency spill containment and will require at least 60kL of reserve capacity between top water level and spillway level. The stormwater dam will be designed to fully retain the 90th percentile rainfall event and the 20 year, 2 hour storm runoff is selected as the minimum design criteria (this is a commonly used criteria for detention in other locations around NSW). Overflows in extreme rainfall events are expected to be sufficiently diluted to meet ANZECC and ARMCANZ (2000) guidelines for receiving waters (Lachlan River). Event sampling and testing will be undertaken to confirm this expectation.

- An oil-grit separator will be installed to treat water from carpark and road areas prior to it entering the stormwater dam. This will remove coarse sediments and hydrocarbons prior to discharge to the stormwater dam.

- Internal roads and areas where storage, transfer or processing of potentially contamination material is proposed will be paved and graded to direct runoff and potential spills to the stormwater drainage system. Gutters, bunds, swales and pipe networks will be installed to direct flows from these areas to the stormwater dam.

- Bunds will be constructed around all portions of the site in which potentially contaminating materials are stored, handled or processed. Wherever practical, these areas will be roofed or otherwise covered and will include a fully contained drainage system. Bunds will prevent entry of runoff from surrounding areas for all events up to the 100 year ARI storm and will fully contain any potential spill within the bunded areas. Design of bunding, drainage and pump-out systems etc. will be in accordance with the relevant Australian Standards.

4 IMPACT ASSESSMENT

4.1 CONSTRUCTION

Minor excavations will occur during the construction phase of the project. The key soil disturbances will result from construction of plant structures, construction of the raw water supply dam, effluent dam, stormwater dam, salt evaporation cells and laying of pipelines to connect the site to water and other utilities.

Potential impacts associated with these activities include:

- movement of sediment laden runoff from the site due to stormwater flowing over excavated or disturbed areas, including any temporary stockpile areas;
- soil erosion; and
- spills of fuels or chemicals.

During construction and excavation activities, best management practices will be implemented to ensure the risk of soil erosion and transport of sediment laden run-off from the work area is minimal. Details of erosion and sediment control measures are provided in *Section 5.*

4.2 OPERATION

4.2.1 Water Supply

Raw water extracted for use in the ethanol production facility will not impact on other local water users as it will be drawn from the source (Lachlan River) in association with licence conditions and in accordance with the *Water Sharing Plan for the Lachlan Regulated River Water Source 2003*.

The raw water dam on site has been sized to allow for approximately 30 days contingency supply. Therefore there should not be an impact on operations should water be unavailable from the source for a period of up to 30 days.

Potable water demand on the site will not be high and should not, in itself, place significant demands on the existing Condobolin water supply.

4.2.2 *Effluent Irrigation*

Effluent from the ethanol production process that is not recycled or diverted to the salt evaporation beds will be reused for irrigation. Uncontrolled discharges of effluent have the potential to adversely affect receiving waters and associated flora and fauna unless treated or sufficiently diluted.

Unless irrigation is carefully planned and monitored adverse impacts may occur due to:

- excess irrigation water of unacceptable quality percolating to groundwater (potentially affecting beneficial groundwater uses) and/ or running off irrigation areas and entering receiving waters;
- excess irrigation water percolating to groundwater and leading to elevation of the groundwater table;
- insufficient irrigation water causing crop growth problems;
- nutrient build up which can be leached to groundwater;
- salt build up causing crop growth health problems and potential leaching to groundwater.

Irrigation Strategy

The site irrigation strategy has been developed to ensure sustainable irrigation of effluent. A basic element of this plan will be that effluent will be applied at a rate that will maintain a soil moisture deficit while meeting targets for nutrient uptake, water use and salt flushing that are a function of soil conditions, climate and crop type. This will ensure that effluent does not runoff the irrigation area, potentially polluting Gum Bend Lake or the Lachlan River.

The frequency of irrigation in the water balance was determined by the rate of change in soil moisture content. The irrigation strategy is designed to avoid excessively frequent irrigation of the soil and thereby minimising runoff and/or percolation. In the water balance, irrigation water is applied when the soil deficit equalled the daily effluent volume to be applied. If the application of effluent to the irrigation area exceeds this estimated deficit, there is potential for it to migrate beyond the root zone to groundwater.

The daily effluent flow from plant operations to the effluent storage dam for irrigation is 1.15Ml/day and the available irrigation area is a minimum of 55ha. Therefore, the modelled application rate, for 1.15Ml/day effluent flow and irrigating 55 hectares of lucerne is an average of 2.1mm/day.

It should also be noted that a leaching allowance for effluent irrigation is required to allow leaching of any accumulated salts to below the crop root zone. *Section 1.1.1* details this requirement.

Effluent Classification

The effluent was classified, based on criteria outlined in *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004), to assess environmental management requirements. The proposed quality of effluent from the ethanol production process and a classification rating is shown in *Table 4.1*. The expected characteristics of the effluent indicate that it will be need to be classed as medium strength due to the TDS concentration.

Typical effluent quality data was obtained from PDF and AEL (2007), and is summarised in *Table 4.1*. This is the result of predicted effluent quality from the ethanol plant and waste water treatment vendors as well as water quality data provided by DNR for the main water supply sourced from the Lachlan River. The key parameters as well as those used in the DEC's (2004) effluent strength classification are discussed below.

The full suite of the calculated effluent quality results are presented in *Annex C.*

Table 4.1 Predicted Effluent Quality

Parameter	Units	Average Concentration
pH		8
EC	dS/m	0.9-1.1
TDS	mg/L	752
TSS	mg/L	168.4
BOD_5	mg/L O_2	33.88
Oil and Grease	mg/L	1.44
TP	mg/L	0.06
TN	mg/L	25.9
TKN	mg/L	4.52
NO_x	mg/L	11.23 (total NO_2 + NO_3)
Ammonia as NH_4^+	mg/L	10.15
Ortho Phosphate	mg/L	No data
Coliform	cfu/100mL	0 at 95 %ile
Chlorophyll "a"	mg/L	No data

Source: Process Design & Fabrication Pty. Ltd, M06062-CA-003

Organic matter in effluent is measured by 5-day Biochemical Oxygen Demand (BOD_5). Organic matter is removed from effluent by land application, with loading rates greatly influencing the resting period for soil re-aeration and infiltration rates due to clogging of soil pores. The BOD_5 level of the untreated effluent is low at 33.88 mg/L.

Total dissolved salts (TDS) is a measure of salinity. Levels between 600-1,000mg/L are considered medium strength. The average value of TDS for the effluent is medium at 752mg/L.

The range of **pH** of the effluent is 7-9, which is suitable for effluent irrigation without adjustment.

The **total suspended solids** (TSS) average value is expected to be 168.4mg/L in effluent. This is relatively low however TSS needs to remain at a low level to avoid clogging sprinkler nozzles and soil pores and the coating of leaf surfaces.

Nutrients are very low for both nitrogen (N) and phosphorus (P).

The strength of the effluent is important when determining the wet weather storage volume requirements. The untreated effluent falls into the 'medium strength' category according to DEC 2004 guidelines although this is solely as a result of the concentration of TDS.

Table 4.2 ***Effluent Strength Classification***

Parameter	Approximate Effluent Concentration mg/L	Effluent Strength Classification (DEC, 2004)
BOD_5	33.88	LOW
TN	25.9	LOW
TP	0.06	LOW
TDS	752	MEDIUM
Oil and grease	1.44	LOW
TSS	168.4	*N/A*
EFFLUENT STRENGTH		**MEDIUM**

1. Classification is based on Table 3.1 of the DEC (2004) *Environmental Guidelines: Use of Effluent by Irrigation*

The DEC guidelines suggest that for full reuse schemes with medium strength effluent, the allowable frequency of uncontrolled discharges which inevitably occur as a result of prolonged rainfall events should be limited to 75% of years (DEC, 2004). As described in the following section, preliminary investigations indicate that sizing of the effluent dam at 40ML meets this requirement.

Water Balance

It is important to ensure that sufficient land and wet weather storage is available when designing an effluent irrigation scheme to avoid unnecessary discharges to the environment. Detailed water balances are used to ensure that sufficient land and storage is available throughout the year.

A daily water balance has been prepared in accordance with the DEC (2004) *Environmental Guidelines: Use of Effluent by Irrigation* to ensure that the effluent irrigation system will provide an efficient and sustainable means of managing effluent from the production process (refer to *Annex D*). The approach for the irrigation area water balance has also been adapted from the nominated area method outlined in *Environment & Health Protection Guidelines* (1998).

Lucerne cropping was investigated to determine the wet weather storage requirements for the predicted effluent volumes produced.

In an effluent irrigation scheme, the volume of effluent that can be applied to a site plus the rainfall should generally equal the amount of water able to be used by plants when natural runoff and percolation is taken into account. This minimises problems associated with runoff and waterlogging of soil. The maximum amount of effluent that can be applied can be calculated from the following formula:

Effluent applied = evapo-transpiration + deep drainage + surface runoff – precipitation

If soil moisture is too high, for example during periods of wet weather, the effluent is detained in the wet weather storage pond.

The variables used in the daily water balance model were:

- *Effluent applied*: the effluent available for irrigation is the total of the daily effluent produced (1150kL) minus the evaporation loss from the effluent dam.

- *Precipitation and Evapo-transpiration:* Daily rainfall records from the BoM station 0050052 were analysed for the 90th percentile and average rainfall years (1984 and 1987 respectively), to ensure that the storage is large enough to ensure any uncontrolled discharges are limited to 25% of years.

- Crop Factors provided in *Table 4.1* of the DEC's 2004 *Effluent Irrigation Guidelines* and the daily evaporation recorded at BoM station 050052 were used.

- *Plant Root Depth and Available Soil Water*: The plant root depth was taken to be 0.3m for lucerne. Plant available soil water was based on this value and the soil types at the site, and was calculated to be 200mm/m.

- *Surface Runoff and Drainage (Percolation)*: Surface runoff was modelled to occur when the soil saturation limit was reached. It was assumed that rainfall throughout the year would provide the necessary percolation required to leach salts from the effluent out of the root zone. Percolation through soil at the design rates for saturated hydraulic conductivity was conservatively taken to be 0.05mm/hr.

A spreadsheet water balance model was used in accordance with the DEC (2004) *Guidelines*, using daily historical data over one year.

Effluent Storage Requirements

Any excess effluent which cannot be applied to the irrigation area will be stored in the effluent dam and used on days when there is a soil moisture deficit and additional effluent can be sustainably applied.

A daily water balance was used to assess the wet weather storage requirements (refer to *Annex D*). Daily data provides more accurate and realistic results than a monthly water balance and reduces over-design, which can occur in a monthly water balance where the effects of uneven distribution of rainfall over the month is not taken into account, reducing the potential for irrigation over more days throughout the year.

A spreadsheet model using daily historical data for two separate years (1984 and 1987) classified as the 90th percentile and average rainfall years respectively was used to assess a worst-case scenario. Based on the water balance model, the worst of these years requires a maximum of 33 continuous days for which effluent will be required to be stored. The daily effluent storage volume required based on this data and sufficient to limit uncontrolled discharges such that they occur only during only 1 in 4 of years is 37.95Ml.

Based on this calculation, a conservative volume was determined to allow for additional hydraulic retention time should irrigation be delayed for an unusually long period of time. Five weeks (35 days) of effluent storage volume has been provided in the effluent dam to a volume of 40Ml. This is able to account for the extended periods of approximately 33-days where irrigation is not possible (as modelled in the daily water balance), with additional 2 days' allowance for system 'down-time' such as for maintenance or pump or system failure and extended periods during the months of June-July where cooler weather may limit, although not necessarily preclude, effluent irrigation.

The 40Ml of storages will ensure that are no discharges of effluent from the site up to the 75th percentile rainfall event, at which time overflows are expected to be sufficiently diluted to meet ANZECC and ARMCANZ (2000) guidelines for receiving waters (Lachlan River).

Given the nature of soils on the site, the effluent dam will require a HDPE liner or similar to ensure effluent does not percolate through to groundwater.

4.2.3 Size And Suitability Of Irrigation Area

The potential irrigation area was calculated based on a combination of calculated effluent flows and NSW DEC (2004) recommended buffer areas, including:

- 20m from all property boundaries bordering the edge of the irrigation area; and
- more than 50m from all houses, roads, existing grazed vegetation and drainage lines.

The total area available for irrigation of treated effluent, taking into account the buffers described above, is a minimum of 55 hectares and is illustrated in *Figure 1.2*.

Agsol (2007) conducted an independent review of the proposed irrigation scheme, including the suitability of the soils to accommodate an effluent irrigation scheme (refer *Annex A*). This report indicated that the irrigation area will be suitable for a sustainable effluent irrigation scheme. The limited soils data suggests that the soils have only manageable limitations including sodicity and possibly below plant root zone salinity.

Agsol (2007) considered it likely that a suitable crop management system can be put in place which could immobilise the nutrient content of the effluent (Agsol, 2007). Calculated effluent quality data show that concentrations of nutrients and electrical conductivity can be managed as required given the low concentrations of these constituents as outlined below.

Agsol (2007) stated that if groundwater is not present within three metres of the ground surface and there is a barrier to groundwater movement (such as clay subsoil) risks to any underlying groundwater resource should be minimal. The review of borelog information presented in *Section 2.6* indicates that groundwater at the site is unlikely to be present within five metres of the ground surface. Geotechnical and hydraulic investigations undertaken for the development of the irrigation plan will enable identification of potential barriers to groundwater movement provided by the subsoils. However, as discussed in *Section 2.6*, it is likely that low permeability sediments are present between the shallow water bearing zone and ground surface, which could impede percolation to groundwater. A number of groundwater monitoring bores will be established on the site as part of the EMP, and will accurately determine the depth to groundwater across the site.

4.2.4 Water Quality

The likely pollutants of concern during operation of the facility are those associated with the effluent. A full assessment of expected effluent quality has been conducted and the expected nutrient concentrations in effluent are very low. The moderate salt levels (represented as EC and TDS) are of primary concern solely because this is the component of the effluent that creates a 'medium strength' effluent.

Salt Balance

The DEC guidelines recommend that when using effluent that contains more than 500mg/L of TDS, a higher level of salinity control to maintain a viable and lasting system is required. A detailed salt balance for the irrigation area has been undertaken to ensure salinity is appropriately managed.

The EC value of the effluent was taken into account by calculating a leaching requirement for removal of salts out of the root zone. This was calculated to be 92mm per year. Rainfall depth can be monitored through the year to assess whether this will provide the required leaching. However due to deficit between evaporation and rainfall and to account for the possibility that seasonal rainfall may not provide the required 92mm to leach salts out of the root zone, additional irrigation depth may be required at least once per year to provide this leaching.

Complete salt balances are provided in *Annex E*.

Nutrient Balances

The principal objective in an effluent irrigation scheme is to use or immobilise the added nutrients quickly to prevent potential contamination of ground and surface waters. To achieve this, the amount of each nutrient applied in the effluent must be less than or similar to the amount removed from the site by the particular agricultural activity, as well as the fixing of phosphorous by the soil and gaseous losses of nitrogen to the atmosphere.

Nitrogen and phosphorus were examined in the nutrient balances. Inputs to the nutrient balances included:

- the crop to be used;
- average annual dry matter yield;
- average annual effluent application rate;
- average nutrient concentrations in the effluent;

- annual load of nutrients and the proportion available to plants; and
- the approximate quantity of nutrients exported from the site each year through grazing, leaching, or immobilisation in soil , depending on the nutrient.

Phosphorus

Results from phosphorus modelling in accordance with the DEC guidelines (see *Annex E*) show that the quantities of phosphorous that would accumulate in the soil will continue to result in a net deficit for the modelled life of the ethanol plant of 80 years. Modelling using an estimated and extremely conservative phosphorus sorption capacity of site soils at the proposed irrigation area shows that the life of the soil for phosphorus uptake with the predicted concentration in the effluent is in the order of 4300 years.

Nitrogen

The level of nitrogen deficiency in the soils, low nitrogen content of the effluent and the extent of nitrogen uptake and decomposition is such that additional fertiliser would be required to provide long-term nutrition to boost pasture or crop production further.

After a ten year application the soils indicate a net nitrogen deficit of approximately 67kg/ha for a lucerne cropping enterprise.

No leaching or soil accumulation is predicted to occur based on the nutrient modelling. The complete nutrient budgets are presented in *Annex E*.

Stormwater Management

The stormwater management system will capture runoff from all hard surfaces across the site. Water from road and carpark areas will be treated via an oil/grit separator and then stored in the stormwater dam along with water from roof areas. This water will be disposed of via evaporation, or will be irrigated or used to top up the raw water supply for the ethanol production process. The quality of this water is expected to be satisfactory for ethanol production and, because all water contained in the dam will be pumped to the raw water dam within 48 hours, there will be no intentional discharges and hence no water quality impacts downstream of this dam. Overflows in extreme rainfall events are expected to be sufficiently diluted to meet ANZECC 2000 guidelines for receiving waters (Lachlan River). Event sampling and testing will be undertaken to confirm this expectation.

There is potential for chemicals and materials stored, handled or processed on site to spill, thus potentially polluting local waterways. Installation of bunds around all portions of the site in which potentially contaminating materials are stored, handled or processed, will ensure that this risk is appropriately managed.

There is potential for groundwater and surface water quality impacts as a result of failure of the proposed on-site septic system. Most systems are designed to have a life of 20-30 years, with regular maintenance to remove sludge that has built up. If properly maintained, in accordance with recommendations of the septic system supplier, the system should not impact on the quality of ground and surface water.

There is potential for leakage from the effluent dam or stormwater dam to contaminate groundwater unless dams are lined or soil permeability is sufficiently low ($< 10^{-11}$ m/s).

4.2.5 Flooding

As indicated in *Section 2.5*, a large portion (>50%) of the site is subject to flooding during a 1 in 100 year ARI flood event, with the flood level estimated as 188.4 m AHD.

Potential impacts include reduction of flood storage volume and impedance of flood flows with resultant increases in flood levels upstream of the site. Because the proposed site layout has buildings within the flood prone area there is potential for floods to cause damage to buildings and contents and to disrupt production.

As the area of the site is small relative to the floodplain and because flood velocities will be low, impacts on flood levels as a result of development would be insignificant. Detailed hydraulic analysis would be required to confirm the quantum and extent of flood afflux.

5 MITIGATION AND MONITORING

5.1 MITIGATION

5.1.1 Construction Phase

A Soil and Water Management Plan will be prepared prior to any construction activities in accordance with *Managing Urban Stormwater – Soils and Construction* (Landcom, 2004). Measures to prevent impacts to water resources during construction will include:

- installation of temporary erosion and sediment control structures such as straw bales and sediment fences to prevent the movement of sediment from construction areas;
- installation of sediment basins and/or use of existing dams to contain sediment laden water, allow sufficient settlement time and flocculation if required and discharge of water following testing to confirm water quality meets relevant guidelines (eg < 50 mg/L suspended solids, no visible oils and greases etc);
- minimisation of time excavated surfaces are left exposed;
- restriction of traffic to defined internal roads;
- ensuring chemicals are appropriately stored and bunded;
- if required, cleaning soil adhered to tyres by hosing down in bunded areas prior to departure from the site; and
- regular inspection and maintenance of erosion/siltation control devices to ensure effectiveness for the entire construction period.

5.1.2 Operation Phase

Water Supply

The proposed water management system has been designed to maximise recycling and beneficial use of site water. All water discharged from the ethanol production process will be either recycled for further use within the plant following treatment, or used for irrigation, or evaporated in salt beds. Recycling will minimise demand for raw water from off-site.

In the event of mechanical failure or interruption of power supply to the secondary water treatment plant, effluent would be directed to the effluent dam resulting in a small increase in BOD levels. Mitigation of the impacts of such a malfunctioning would involve the short-term use of an aerator in the effluent storage dam (approx. 2 – 3 days) to reduce the BOD while repairs are carried out to the plant. Monthly water quality monitoring of the effluent dam would monitor this level.

Storages

Storages containing effluent or potentially contaminated water will be designed to fully contain effluent / runoff for the 75th and 90th percentile of all rainfall events respectively. In addition, the stormwater dam will be designed to fully retain the 20 year, 2 hour storm runoff (this is a commonly used criteria for detention in other locations around NSW). Clean water storages will generally be designed to contain flows up to the 10 year, 2 hour ARI event with spillways designed to convey the 100 year ARI overflows. All onsite dams will be constructed with appropriate liners (HDPE liner or similar) to ensure water retention.

Agsol (2007) suggested that to manage potential salinity and nutrient accumulation, final dam configuration could be a combination of deep and shallow sections to be used as appropriate during irrigation and non-irrigation periods.

Flooding

The assessment of flooding at the site presented in this report has been based on a flood frequency analysis (from the Draft Lachlan River Jemalong Gap to Condobolin Floodplain Risk Management Study) which was based on an incomplete dataset. Further, the Draft Lachlan River Jemalong Gap to Condobolin Floodplain Risk Management Study from which information was obtained focused on the section of the Lachlan River upstream of Condoblin to Jemalong Gap. Therefore this should be taken only as an indicative assessment of the flood potential of the site.

A flood study commissioned by Lachlan Shire Council is currently being prepared by Lyall and Associates Consulting Water Engineers and includes the stretch of the Lachlan River downstream of Condobolin and adjacent to the site. This study is due to be completed in mid-2007. The results of this study will be analysed during the detailed design phase of the project and a detailed assessment of site flooding made. Mitigation measures adopted will be based on the detailed assessment and may include:

- filling of the area to raise the plant to above the 100 year ARI flood level (as an indication, the area would need to be filled from between 0 to 1.3m across the gradient to mitigate against inundation by a 100 year ARI flood level of 188.4m at the site). Compensatory flood storage volume can be created by excavating the fill from within the flood zone. The relatively flat topography of the area around the site, low flood velocities, breadth of the floodplain and location of the site within it indicate that raising the small area of land where the plant will be located would not result in significant changes to flood behaviour around the site;

- design of the salt evaporation system perimeter containment bund to be either 300mm freeboard above the 100yr flood level, or 500mm freeboard above the critical 100yr rainfall event, whichever is higher;

- construction of a levee bank around the plant; and

- relocation of the buildings and above ground structures to above the flood line, in the more elevated eastern and north-eastern portion of the site (this is considered to be a last resort measure as it will bring the facility closer to the residences east of the site).

The relatively flat topography of the area around the site, the low flood velocities, the breadth of the floodplain and location of the site within it suggest that raising the small area of land where the plant will be located would not result in significant changes to flood behaviour around the site.

Stormwater

A detailed stormwater management plan will be developed for the facility. It will incorporate the concepts outlined in *Section 3.6*. Stormwater runoff from potentially dirty areas e.g. carparks, will be fully retained on-site to avoid potential discharges and impacts on receiving waters. Runoff from clean areas i.e. undeveloped parts of the site, will be diverted around dirty areas to retain clean water flows to receiving waters.

Irrigation Area

A detailed irrigation schedule and monitoring program will be determined before any irrigation with reclaimed water occurs, prepared as part of the site Construction Environmental Management Plan. The plan is included in the Statement of Commitments will also detail monitoring of the irrigation area (see *Section 5.2*).

Adherence to the detailed irrigation plan, including seasonal application rates, developed for the project will ensure that excess effluent is not applied to the irrigation area and hence infiltration to groundwater does not occur. For this purpose, maintenance of a soil moisture deficit, to the extent that any specific crop irrigation requirements allow, will be one of the requirements of the detailed irrigation plan. This will also prevent inefficient use of water.

Agsol (2007) indicated the need for a detailed soil survey of the proposed irrigation area on the site, undertaken for the typical 0-20, 20-40 and 40-100cm soil materials, with analysis of pH, salinity, sodicity, CEC and phosphorus sorption capacity and estimates of saturated hydraulic conductivity and available water holding capacity. The results of this survey would also feed into the irrigation plan.

Sewerage

The on-site septic system will be regularly maintained to ensure it continues to operate efficiently.

5.2 MONITORING

5.2.1 Effluent Monitoring

Effluent from the ethanol production facility will be monitored as soon as practical after commencement of operations to characterise its quality. This characterisation will include analysis of the parameters listed in *Table 5.1*. *Table 5.1* also shows the recommended monitoring frequency for the effluent for ongoing operations.

Table 5.1 Effluent Monitoring

Parameter	Monitoring Frequency
Total Suspended Solids	Monthly
Oil and grease	Quarterly
Total Phosphorous	Quarterly
Total Nitrogen	Quarterly
Biochemical Oxygen Demand	Monthly
pH	Monthly
Total Dissolved Solids	Monthly
Cations	Quarterly
Sodium Adsorption Ratio	Quarterly
Metals	Yearly

Based on recommendation in DEC 2004. Monitoring frequency and parameters should be assessed on a regular basis and reviewed based on previous monitoring results.

5.2.2 *Soil Monitoring*

The NSW Department of Primary Industries has recommended a soil sampling strategy for surface and profile samples (DEC, 2004). This includes:

- a composite soil sample of 40 soil cores per 1-2 ha, taken at depth of 0-10cm; and
- composite soil samples of 5 cores at four depth intervals to 1 metre within a 5 meter diameter plot (the four depth intervals should be within 0-20, 20-40, 40-70 and 70-100cm depth increments and positioned within major soil layers).

Soils will be monitored in accordance with this procedure for the parameters outlined in *Table 5.2* annually for the first three years of operation. Monitoring requirements will be reviewed after this time.

Table 5.2 Soil Monitoring

Parameter	Sampling Frequency	
	Surface Soil	**Soil at four depth increments**
pH	Annually	Annually
Electrical Conductivity	Annually	Annually
Nitration – N	Annually	Annually
Total N	After 3 years	N/A
Available P	Annually	N/A
Total P	After 3 years	Every 3 years
Exchangeable sodium percentage	Annually	Every 3 years
Heavy metals and pesticides	After 10 years	N/A
P sorption capacity	After 3 years	Every 3 years

Based on Table 5.2 DEC, 2004

5.2.3 *Groundwater*

The *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004) recommends groundwater monitoring if groundwater is location within 10m of the ground surface and/or if the proposed irrigation scheme has the potential to put groundwater at risk. Data from historical bore logs in the region indicates that there is potential for groundwater within 10m of the ground surface. Further assessment of groundwater resources will be undertaken as part of the development of the detailed irrigation plan and site EMP, including the installation of a number of groundwater monitoring bores located up and down gradient of the irrigation area, and down stream of the storage dams and salt evaporation system.

6 STATEMENT OF COMMITMENTS

From the assessment presented above, the following form commitments of AEL in regards to water resources:

- Erosion and sediment controls will be implemented during construction in accordance with *Managing Urban Stormwater – Soils and Construction* (Landcom, 2004).
- Detailed design and operation of the salt evaporation system will be determined during the preparation of the site EMP.
- A detailed irrigation plan will be developed prior to commencement of operations and following a full analysis of soil infiltration rates and hydraulic conductivity at the irrigation area. It will detail aspects such as:
  - types of crops and cropping methods;
  - fertiliser management and details of any required treatments to address potentially limiting soil conditions e.g. application of gypsum;
  - the method and scheduling of irrigation (in accordance with DEC (2004b) *Environmental Guidelines: Use of Effluent by Irrigation*), including application rates and how soil moisture deficit will be maintained (typically at five to ten millimetres) and monitored to ensure excess effluent is not applied to the area (resulting in infiltration of excess effluent to groundwater and/or runoff to receiving waters of Gum Bend Lake and the Lachlan River);
  - a detailed assessment of the required size of the effluent dam;
  - the level and intensity of monitoring required, and an assessment of the requirement for groundwater monitoring;
  - triggers for cessation of irrigation;
  - responsibilities for operation of the effluent irrigation scheme; and
  - incident and emergency response procedures e.g. in advent of equipment failure.
- AEL will establish groundwater monitoring bores and incorporate monitoring, as specified in *Section 5.2* into their site operational procedures.
- All onsite dams will be constructed with appropriate liners (HDPE liner or similar) to ensure water retention within the dams.
- The on-site septic system will be regularly maintained.

REFERENCES

ACT Commissioner of the Environment (2004) **Upper Lachlan State of the Environment Report.** http://www.envcomm.act.gov.au/soe/soe2004/UpperLachlan/groundwater.htm

ANZECC & ARMCANZ (2000) **Australian and New Zealand Guidelines for Fresh and Marine Water Quality** Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Bourchier J. (1998) **Agriculture Notes: Irrigation of lucerne for hay**, AG0230, ISSN 1329-8062, March 1998.
http://www.dpi.vic.gov.au/dpi/nreninf.nsf/9e58661e880ba9e44a256c640023eb2e/06c8ce682794697eca256f160011a71a/$FILE/AG0230.pdf

DEC (2004) **Environmental Guidelines: Use of Effluent by Irrigation** Department of Environment and Conservation (NSW), Sydney.

DEC (2006) **NSW Water Quality and River Flow Objectives** http://www.environment.nsw.gov.au/ieo/, last updated 28th June 2006.

Department of Local Government, Environment Protection Authority, Department of Health, Department of Land and Water Conservation and Department of Urban Affairs and Planning (1998) **Environment and Health Protection Guidelines: On-site Sewage Management for Single Households**

Department of Primary Industries (DPI, 2007) **Victorian Resources Online**, Last Updated 31/1/2007
http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_farmwater_efficient_irrigation_2.3.7.2

GTS (2007) **Condobolin Ethanol Site, Preliminary Geotechnical Investigation for Swan Hill Ethanol Pty Ltd** GTS Report Number 06/4325, January 2007.

Landcom (2004) **Managing Urban Stormwater: Soils and Construction** Sydney.

Annex A

Agsol Irrigation Assessment

Proposed Ethanol Plant at Condobolin- Suitability for Effluent Reuse by Irrigation

Agsol Pty Limited

Prepared for Environmental Resources Management Australia Pty Ltd and Agri Energy Limited

March 2007

Proposed ethanol plant at Condobolin- suitability for effluent reuse by irrigation.

Background

ERM have requested Agsol to review the irrigation issues for three proposed ethanol plants at Coleambally, Oaklands and Condobolin. ERM have provided lab results, a soils description and extracts from the Environmental Assessment Report related to wastewater and irrigation. A geotechnical report undertaken by GTS (2007) was also provided.

Specifically ERM have requested that Agsol:

- review the data;
- provide advice on expected ranges of irrigation parameters and criteria;
- advise what additional data will be required for a detailed irrigation plan (expected to be completed following consent, as a condition of approval);
- advise if the scheme is feasible;
- comment on appropriate crops, irrigation methods, adequacy of irrigation area; and
- produce a short report summarising the above.

This report undertakes the above for the proposed ethanol plant at Condobolin.

Wastewater characteristics

ERM have provided data on the probable characteristics of the wastewater as shown in Table 1 below. This data has been used to provide a preliminary indication of the acceptability of the effluent quality for irrigation of crops. A detailed assessment will be undertaken once further details of the wastewater quality are known.

Table 1 Probable characteristics of wastewater

Parameter	Expected Concentration	Classification[1]
BOD_5	362 mg/L	Medium Strength
Total Dissolved Solids	1010 mg/L	High Strength
Nutrients	No data is currently available	-

Classification is based on Table 3.1 of the DEC (2004) *Environmental Guidelines for Use of Effluent by Irrigation* (2004)
Source: Process Design & Fabrication Pty. Ltd, M06062-CA-003

Classification of effluent is an important consideration as it dictates the acceptable frequency of discharge to surface waters from any storage. Agsol notes that whilst the wastewater is classified as high strength in Table 1, due to the concentration of total dissolved solids (TDS), the TDS concentration only exceeds the guideline for medium strength by 10 mg/l. DEC (2004) guidelines take into account that TDS may include nutrients such as nitrogen, and that it is reasonable to reduce the TDS accordingly. Hence Agsol concludes that in the absence of data on nitrogen and phosphorus the recycled water could be considered medium strength. To be classified as medium

strength, nitrogen concentrations would need to be less than 100 mg/l and phosphorus less than 20 mg/l. DEC (2004) also notes that the criteria for effluent strength relates to the quality of discharge, not the quality in the storage or what is produced.

Without appropriate treatment processes, effluent generated from ethanol production is typically high in BOD and may produce an unacceptable pH (i.e. pH >8.5 and/or less than 6.5). It may also have high levels of nitrogen and phosphorus. Ideally the effluent should have a pH in the range of 6.5 to 7.5 and a Sodium Adsorption Ratio (SAR) of less than 6. Acceptable levels of nitrogen and phosphorus will be determined by the capacity of the irrigated crop to uptake these nutrients.

Wastewater storage requirements

Wastewater from the production process will be stored in a storage dam prior to reuse by irrigation. The wastewater to be used for irrigation includes:

- backwash from the raw water treatment process (approximately 18 kL/day);
- the stream from the secondary anaerobic digestion treatment system which is not recycled (approximately 1546 kL/day);
- blowdown from the cooling tower and the boiler (approximately 52 kL/day) ; and
- regeneration streams from the water softener unit and the membrane treatment (approximately 244 kL/day).

Agsol concludes that the total potential volume of wastewater is 1860 kL/day.

For medium strength effluents DEC (2004) guidelines recommend that storage dams should not discharge to surface waters except in the one in four wettest year. Agsol notes that the evaporation potential for Condobolin is relatively high and that the dam design could include maximising the surface area to maximise evaporation potential thereby reducing the storage requirement and the requirements for disposal of wastewater through irrigation. However, shallow dams are also prone to algae growth. Algae can clog irrigation equipment and impact on irrigation water quality. Furthermore promoting evaporation also increases the salinity of the effluent and hence there is a risk that any discharged effluent would become ‘high strength’ requiring a design of no discharges except in the one in ten wettest year.

The current proposal is for a 40 ML effluent dam to be located to the south of the production buildings to store process wastewater from the facility. The dam is proposed to be approximately 6ha in area and 0.7m deep. A detailed assessment of the required size of this dam will be undertaken during development of the detailed irrigation plan for the facility. Final dam configuration could be a combination of deep and shallow sections to be used as appropriate during irrigation and non-irrigation seasons to manage salinity and nutrient (nitrogen and phosphorus) accumulation. Agsol notes that the dam volume could be increased by increasing the height of the walls if a detailed assessment showed that more storage was needed.

Land area for irrigation

From the effluent dam, it is proposed that water will be pumped to an irrigation area with a crop such as barley or lucerne. Lucerne has a high requirement for water and can use 7-10 ML/ha of irrigation water over a full irrigation season, in addition to normal rainfall (Bourchier, 1998). Lucerne has medium salt tolerance and a high nutrient uptake while barley has a high salt tolerance and a moderate nutrient uptake (DEC, 2004).

Agsol concludes that the irrigation area (55ha) will be suitable provided nitrogen and phosphorus levels fall within the medium strength category and a crop is grown which is harvested regularly and removed off site. The site management should minimise periods when the soil is bare. A specific crop recommendation cannot be made until more is known about the likely quantity of nitrogen and phosphorus in the effluent as well as other factors such as pH. Nonetheless it is likely that a suitable crop management system can be put in place which immobilises the nutrient content of the effluent.

DEC (2004) recommends that a maximum of 1500 kg/ha/month of BOD should be applied to an irrigation site. Given the expected BOD shown in Table 1, the maximum application rate for the site would equate to 4.15 ML/ha/mth of irrigation water. Crops to be used on the Condobolin site will likely have uptakes of between 7 and 10ML/ha/year (0.6 – 0.8ML/ha/month). Therefore the anticipated BOD content of the wastewater to be irrigated is not expected to limit application rate and hence crop growth on the Condobolin site.

Soil Landscape

According to DNR's 1:100000 soil landscape map, three soil landscapes occur in the vicinity of the proposed development. These are the Ootha, Derriwong and Mulgutherie soil landscapes.

Ootha soil landscape

The Ootha soil landscape occurs on very gently undulating rises or rarely low hills on Ordovician, Silurian and Devonian metasediments. Shallow moderately drained red earth (red kandosols) are the dominant soils with shallow well drained lithosols on crests. Red podsolic soils (Red chromosols) occur on lower lying areas. Limitations are described as wind erosion hazard, localised salinity and water erosion hazard, high run-on and stony soils of low fertility.

Derriwong soil landscape

This landscape occurs on level to gently undulating plains east of Condobolin on quaternary alluvium and colluvium. Deep poorly drained Red Brown earths including sodic types are the main soil type. On more elevated areas are non-calcic brown soils. Limitations include water and wind erosion hazard, localised high run-on, flood hazard, sodic dispersible soil, localised salinity, localised plasticity, low fertility and structure decline.

Mulgutherie soil landscape

These are heavy surface textured floodplain soils. Soils are deep poorly drained grey clays and occasional red clays. Limitations are described as flood hazard, seasonal water logging, and soils of low permeability, high shrink-swell, sodicity and poor structure.

Soil Testing

A soil investigation has been undertaken by GTS consultants. GTS (2007) notes that the site is relatively flat, and has no rock outcrop. During the extreme drought conditions at the time of survey, cracks were observed in the soil. This suggests that the site is typical of the Derriwong or Mulgutherie soil landscapes.

GTS excavated 6 pits that revealed a similar soil type with about 20 cm of silty sand overlying plastic silty clays. Pits were excavated up to 4 metres and no groundwater was encountered.

Agsol notes that if groundwater is not present in the top 3 metres and there is a barrier to groundwater movement (such as clay subsoil) risks to any underlying groundwater resource should be minimal. Nonetheless the potential for shallow groundwater resources (i.e. less than 10 metres below ground surface) should be investigated during the detailed design.

The GTS (2007) report describes the soil material as likely to be unsuitable for dam construction because of lack of clay and its gravely nature. This is inconsistent with the above soil description and will require further clarification.

Agsol has reviewed the soil analysis from Ecowise environmental. This is summarised in Table 2 below.

Table 2 Soil laboratory data at the site

Sample number	Pit	Depth (cm)	Texture	pH	EC dS/m	ECse dS/m	CEC mequiv/100g	Exch Na mg/kg	ESP
4479A	1	20	Sandy clay	7.6	.08	0.7	18	95	2.3
4479G	1	100	Sandy clay plus sandstone	8.2	0.47	5.7	0.19 (?)	780	?
4479D	4	30	Sandy clay	7.4	0.2	1.8	27	2100	34
4479H	4	110	Sandy clay	8.3	1.3	11.8	20	3000	65
4479I	5	50	Sandy clay plus limestone	7.9	0.14	1.4	22	650	12.9
4479E	5	70	Sandy clay	7.8	0.75	6.8	25	1500	26
4479J	5	250	Silty clay	8.8	0.26	2.3	19	2700	62
4479K	5	350	Silty clay	9.3	0.28	2.52	23	2700	51
4479TP1	1?	Not identified	?	7.9	0.05	<1	9.2	47	2.2
4479TP3	3?	Not identified	?	7.7	.05	<1	15	200	5.6
4479TP5	5?	Not identified	?	7.6	.06	<1	20	380	8.2

The site and laboratory data suggest red earth soils with surface soils generally suitable for cultivation underlain by very sodic subsoils which are moderately saline. This description fits the Derriwong soil landscape description. Soil pH is slightly alkaline and ideally should be reduced to between 6.5 and 7.0. The sampling strategy used to obtain results is not appropriate to describe agricultural /irrigation potential and it would be prudent to re-evaluate the soil during the detailed design stage. In particular the phosphorus sorption potential of the soil needs to be established and the extent and severity of sodicity and salinity needs to be established.

The suitability of these soils for cultivation will depend on the interaction of the effluent with the soil and the ability to ameliorate the soil (e.g. with gypsum to overcome sodicity). A relatively low pH effluent (say 6.5) will have a positive impact, as would an effluent with a low SAR (say 3 or less). It will also be important that salt in the soil and effluent is able to drain away from the irrigation site to an appropriate ground or surface water resource without negatively impacting on that resource.

Conclusions

The cropping area and effluent storage site identified are likely to be sufficient for a sustainable effluent irrigation scheme. The limited soils data provided suggests that the soils are suitable with manageable limitations including sodicity and possibly below plant root zone salinity. The effluent is likely to be classified by DEC as 'medium strength' although data on likely levels of phosphorus and nitrogen would need to be provided to confirm this. This means that the irrigation scheme would likely need to be designed so as not to discharge to the environment except in the one in four wettest years.

Recommendations

- A detailed soil survey of the site should be undertaken to refine the agricultural irrigation of the site. Tests should be taken of the typical 0-20 cm, 20-40 and 40-100 cm soil materials and include calculations of pH, salinity, sodicity, cation exchange capacity, phosphorus sorption capacity and estimates of saturated hydraulic conductivity and available water holding capacity.
- If high levels of soil sodicity occur within the plant root zone of the proposed crop, gypsum should be applied to the soil at a suitable rate.
- Sufficient effluent storage will need to be provided that meets DEC requirements for acceptable effluent discharges to the environment.
- The storage size will need to be determined from a daily water balance which takes into account daily rainfall data, estimates of daily evapo-transpiration, the type of crop grown, the soil type, irrigation system and harvesting arrangements.
- To enable classification of wastewater as medium strength the following effluent quality should be achieved:
    - Nitrogen <100 mg/l
    - Phosphorus <20 mg/l
    - BOD <1500 mg/l
    - Total dissolved solids – 'fertiliser component' <1000 mg/l
- To ensure a good quality crop the pH of the effluent should be between 6.5 and 7.5.
- To minimise odours from irrigation, the BOD should be reduced so that no more than 1500kg/ha is applied in any one month.
- To minimise the salinity of effluent, evaporation from the storage should be regulated through dam design.
- The crop management system should ensure that all nitrogen and phosphorus in effluent is immobilised by the crop/soil system. A nutrient budget will need to be undertaken once the likely nitrogen and phosphorus concentration of the final effluent is known. If the levels are still too high, consideration will need to be given to further treatment of the effluent.
- The crop management system should minimise the incidences of bare soil.
- A salt balance should be undertaken to determine the likely contribution of salt to the wider environment and if a concern a management system put in place to minimise salt impacts.

References

Bourchier J. (1998) **Agriculture Notes: Irrigation of lucerne for hay**, AG0230, ISSN 1329-8062, March 1998. *http://www.dpi.vic.gov.au/dpi/nreninf.nsf/9e58661e880ba9e44a256c640023eb2e/06c8ce682794697eca256f160011a71a/$FILE/AG0230.pdf*

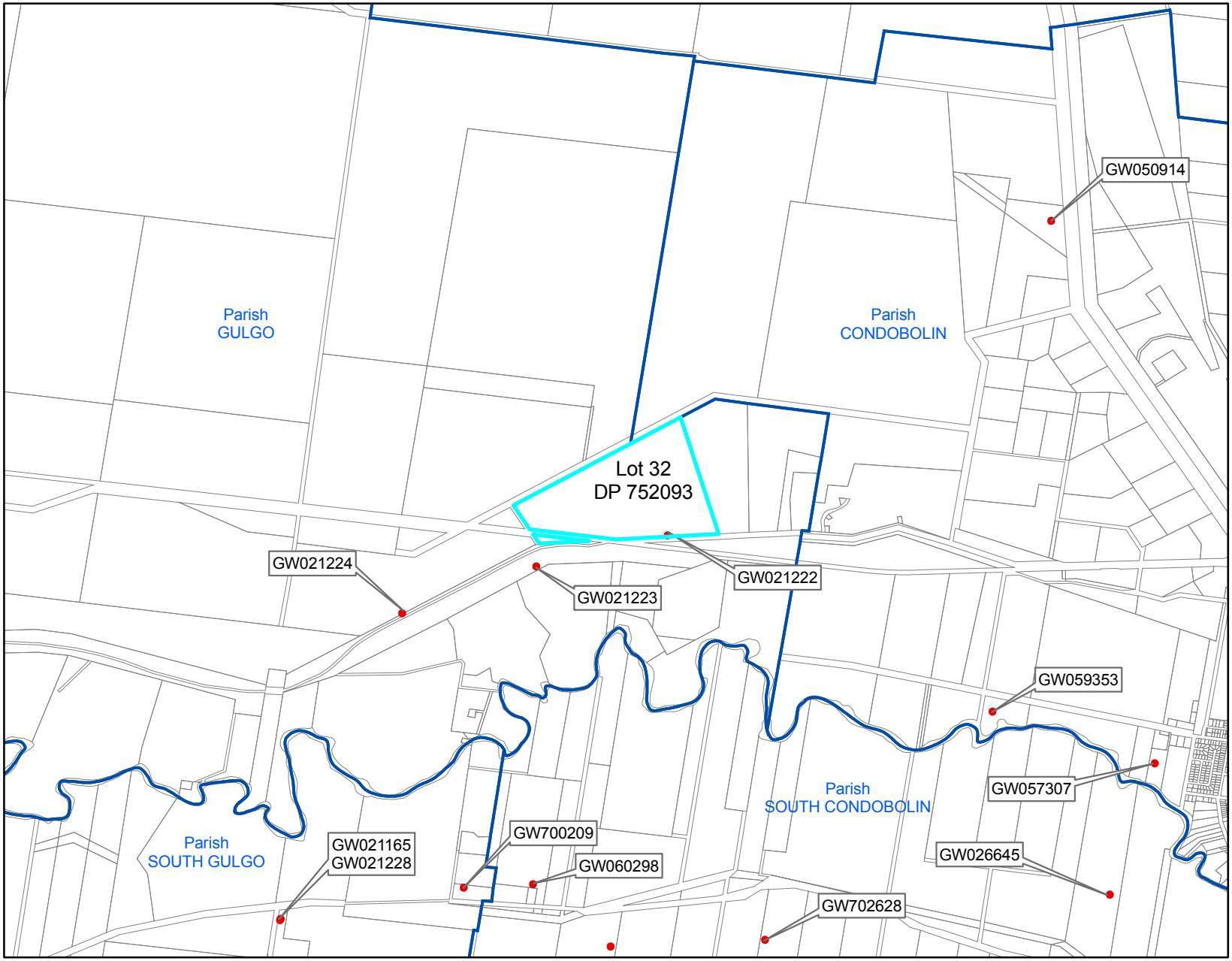
DEC (2004) **Environmental Guidelines: Use of Effluent by Irrigation** Department of Environment and Conservation (NSW), Sydney.

Geotechnical Testing Services (2007) **Condobolin Ethanol Site – Preliminary Geotechnical Investigation.** Prepared for Agri Energy Limited, February 2007.

Annex B

Bore Logs

Groundwater Bores in the Area



N

Legend

- Groundwater Bores
- Cadastre Parcels
- Parish

0 0.5 1 2 3 4 Kilometers

NSW Government
DEPARTMENT OF NATURAL RESOURCES

Produced by the Department of Natural Resources
Information Sciences Branch, Orange
Date: October 2006 Project Number: PN00799 WR2006-257A
Projection : [Geographic] Datum : [GDA94]

SOURCES
This map has been compiled from data supplied by the:
Department of Natural Resources, NSW
© Base cadastre/topographic/orthorectified imagery data supplied by NSW Department of Lands

Bore data has been supplied to the Department by drillers, licensees and other sources and the Department does not verify the accuracy of this data.

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Department of Natural Resources of any map discrepancies.

Date/Time :09-Oct-2006 1:30 PM
User :VMARTIN
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :30-Aug-2006
System :Groundwater
Database :Edbp

NSW Government
DEPARTMENT OF NATURAL RESOURCES

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW021165

Converted From HYDSYS

Licence :
Licence Status
Authorised Purpose(s) **Intended Purpose(s)**
G/WATER XPLORE

Work Type : Bore
Work Status : Test Hole
Construct. Method : Cable Tool
Owner Type :D.W.R. (NSW Dept Infrastructure, Planning & Nat Re

Commenced Date : **Final Depth :** 51.50 m
Completion Date :01-Nov-1965 **Drilled Depth :** 75.00 m

Contractor Name :
Driller :
Assistant Driller's Name :

Property : **Standing Water Level :**
GWMA : **Salinity :** (Unknown)
GW Zone : **Yield :**

Site Details

Site Chosen By **County** **Parish** **Portion/Lot DP**
Form A :GIPPS SOUTH GULGO 98
Licensed :

Region :70 - LACHLAN **CMA Map :**8331-N CONDOBOLIN
River Basin :412 - LACHLAN RIVER **Grid Zone :**55/2 **Scale :**1:50,000
Area / District :

Elevation : 186.20 m (A.H.D.) **Northing :**6337355 **Latitude (S) :**33° 6' 8"
Elevation Source :R.L. at Surface **Easting :**505568 **Longitude (E) :**147° 3' 35"

GS Map :0059A1 **AMG Zone :**55 **Coordinate Source :**GPS - Global Positioning System

Construction

Negative depths indicate Above Ground Level;
H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	51.50	74.90	203			
1		Casing	Casing Protector	-0.30	0.60	203			(Unknown)
1	1	Casing	P.V.C.	-0.30	24.90	50			(Unknown)
1	2	Casing	P.V.C.	-0.30	51.50	50			(Unknown)
1	1	Opening	Slots	15.20	18.20	50		1	Slotted On Site; SL: 0mm; A: 1.58mm
1	1	Opening	Slots	22.50	23.70	50		2	Slotted On Site; SL: 0mm; A: 1.58mm
1	2	Opening	Slots	49.00	50.50	50		3	Slotted On Site; SL: 0mm; A: 1.58mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
7.00	8.20	1.20	Unconsolidated	5.70		0.00			(Unknown)
12.10	20.90	8.80	Unconsolidated	5.70		0.38			0-500 ppm
49.00	54.70	5.70	Unconsolidated	7.30		0.25			3001-7000 ppm

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.61	0.61	Topsoil	Topsoil	
0.61	3.66	3.05	Loam	Loam	
3.66	4.57	0.91	Clay Gravel	Clay	
4.57	7.01	2.44	Clay	Clay	
7.01	8.23	1.22	Sand Coarse Water Supply	Sand	
8.23	12.19	3.96	Clay Grey Sandy	Clay	
12.19	16.15	3.96	Gravel Brownish Fine Water Supply	Gravel	
12.19	16.15	3.96	Sand Coarse Clay Bands	Sand	
16.15	21.03	4.88	Gravel Fine Water Supply	Gravel	
16.15	21.03	4.88	Sand Coarse Very Clayey	Sand	
21.03	25.60	4.57	Clay Grey Gravel	Clay	
25.60	27.43	1.83	Gravel Fine Sand	Gravel	
27.43	33.53	6.10	Clay Sandy	Clay	
33.53	34.14	0.61	Gravel Fine	Gravel	
33.53	34.14	0.61	Sand Dry	Sand	
34.14	39.62	5.48	Clay Red Grey	Clay	
39.62	49.07	9.45	Clay	Clay	
49.07	54.25	5.18	Sand Coarse Water Supply	Sand	
54.25	54.86	0.61	Gravel Brownish Fine Water Supply	Gravel	
54.86	60.05	5.19	Clay	Clay	
54.86	60.05	5.19	Slate Bands	Slate	
60.05	65.23	5.18	Shale Grey Decomposed	Shale	
60.05	65.23	5.18	Slate Bands	Slate	
65.23	68.88	3.65	Shale Grey Decomposed Bands	Shale	
68.88	71.02	2.14	Shale Grey	Shale	
68.88	71.02	2.14	Slate Bands	Slate	
71.02	74.98	3.96	Slate	Slate	

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW021165 *Converted From HYDSYS*

Remarks

2 PVCS INSERTED IN ONE HOLE WEEBAR HILL

***** End of GW021165 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW021222

Converted From HYDSYS

Licence :

Licence Status
Authorised Purpose(s) **Intended Purpose(s)**
G/WATER XPLORE

Work Type : Bore
Work Status : Test Hole
Construct. Method : Cable Tool
Owner Type : D.W.R. (NSW Dept Infrastructure, Planning & Nat Re

Commenced Date : **Final Depth :** 0.00
Completion Date : 01-Nov-1965 **Drilled Depth :** 14.60 m

Contractor Name :
Driller :
Assistant Driller's Name :

Property :
GWMA :
GW Zone :

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By

County **Parish** **Portion/Lot DP**
Form A : CUNNINGHAM GULGO 9
Licensed :

Region : 70 - LACHLAN
River Basin : 412 - LACHLAN RIVER
Area / District :

CMA Map : 8331-N CONDOBOLIN
Grid Zone : 55/2 **Scale :** 1:50,000

Elevation : 187.30 m (A.H.D.)
Elevation Source : R.L. at Surface

Northing : 6340790 **Latitude (S) :** 33° 4' 17"
Easting : 508467 **Longitude (E) :** 147° 5' 27"

GS Map : 0059A1 **AMG Zone :** 55 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	0.00	14.60	203			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.61	0.61	Topsoil	Topsoil	
0.61	1.22	0.61	Loam Red	Loam	
1.22	2.44	1.22	Clay Gravel	Clay	
2.44	3.66	1.22	Driller	(Unknown)	
3.66	6.10	2.44	Clay Gravel	Clay	
6.10	10.06	3.96	Clay Sandy	Clay	
10.06	10.97	0.91	Rock	Rock	
10.97	14.63	3.66	Bedrock	Bedrock	

Remarks

WEEBAR HILL

***** End of GW021222 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW021223

Converted From HYDSYS

Licence :

Licence Status

Authorised Purpose(s) | **Intended Purpose(s)**

Work Type : Bore | G/WATER XPLORE

Work Status : Test Hole

Construct. Method : Cable Tool

Owner Type : D.W.R. (NSW Dept Infrastructure, Planning & Nat Re

Commenced Date :

Completion Date : 01-Dec-1965

Final Depth : 0.00

Drilled Depth : 69.20 m

Contractor Name :

Driller :

Assistant Driller's Name :

Property :

GWMA :

GW Zone :

Standing Water Level :

Salinity : (Unknown)

Yield :

Site Details

Site Chosen By

County | **Parish** | **Portion/Lot DP**

Form A : CUNNINGHAM | GULGO | 38

Licensed :

Region : 70 - LACHLAN

River Basin : 412 - LACHLAN RIVER

Area / District :

CMA Map : 8331-N CONDOBOLIN

Grid Zone : 55/2

Scale : 1:50,000

Elevation : 186.50 m (A.H.D.)

Elevation Source : R.L. at Surface

Northing : 6340500

Easting : 507500

Latitude (S) : 33° 4' 26"

Longitude (E) : 147° 4' 49"

GS Map : 0059A1

AMG Zone : 55

Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	0.00	69.10	203			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Topsoil	Topsoil	
0.30	0.91	0.61	Clay Grey	Clay	
0.91	1.83	0.92	Clay	Clay	
1.83	3.35	1.52	Clay Reddish Grey	Clay	
3.35	9.14	5.79	Clay Grey	Clay	
9.14	15.85	6.71	Clay Reddish Grey Stoney	Clay	
15.85	21.95	6.10	Clay Reddish Grey	Clay	
21.95	23.77	1.82	Clay Red Gravel	Clay	
23.77	24.99	1.22	Quartzite	Quartzite	
24.99	26.52	1.53	Clay Red Grey Gravel	Clay	
26.52	29.87	3.35	Clay Variegated Gritty	Clay	
29.87	33.53	3.66	Clay Dark Red Grey	Clay	
33.53	36.27	2.74	Shale Dark Red Grey Decomposed	Shale	
36.27	38.10	1.83	Shale Red Grey Sandy Decomposed	Shale	
38.10	41.76	3.66	Shale Yellow Grey Decomposed	Shale	
41.76	49.99	8.23	Rock Decomposed	Rock	
49.99	53.95	3.96	Shale Grey Decomposed	Shale	
53.95	58.52	4.57	Shale Decomposed	Shale	
58.52	59.74	1.22	Rock Shale Decomposed	Rock	
59.74	67.06	7.32	Shale Yellow Decomposed	Shale	
67.06	69.19	2.13	Slate	Slate	

Remarks

WEEBAR HILL

***** End of GW021223 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW021224 *Converted From HYDSYS*

Licence : **Licence Status**
Authorised Purpose(s) **Intended Purpose(s)**
Work Type : Bore G/WATER XPLORE
Work Status : Test Hole
Construct. Method : Cable Tool
Owner Type : D.W.R. (NSW Dept Infrastructure, Planning & Nat Re

Commenced Date : **Final Depth :** 28.60 m
Completion Date : 01-Dec-1965 **Drilled Depth :** 55.20 m

Contractor Name :
Driller :
Assistant Driller's Name :

Property : **Standing Water Level :**
GWMA : **Salinity :** (Unknown)
GW Zone : **Yield :**

Site Details

Site Chosen By **County** **Parish** **Portion/Lot DP**
Form A : CUNNINGHAM GULGO 16
Licensed :

Region : 70 - LACHLAN **CMA Map :** 8331-N CONDOBOLIN
River Basin : 412 - LACHLAN RIVER **Grid Zone :** 55/2 **Scale :** 1:50,000
Area / District :

Elevation : 186.90 m (A.H.D.) **Northing :** 6340090 **Latitude (S) :** 33° 4' 40"
Elevation Source : R.L. at Surface **Easting :** 506486 **Longitude (E) :** 147° 4' 10"

GS Map : 0059A1 **AMG Zone :** 55 **Coordinate Source :** GPS - Global Positioning System

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	28.60	55.00	203			
1	1	Casing	Threaded Steel	-0.60	28.60	203			(Unknown)
1	1	Opening	Slots	11.50	11.50	203		1	SL: 0mm; A: 0mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
11.50	12.40	0.90	Unconsolidated	8.20		0.38			(Unknown)
28.60	31.00	2.40	Unconsolidated	9.10		0.61			(Unknown)
35.30	37.70	2.40	Unconsolidated	8.80		0.63			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.61	0.61	Topsoil	Topsoil	
0.61	2.44	1.83	Clay Gravel	Clay	
2.44	6.10	3.66	Clay Stoney	Clay	
6.10	11.58	5.48	Clay Grey	Clay	
11.58	12.50	0.92	Clay Sandy Water Supply	Clay	
12.50	28.65	16.15	Clay	Clay	
28.65	31.09	2.44	Gravel Stones Water Supply	Gravel	
31.09	35.36	4.27	Clay Gravel	Clay	
35.36	37.80	2.44	Gravel Brownish Coarse Water Supply	Gravel	
35.36	37.80	2.44	Sand Fine	Sand	
37.80	45.42	7.62	Clay Stoney	Clay	
45.42	51.82	6.40	Slate	Slate	
51.82	55.17	3.35	Bedrock	Bedrock	

Remarks

SLOT DETAILS UNCERTAIN WEEBAR HILL

***** End of GW021224 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW021228

Converted From HYDSYS

Licence :

Licence Status

Authorised Purpose(s)

Intended Purpose(s)

Work Type : Bore — G/WATER XPLORE

Work Status : Test Hole

Construct. Method : Cable Tool

Owner Type : D.W.R. (NSW Dept Infrastructure, Planning & Nat Re

Commenced Date :

Completion Date : 01-Nov-1965

Final Depth : 0.00

Drilled Depth : 25.30 m

Contractor Name :

Driller :

Assistant Driller's Name :

Property :

GWMA :

GW Zone :

Standing Water Level :

Salinity : 0-500 ppm

Yield :

Site Details

Site Chosen By

County

Form A : GIPPS

Licensed :

Parish SOUTH GULGO

Portion/Lot DP 98

Region : 70 - LACHLAN

River Basin : 412 - LACHLAN RIVER

Area / District :

CMA Map : 8331-N CONDOBOLIN

Grid Zone : 55/2

Scale : 1:50,000

Elevation :

Elevation Source : (Unknown)

Northing : 6337376

Easting : 505585

Latitude (S) : 33° 6' 8"

Longitude (E) : 147° 3' 35"

GS Map : 0059A1

AMG Zone : 55

Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	0.00	25.20	203			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
8.50	10.30	1.80	Unconsolidated	6.00		0.00			0-500 ppm
12.80	19.80	7.00	Unconsolidated	5.40		0.38			0-500 ppm

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.61	0.61	Topsoil	Topsoil	
0.61	3.05	2.44	Loam	Loam	
3.05	7.01	3.96	Clay Gravel	Clay	
7.01	9.14	2.13	Clay Sandy Water Supply	Clay	
9.14	9.75	0.61	Sand Coarse Water Supply	Sand	
9.75	10.36	0.61	Gravel Fine Water Supply	Gravel	
10.36	10.97	0.61	Gravel Coarse	Gravel	
10.97	13.41	2.44	Clay Grey Water Supply	Clay	
13.41	16.46	3.05	Gravel Brownish Coarse Water Supply	Gravel	
16.46	18.29	1.83	Sand Coarse Clay Bands Water Supply	Sand	
18.29	20.73	2.44	Sand Very Coarse Water Supply	Sand	
18.29	20.73	2.44	Gravel Fine Very Clayey	Gravel	
20.73	24.69	3.96	Clay Gravel	Clay	
24.69	25.30	0.61	Clay Grey	Clay	

Remarks

WEEBAR HILL

***** End of GW021228 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW026645

Converted From HYDSYS

Licence :70BL019637
Licence Status Active

Work Type : Bore
Work Status : Test Hole
Construct. Method :(Unknown)
Owner Type : Private

Authorised Purpose(s)	**Intended Purpose(s)**
IRRIGATION	IRRIGATION

Commenced Date :
Completion Date :01-Jan-1967
Final Depth : 0.00
Drilled Depth : 41.80 m

Contractor Name :
Driller :
Assistant Driller's Name :

Property : - MERRIWEE
GWMA :011 - UPPER LACHLAN (U/S LAKE CARGELLIG
GW Zone :008 - LACHLAN WOLLOM.-LAKE

Standing Water Level :
Salinity : 1001-3000 ppm
Yield :

Site Details

Site Chosen By	**County**	**Parish**	**Portion/Lot DP**
	Form A :GIPPS	SOUTH CONDOBOLIN	107
	Licensed :GIPPS	SOUTH CONDOBOLIN	107

Region :70 - LACHLAN
River Basin :412 - LACHLAN RIVER
Area / District :

CMA Map :8331-N CONDOBOLIN
Grid Zone :55/2 **Scale :**1:50,000

Elevation :
Elevation Source :(Unknown)

Northing :6337589 **Latitude (S) :**33° 6' 1"
Easting :511793 **Longitude (E) :**147° 7' 35"

GS Map :0059A1 **AMG Zone :**55 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component Type		From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	0.00	41.80	0			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.61	0.61	Topsoil	Topsoil	
0.61	1.83	1.22	Clay	Clay	
1.83	5.79	3.96	Clay Grey Black Streaks Brown Streaks	Clay	
5.79	6.40	0.61	Clay Grey Silty Limestone	Clay	
6.40	7.32	0.92	Wash Limestone	Wash	
7.32	9.14	1.82	Clay Grey Silty Slightly Sandy	Clay	
9.14	11.58	2.44	Clay Grey Very Silty Black Streaks	Clay	
11.58	13.72	2.14	Clay Grey Sandy Black Streaks	Clay	
13.72	17.68	3.96	Clay Grey	Clay	
13.72	17.68	3.96	Wash Bands	Wash	
17.68	21.95	4.27	Gravel Very Silty Fine-medium	Gravel	
21.95	28.65	6.70	Clay Very Tough	Clay	
28.65	32.92	4.27	Clay Grey Rusty	Clay	
32.92	35.66	2.74	Colluvium	Colluvium	
32.92	35.66	2.74	Clay Bands	Clay	
35.66	40.84	5.18	Clay Multicoloured	Clay	
35.66	40.84	5.18	Wash Bands	Wash	
40.84	41.76	0.92	Slate Very Tough Decomposed	Slate	
40.84	41.76	0.92	Bedrock Slate	Bedrock	

Remarks

***** End of GW026645 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW050914

Converted From HYDSYS

Licence :70BL111730

Licence Status Active

Work Type : Bore open thru rock
Work Status :(Unknown)
Construct. Method : Cable Tool
Owner Type : Private

Authorised Purpose(s)	**Intended Purpose(s)**
DOMESTIC	DOMESTIC
STOCK	STOCK

Commenced Date :
Completion Date :01-Feb-1980
Final Depth : 44.20 m
Drilled Depth : 44.20 m

Contractor Name :
Driller :1472 SLATER, Patrick John
Assistant Driller's Name :

Property : - N/A
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By

	County	**Parish**	**Portion/Lot DP**
Form A :	CUNNINGHAM	CONDOBOLIN	156
Licensed :	CUNNINGHAM	CONDOBOLIN	156

Region :70 - LACHLAN
River Basin :412 - LACHLAN RIVER
Area / District :

CMA Map :8331-N CONDOBOLIN
Grid Zone :55/2 **Scale :**1:50,000

Elevation :
Elevation Source :(Unknown)

Northing :6343594 **Latitude (S) :**33° 2' 46"
Easting :511365 **Longitude (E) :**147° 7' 18"

GS Map :0059A1 **AMG Zone :**55 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	6.00	152			(Unknown)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
33.20	36.90	3.70	Fractured	28.40		0.30			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	2.00	2.00	Soil	Soil	
2.00	44.22	42.22	Schist Yellow Water Supply	Schist	

Remarks

***** End of GW050914 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW057307 *Converted From HYDSYS*

Licence :70BL124921 **Licence Status** Active

Authorised Purpose(s) DOMESTIC **Intended Purpose(s)** DOMESTIC

Work Type : Bore open thru rock
Work Status :(Unknown)
Construct. Method : Cable Tool
Owner Type : Private

Commenced Date : **Final Depth :** 25.00 m
Completion Date :01-Dec-1982 **Drilled Depth :** 25.10 m

Contractor Name :
Driller :1472 SLATER, Patrick John
Assistant Driller's Name :

Property : - N/A **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	CUNNINGHAM	CONDOBOLIN	53
Licensed :	CUNNINGHAM	CONDOBOLIN	4

Region :70 - LACHLAN **CMA Map :**8331-N CONDOBOLIN
River Basin :412 - LACHLAN RIVER **Grid Zone :**55/2 **Scale :**1:50,000
Area / District :

Elevation : **Northing :**6338760 **Latitude (S) :**33° 5' 23"
Elevation Source :(Unknown) **Easting :**512135 **Longitude (E) :**147° 7' 48"

GS Map :0059A1 **AMG Zone :**55 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.30	3.00	168			(Unknown)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
10.00	10.00	0.00	Fractured	10.00					(Unknown)
25.00	25.00	0.00	Fractured	10.00					(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Gravel	Gravel	
1.00	25.05	24.05	Shale Water Bearing	Shale	

Remarks

***** End of GW057307 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW059353

Converted From HYDSYS

Licence : 70BL127368
Licence Status Lapsed

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Cable Tool
Owner Type : Private

Authorised Purpose(s)	Intended Purpose(s)
DOMESTIC	IRRIGATION
FARMING	
IRRIGATION	
STOCK	

Commenced Date :
Completion Date : 01-Nov-1982
Final Depth : 18.60 m
Drilled Depth : 18.60 m

Contractor Name :
Driller : 1472 SLATER, Patrick John
Assistant Driller's Name :

Property : - N/A
GWMA : 011 - UPPER LACHLAN (U/S LAKE CARGELLIG
GW Zone : 008 - LACHLAN WOLLOM.-LAKE
Standing Water Level :
Salinity : 1001-3000 ppm
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : CUNNINGHAM	CONDOBOLIN	55
	Licensed : CUNNINGHAM	CONDOBOLIN	55

Region : 70 - LACHLAN
River Basin : 412 - LACHLAN RIVER
Area / District :
CMA Map : 8331-N CONDOBOLIN
Grid Zone : 55/2
Scale : 1:50,000

Elevation :
Elevation Source : (Unknown)
Northing : 6339200
Easting : 510910
Latitude (S) : 33° 5' 8"
Longitude (E) : 147° 7' 1"

GS Map : 0059A1
AMG Zone : 55
Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-1.20	18.60	168			Seated on Bottom
1	1	Opening	Slots - Vertical	12.60	18.60	168		1	SL: 0mm; A: 3mm
1	1	Annulus	Crushed Aggregate	6.00	18.60	0			Ungraded; GS: 10-20mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
6.00	16.00	10.00	Unconsolidated						Good
16.70	18.60	1.90	Unconsolidated	6.00		5.05			Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	6.00	6.00	Clay	Clay	
6.00	8.00	2.00	Sand Water Bearing	Sand	
8.00	16.00	8.00	Gravel Water Bearing	Gravel	
16.00	16.70	0.70	Clay	Clay	
16.70	18.60	1.90	Gravel Water Supply	Gravel	

Remarks

***** End of GW059353 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW060298

Converted From HYDSYS

Licence : 70BL137997
Licence Status Active
Work Type : Bore
Work Status : Supply Obtained
Construct. Method : Cable Tool
Owner Type : Private

Authorised Purpose(s)	Intended Purpose(s)
DOMESTIC	IRRIGATION
STOCK	

Commenced Date :
Completion Date : 01-Nov-1982
Final Depth : 14.40 m
Drilled Depth : 32.50 m

Contractor Name :
Driller : 1472 SLATER, Patrick John
Assistant Driller's Name :

Property : - N/A
GWMA : 011 - UPPER LACHLAN (U/S LAKE CARGELLIG
GW Zone : 008 - LACHLAN WOLLOM.-LAKE
Standing Water Level :
Salinity :
Yield :
Other

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : GIPPS	SOUTH CONDOBOLIN	L12 (4)
	Licensed : GIPPS	SOUTH CONDOBOLIN	LT12

Region : 70 - LACHLAN
River Basin : 412 - LACHLAN RIVER
Area / District :
CMA Map : 8331-N CONDOBOLIN
Grid Zone : 55/2 **Scale :** 1:50,000

Elevation :
Elevation Source : (Unknown)
Northing : 6337660 **Latitude (S) :** 33° 5' 58"
Easting : 507465 **Longitude (E) :** 147° 4' 48"

GS Map : 0059A1 **AMG Zone :** 55
Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	14.40	32.50	0			
1	1	Casing	Welded Steel	-0.50	12.80	168			Seated
1	1	Opening	Screen	12.80	14.40	160		1	Johnson; Stainless Steel; SL: 0mm; A: 1.4mm
1	1	Annulus	Crushed Aggregate	0.00	14.40	0			(Unknown); GS: 10-20mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
9.70	14.40	4.70	Unconsolidated	7.90					Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.70	0.70	Clay	Clay	
0.70	14.42	13.72	Gravel Water Bearing	Gravel	
14.42	20.00	5.58	Clay	Clay	
20.00	28.00	8.00	Clay Sandy	Clay	
28.00	30.00	2.00	Clay	Clay	
30.00	32.50	2.50	Shale	Shale	

Remarks

SALINITY-TOO SALTY FOR DRINKING

***** End of GW060298 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW700209

Licence : 70BL226297
Licence Status Active

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	
Work Status : (Unknown)	STOCK	
Construct. Method : Cable Tool		
Owner Type :		

Commenced Date : **Final Depth :** 18.00 m
Completion Date : 16-Dec-1995 **Drilled Depth :**

Contractor Name : P.J. SLATER
Driller : 1472 SLATER, Patrick John
Assistant Driller's Name :

Property : - LACHLAN RIVER DOWNS **Standing Water Level :**
GWMA : - **Salinity :**
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : GIPPS	SOUTH GULGO	PART 92
	Licensed : GIPPS	SOUTH GULGO	PART 92

Region : 70 - LACHLAN **CMA Map :** 8331-N CONDOBOLIN
River Basin : **Grid Zone :** 55/2 **Scale :** 1:50,000
Area / District :

Elevation : **Northing :** 6337650 **Latitude (S) :** 33° 5' 59"
Elevation Source : **Easting :** 506950 **Longitude (E) :** 147° 4' 28"

GS Map : **AMG Zone :** 55 **Coordinate Source :** Map Interpretation

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Other	-0.50	6.00	168			Suspended in Clamps
1	1	Casing	P.V.C.	0.00	18.00	155			Seated on Bottom; Cap
1	1	Opening	Slots - Horizontal	16.50	18.00	155		1	(Unknown); Sawn; SL: 5.5mm; A: 2mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
6.00	6.20	0.20		5.00		0.02			
16.50	18.00	1.50		5.00		0.90	18.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

data not complete, front of form "a" only

***** End of GW700209 *****

DEPARTMENT OF NATURAL RESOURCES
Work Summary

GW702628

Licence : 70BL230754

Licence Status Active

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : Supply Obtained	STOCK	STOCK
Construct. Method : Cable Tool (Mud Stabilised)		
Owner Type : Private		

Commenced Date : **Final Depth :** 25.00 m
Completion Date : 26-May-2005 **Drilled Depth :** 26.00 m

Contractor Name : Milne Drilling
Driller : 1669 MILNE, Howard William
Assistant Driller's Name : Brad Newton

Property : - LOT 97
GWMA : -
GW Zone : -

Standing Water Level : 7.30 m
Salinity : 2,500.00 mg/L
Yield : 1.25 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
Client	**Form A :** GIPPS	SOUTH CONDOBOLIN	PT97//753113
	Licensed : GIPPS	SOUTH CONDOBOLIN	97 753113

Region : 70 - LACHLAN
River Basin : 412 - LACHLAN RIVER
Area / District :

CMA Map : 8331-N CONDOBOLIN
Grid Zone : 55/2 **Scale :** 1:50,000

Elevation :
Elevation Source :

Northing : 6337175 **Latitude (S) :** 33° 6' 14"
Easting : 509205 **Longitude (E) :** 147° 5' 55"

GS Map : 59AB1 **AMG Zone :** 55 **Coordinate Source :** GIS - Geographic Information System

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	25.00	150			Cable Tool (Mud Stabilised)
1	1	Casing	PVC Class 12	0.00	22.00	150	134		Screwed and Glued; Seated on Bottom
1	1	Casing	PVC Class 12	24.00	25.00	150	134		Screwed and Glued; Seated on Bottom; Cap; S: 24~25m
1	1	Opening	Screen - Wedge Wire	22.00	24.00	150			Stainless Steel 304; A: .51mm; Other
1		Annulus	Waterworn/Rounded	0.00	25.00	150	150		Graded; GS: 3-5mm; 1m³; PL: Poured/Shovelled

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
21.00	24.00	3.00		7.30	8.20	1.25		4.00	2500.00

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	6.00	6.00	Sandy Clay	Sandy Clay	
6.00	14.00	8.00	Silty Clay	Silty Clay	
14.00	15.00	1.00	Silt, sandy	Silt	
15.00	21.00	6.00	Clay, brown	Clay	
21.00	24.00	3.00	Sand, medium/coarse, white	Sand	
24.00	26.00	2.00	Clay, brown grey	Clay	

Remarks

Form A Remarks:
Nat Carling, 15-June-2006: Location based on map provided.

***** End of GW702628 *****

***** End of Report *****

Annex C

Irrigation Water Quality Data

Parameter Effluent Dam	Unit	Raw Water Filter	Process	Boiler	Cooling Tower	Floor Washings	Laboratory	Secondary Water Treatment Plant	Secondary Water Treatment Plant (N)	Total
Volumetric Rate	m3/day	665	0	1.4	126	24	10	285.0	285.0	**1111.4**
pH		7.5-8.0						3.73	7.5 – 9.0	**7 - 9**
Electrical Conductivity	mS / cm	400						0.1	0.1	**900-1100**
Total Dissolved Solids	ppm	250		2000	2000	1300	1300	1300	1300	**752**
Total Suspended Solids	ppm	233				100	100	100	100	**168.4**
Calcium as Ca2+	ppm	4.2		5.45	5.71	20	20	20	20	**21.35**
Magnesium as Mg2+	ppm	3.6		3.41	3.57	3	3	3	3	**3.42**
Chlorides as Cl-	ppm	22		900.0	942.9	0	0	0	0	**147.5**
Active Chlorine as Cl2	ppm	0		0	0.00	0	0	0	0	**0**
Total Iron	ppm	2.9		13.64	14.29	0	0	0	0	**2.09**
Total Manganese	ppm	0.08		1.09	1.14	0	0	0	0	**0.179**
Silica as SiO2 (reactive)	ppm	2.6		126.82	132.86	0	0	0	0	**20.79**
Silica as SiO2 (filter sand)	ppm	0		0	0	0	0	0	0	**0.000**
Sodium as Na+	ppm	15		504.5	528.6			109.22	109.22	**110.7**
Potassium as K+	ppm	2		40.91	42.86	0.012	0.012	0.012	0.012	**6.71**
Sulphates as SO42-	ppm	2		27.27	28.57	0	0	0	0	**4.47**
Nitrates/Nitrites (NO3 - NO2)	ppm	0.0585		4.09	4.29	10	10	10	40	**11.23**
Fluorides as F-	ppm	0.24		3.27	3.43	0	0	0	0	**0.536**
E Coli	no/ml	80				0 at 95%ile	0 at 95%ile	0 at 95%ile	0 at 95%ile	**0 at 95%ile**
Total Coliform Bacteria	no/ml	1047				0 at 95%ile	0 at 95%ile	0 at 95%ile	0 at 95%ile	**0 at 95%ile**
Phosphate as PO43-	ppm	no data		*0.075	no data	no data	no data	no data	no data	**no data**
Total Phosphorus as P	ppm	0.06		*0.075	0.06	0.06	0.06	0.06	0.06	**0.06**
Boron as B	ppm	0.03		0	0	0	0	0	0	**0**
BOD 5	ppm	0		0	0	1200	30	30	30	**33.88**
COD	ppm	33		0	0	200	200	200	200	**77.15**
Total Nitrogen (Kjeldahl)	ppm	0.7		0	10	55	55	55	5	**4.52**
H2S	ppm	0		0	0	0	0	0	0	**0**
Volatile Solids	ppm	0		0	0	30	30	30	30	**8.61**
Fats/Oils	ppm	0		0	0	5	5	5	5	**1.44**
Odour		0						Earthy smell	Earthy smell	**Earthy smell**
Ammonia as NH4+	ppm	4		0	57			55	5	**10.15**

Annex D

Irrigation Water Balance

Wet Weather Storage Requirements for Rainfall Year 1987

Water balance approach has been adapted from the nominated area method outlined in *Environment & Health Protection Guidelines* (1998) and is based on the following equation:

Precipitation + Wastewater applied = Evapotranspiration + Percolation + Runoff

Surface Area of storage	A	m2	60000			
Wastewater Flow to Efflue	Q	L/day	1,150,000		RAINDAYS	**96**
Design Percolation Rate	R	mm/hr	0.05		TOTAL RF	**461.6**
Land Area	L	m2	**550,000**			

Parameter	Day	Precipitation	Evaporation	Evap from Storage	Crop Factor	**Inputs**	Precipitation	Effluent Irrigation	Total Inputs	**Outputs**	Evapotranspiration	Percolation	Runoff	Total Outputs	**Storage**	Days of non irrigation	Cumulative days of non irrigation	Maximum Number of non irrigation days	**Storage Volume Required**
Symbol	D	P	E	Es	C		P	W	IN		ET	B	Run	OUT	S				
Formula	-	-	-	E x A			-	(Q-Es)/L	(P + W)		E x C	R/7	if P>E, (P-ET-B), 0	ET + B + Run	IN - OUT	IF (S during any of past 3 days >0,1, 0)		days	(Max Days x Q) /1000
Units		mm/day	mm/day	L/day			mm/day	mm/day	mm/day		mm/day	mm/day		mm/day	mm/day	days	days	days	m3
1	01/01/87	13.2	8.8	528000	0.95		13.2	1.13	14.3		8.36	1.2	3.6	13.2	1.13			**33**	**37,950**
2	02/01/87	0	5.2	312000	0.95		0.0	1.52	1.5		4.94	1.2	0.0	6.1	-4.62				
3	03/01/87	10	10.4	624000	0.95		10.0	0.96	10.96		9.88	1.2	0.0	11.1	-0.12	1	1		
4	04/01/87	0	9.2	552000	0.95		0.0	1.09	1.1		8.74	1.2	0.0	9.9	-8.85	0	0		
5	05/01/87	0	7	420000	0.95		0.0	1.33	1.3		6.65	1.2	0.0	7.9	-6.52	0	0		
6	06/01/87	0	5.8	348000	0.95		0.0	1.46	1.5		5.51	1.2	0.0	6.7	-5.25	0	0		
7	07/01/87	0	10.8	648000	0.95		0.0	0.91	0.9		10.26	1.2	0.0	11.5	-10.55	0	0		
8	08/01/87	0.2	9.8	588000	0.95		0.2	1.02	1.2		9.31	1.2	0.0	10.5	-9.29	0	0		
9	09/01/87	0	12.8	768000	0.95		0.0	0.69	0.7		12.16	1.2	0.0	13.4	-12.67	0	0		
10	10/01/87	0	11.2	672000	0.95		0.0	0.87	0.9		10.64	1.2	0.0	11.8	-10.97	0	0		
11	11/01/87	0	11.1	666000	0.95		0.0	0.88	0.9		10.545	1.2	0.0	11.7	-10.87	0	0		
12	12/01/87	0	8.8	528000	0.95		0.0	1.13	1.1		8.36	1.2	0.0	9.6	-8.43	0	0		
13	13/01/87	5	4.2	252000	0.95		5.0	1.63	6.6		3.99	1.2	-0.2	5.0	1.63	1	1		
14	14/01/87	0	9	540000	0.95		0.0	1.11	1.1		8.55	1.2	0.0	9.8	-8.64	1	2		
15	15/01/87	0	11.6	696000	0.95		0.0	0.83	0.8		11.02	1.2	0.0	12.2	-11.39	1	3		
16	16/01/87	0	9.8	588000	0.95		0.0	1.02	1.0		9.31	1.2	0.0	10.5	-9.49	0	0		
17	17/01/87	0	15.6	936000	0.95		0.0	0.39	0.4		14.82	1.2	0.0	16.0	-15.63	0	0		
18	18/01/87	0	13.1	786000	0.95		0.0	0.66	0.7		12.445	1.2	0.0	13.6	-12.98	0	0		
19	19/01/87	0	11.2	672000	0.95		0.0	0.87	0.9		10.64	1.2	0.0	11.8	-10.97	0	0		
20	20/01/87	0	13.4	804000	0.95		0.0	0.63	0.6		12.73	1.2	0.0	13.9	-13.30	0	0		
21	21/01/87	0.4	11.2	672000	0.95		0.4	0.87	1.3		10.64	1.2	0.0	11.8	-10.57	0	0		
22	22/01/87	1.2	3.4	204000	0.95		1.2	1.72	2.9		3.23	1.2	0.0	4.4	-1.51	0	0		
23	23/01/87	0	10.8	648000	0.95		0.0	0.91	0.9		10.26	1.2	0.0	11.5	-10.55	0	0		
24	24/01/87	0	8	480000	0.95		0.0	1.22	1.2		7.6	1.2	0.0	8.8	-7.58	0	0		
25	25/01/87	0	9.6	576000	0.95		0.0	1.04	1.0		9.12	1.2	0.0	10.3	-9.28	0	0		
26	26/01/87	0.2	6.3	378000	0.95		0.2	1.40	1.6		5.985	1.2	0.0	7.2	-5.58	0	0		
27	27/01/87	0.8	8.8	528000	0.95		0.8	1.13	1.9		8.36	1.2	0.0	9.6	-7.63	0	0		
28	28/01/87	0	11.4	684000	0.95		0.0	0.85	0.8		10.83	1.2	0.0	12.0	-11.18	0	0		
29	29/01/87	0	10.2	612000	0.95		0.0	0.98	1.0		9.69	1.2	0.0	10.9	-9.91	0	0		
30	30/01/87	0	10.2	612000	0.95		0.0	0.98	1.0		9.69	1.2	0.0	10.9	-9.91	0	0		
31	31/01/87	0	11.4	684000	0.95		0.0	0.85	0.8		10.83	1.2	0.0	12.0	-11.18	0	0		
32	01/02/87	0	12	720000	0.9		0.0	0.78	0.8		10.8	1.2	0.0	12.0	-11.22	0	0		
33	02/02/87	0	13	780000	0.9		0.0	0.67	0.7		11.7	1.2	0.0	12.9	-12.23	0	0		
34	03/02/87	2.2	11.4	684000	0.9		2.2	0.85	3.0		10.26	1.2	0.0	11.5	-8.41	0	0		
35	04/02/87	0	14.2	852000	0.9		0.0	0.54	0.5		12.78	1.2	0.0	14.0	-13.44	0	0		
36	05/02/87	0	12.8	768000	0.9		0.0	0.69	0.7		11.52	1.2	0.0	12.7	-12.03	0	0		
37	06/02/87	0	10	600000	0.9		0.0	1.00	1.0		9	1.2	0.0	10.2	-9.20	0	0		
38	07/02/87	0	9.6	576000	0.9		0.0	1.04	1.0		8.64	1.2	0.0	9.8	-8.80	0	0		
39	08/02/87	0	12.8	768000	0.9		0.0	0.69	0.7		11.52	1.2	0.0	12.7	-12.03	0	0		
40	09/02/87	8	12.8	768000	0.9		8.0	0.69	8.7		11.52	1.2	0.0	12.7	-4.03	0	0		
41	10/02/87	0.6	8.4	504000	0.9		0.6	1.17	1.8		7.56	1.2	0.0	8.8	-6.99	0	0		
42	11/02/87	10.2	7.8	468000	0.9		10.2	1.24	11.4		7.02	1.2	2.0	10.2	1.24	1	1		
43	12/02/87	0	9.6	576000	0.9		0.0	1.04	1.0		8.64	1.2	0.0	9.8	-8.80	1	2		
44	13/02/87	0	9	540000	0.9		0.0	1.11	1.1		8.1	1.2	0.0	9.3	-8.19	1	3		
45	14/02/87	0	8.2	492000	0.9		0.0	1.20	1.2		7.38	1.2	0.0	8.6	-7.38	0	0		
46	15/02/87	0	9.8	588000	0.9		0.0	1.02	1.0		8.82	1.2	0.0	10.0	-9.00	0	0		
47	16/02/87	1	8.6	516000	0.9		1.0	1.15	2.2		7.74	1.2	0.0	8.9	-6.79	0	0		
48	17/02/87	0	8.4	504000	0.9		0.0	1.17	1.2		7.56	1.2	0.0	8.8	-7.59	0	0		
49	18/02/87	0	10.8	648000	0.9		0.0	0.91	0.9		9.72	1.2	0.0	10.9	-10.01	0	0		
50	19/02/87	0	8.6	516000	0.9		0.0	1.15	1.2		7.74	1.2	0.0	8.9	-7.79	0	0		
51	20/02/87	0	9.4	564000	0.9		0.0	1.07	1.1		8.46	1.2	0.0	9.7	-8.59	0	0		
52	21/02/87	8.2	3.4	204000	0.9		8.2	1.72	9.9		3.06	1.2	3.9	8.2	1.72	1	1		
53	22/02/87	0	5.6	336000	0.9		0.0	1.48	1.5		5.04	1.2	0.0	6.2	-4.76	1	2		
54	23/02/87	0	9	540000	0.9		0.0	1.11	1.1		8.1	1.2	0.0	9.3	-8.19	1	3		
55	24/02/87	0	6	360000	0.9		0.0	1.44	1.4		5.4	1.2	0.0	6.6	-5.16	0	0		
56	25/02/87	0	11.6	696000	0.9		0.0	0.83	0.8		10.44	1.2	0.0	11.6	-10.81	0	0		
57	26/02/87	0	9.4	564000	0.9		0.0	1.07	1.1		8.46	1.2	0.0	9.7	-8.59	0	0		
58	27/02/87	0	7.6	456000	0.9		0.0	1.26	1.3		6.84	1.2	0.0	8.0	-6.78	0	0		
59	28/02/87	0	12.8	768000	0.9		0.0	0.69	0.7		11.52	1.2	0.0	12.7	-12.03	0	0		
60	01/03/87	12.2	7.6	456000	0.85		12.2	1.26	13.5		6.46	1.2	4.5	12.2	1.26	1	1		
61	02/03/87	21	2.2	132000	0.85		21.0	1.85	22.9		1.87	1.2	17.9	21.0	1.85	1	2		
62	03/03/87	58.2	1	60000	0.85		58.2	1.98	60.2		0.85	1.2	56.2	58.2	1.98	1	3		
63	04/03/87	2.6	2.4	144000	0.85		2.6	1.83	4.4		2.04	1.2	-0.6	2.6	1.83	1	4		
64	05/03/87	0.6	3.2	192000	0.85		0.6	1.74	2.3		2.72	1.2	0.0	3.9	-1.58	1	5		
65	06/03/87	0	4	240000	0.85		0.0	1.65	1.7		3.4	1.2	0.0	4.6	-2.95	1	6		
66	07/03/87	0	7	420000	0.85		0.0	1.33	1.3		5.95	1.2	0.0	7.2	-5.82	0	0		
67	08/03/87	0	6.3	378000	0.85		0.0	1.40	1.4		5.355	1.2	0.0	6.6	-5.15	0	0		
68	09/03/87	0	7.6	456000	0.85		0.0	1.26	1.3		6.46	1.2	0.0	7.7	-6.40	0	0		
69	10/03/87	0	5.2	312000	0.85		0.0	1.52	1.5		4.42	1.2	0.0	5.6	-4.10	0	0		
70	11/03/87	0	5.2	312000	0.85		0.0	1.52	1.5		4.42	1.2	0.0	5.6	-4.10	0	0		
71	12/03/87	0	5.2	312000	0.85		0.0	1.52	1.5		4.42	1.2	0.0	5.6	-4.10	0	0		
72	13/03/87	0	8	480000	0.85		0.0	1.22	1.2		6.8	1.2	0.0	8.0	-6.78	0	0		
73	14/03/87	0	8	480000	0.85		0.0	1.22	1.2		6.8	1.2	0.0	8.0	-6.78	0	0		
74	15/03/87	0	6	360000	0.85		0.0	1.44	1.4		5.1	1.2	0.0	6.3	-4.86	0	0		
75	16/03/87	0	6.2	372000	0.85		0.0	1.41	1.4		5.27	1.2	0.0	6.5	-5.06	0	0		
76	17/03/87	0	6.8	408000	0.85		0.0	1.35	1.3		5.78	1.2	0.0	7.0	-5.63	0	0		
77	18/03/87	0	5.8	348000	0.85		0.0	1.46	1.5		4.93	1.2	0.0	6.1	-4.67	0	0		
78	19/03/87	0	5.4	324000	0.85		0.0	1.50	1.5		4.59	1.2	0.0	5.8	-4.29	0	0		
79	20/03/87	0.8	8	480000	0.85		0.8	1.22	2.0		6.8	1.2	0.0	8.0	-5.98	0	0		
80	21/03/87	0	5.8	348000	0.85		0.0	1.46	1.5		4.93	1.2	0.0	6.1	-4.67	0	0		
81	22/03/87	0	6.6	396000	0.85		0.0	1.37	1.4		5.61	1.2	0.0	6.8	-5.44	0	0		
82	23/03/87	0	6.4	384000	0.85		0.0	1.39	1.4		5.44	1.2	0.0	6.6	-5.25	0	0		
83	24/03/87	0	3.8	228000	0.85		0.0	1.68	1.7		3.23	1.2	0.0	4.4	-2.75	0	0		
84	25/03/87	0	5.2	312000	0.85		0.0	1.52	1.5		4.42	1.2	0.0	5.6	-4.10	0	0		
85	26/03/87	0	6	360000	0.85		0.0	1.44	1.4		5.1	1.2	0.0	6.3	-4.86	0	0		
86	27/03/87	24.6	3	180000	0.85		24.6	1.76	26.4		2.55	1.2	20.9	24.6	1.76	1	1		
87	28/03/87	0.8	2.8	168000	0.85		0.8	1.79	2.6		2.38	1.2	0.0	3.6	-0.99	1	2		
88	29/03/87	8	6.6	396000	0.85		8.0	1.37	9.4		5.61	1.2	1.2	8.0	1.37	1	3		
89	30/03/87	0	8	480000	0.85		0.0	1.22	1.2		6.8	1.2	0.0	8.0	-6.78	1	4		
90	31/03/87	0	4.2	252000	0.85		0.0	1.63	1.6		3.57	1.2	0.0	4.8	-3.14	1	5		
91	01/04/87	0	3.4	204000	0.8		0.0	1.72	1.7		2.72	1.2	0.0	3.9	-2.20	0	0		
92	02/04/87	0	3.4	204000	0.8		0.0	1.72	1.7		2.72	1.2	0.0	3.9	-2.20	0	0		
93	03/04/87	0	4	240000	0.8		0.0	1.65	1.7		3.2	1.2	0.0	4.4	-2.75	0	0		
94	04/04/87	0	3.8	228000	0.8		0.0	1.68	1.7		3.04	1.2	0.0	4.2	-2.56	0	0		
95	05/04/87	0	4.6	276000	0.8		0.0	1.59	1.6		3.68	1.2	0.0	4.9	-3.29	0	0		
96	06/04/87	0	5	300000	0.8		0.0	1.55	1.5		4	1.2	0.0	5.2	-3.65	0	0		
97	07/04/87	0.2	6.8	408000	0.8		0.2	1.35	1.5		5.44	1.2	0.0	6.6	-5.09	0	0		
98	08/04/87	0	6.2	372000	0.8		0.0	1.41	1.4		4.96	1.2	0.0	6.2	-4.75	0	0		
99	09/04/87	0	5.8	348000	0.8		0.0	1.46	1.5		4.64	1.2	0.0	5.8	-4.38	0	0		
100	10/04/87	0	4	240000	0.8		0.0	1.65	1.7		3.2	1.2	0.0	4.4	-2.75	0	0		
101	11/04/87	0	2.8	168000	0.8		0.0	1.79	1.8		2.24	1.2	0.0	3.4	-1.65	0	0		
102	12/04/87	0	3	180000	0.8		0.0	1.76	1.8		2.4	1.2	0.0	3.6	-1.84	0	0		
103	13/04/87	0	5	300000	0.8		0.0	1.55	1.5		4	1.2	0.0	5.2	-3.65	0	0		
104	14/04/87	0	5.4	324000	0.8		0.0	1.50	1.5		4.32	1.2	0.0	5.5	-4.02	0	0		
105	15/04/87	0	5.2	312000	0.8		0.0	1.52	1.5		4.16	1.2	0.0	5.4	-3.84	0	0		
106	16/04/87	0	3.8	228000	0.8		0.0	1.68	1.7		3.04	1.2	0.0	4.2	-2.56	0	0		
107	17/04/87	0	3.3	198000	0.8		0.0	1.73	1.7		2.64	1.2	0.0	3.8	-2.11	0	0		
108	18/04/87	4	1.4	84000	0.8		4.0	1.94	5.9		1.12	1.2	1.7	4.0	1.94	1	1		
109	19/04/87	0	3	180000	0.8		0.0	1.76	1.8		2.4	1.2	0.0	3.6	-1.84	1	2		
110	20/04/87	0	4.6	276000	0.8		0.0	1.59	1.6		3.68	1.2	0.0	4.9	-3.29	1	3		
111	21/04/87	0	4.8	288000	0.8		0.0	1.57	1.6		3.84	1.2	0.0	5.0	-3.47	0	0		
112	22/04/87	0	3.2	192000	0.8		0.0	1.74	1.7		2.56	1.2	0.0	3.8	-2.02	0	0		
113	23/04/87	0	2.2	132000	0.8		0.0	1.85	1.9		1.76	1.2	0.0	3.0	-1.11	0	0		
114	24/04/87	0	3.2	192000	0.8		0.0	1.74	1.7		2.56	1.2	0.0	3.8	-2.02	0	0		
115	25/04/87	0	3	180000	0.8		0.0	1.76	1.8		2.4	1.2	0.0	3.6	-1.84	0	0		
116	26/04/87	0	3.4	204000	0.8		0.0	1.72	1.7		2.72	1.2	0.0	3.9	-2.20	0	0		
117	27/04/87	0	3.8	228000	0.8		0.0	1.68	1.7		3.04	1.2	0.0	4.2	-2.56	0	0		
118	28/04/87	0	6	360000	0.8		0.0	1.44	1.4		4.8	1.2	0.0	6.0	-4.56	0	0		
119	29/04/87	0	3.8	228000	0.8		0.0	1.68	1.7		3.04	1.2	0.0	4.2	-2.56	0	0		
120	30/04/87	0	4.8	288000	0.8		0.0	1.57	1.6		3.84	1.2	0.0	5.0	-3.47	0	0		
121	01/05/87	0	2.4	144000	0.7		0.0	1.83	1.8		1.68	1.2	0.0	2.9	-1.05	0	0		
122	02/05/87	0	2	120000	0.7		0.0	1.87	1.9		1.4	1.2	0.0	2.6	-0.73	0	0		
123	03/05/87	11.8	1.8	108000	0.7		11.8	1.89	13.7		1.26	1.2	9.3	11.8	1.89	1	1		
124	04/05/87	0.2	4.2	252000	0.7		0.2	1.63	1.8		2.94	1.2	0.0	4.1	-2.31	1	2		
125	05/05/87	0	2.2	132000	0.7		0.0	1.85	1.9		1.54	1.2	0.0	2.7	-0.89	1	3		
126	06/05/87	0	2.8	168000	0.7		0.0	1.79	1.8		1.96	1.2	0.0	3.2	-1.37	0	0		
127	07/05/87	0	3.4	204000	0.7		0.0	1.72	1.7		2.38	1.2	0.0	3.6	-1.86	0	0		
128	08/05/87	0	2.4	144000	0.7		0.0	1.83	1.8		1.68	1.2	0.0	2.9	-1.05	0	0		
129	09/05/87	0	3.2	192000	0.7		0.0	1.74	1.7		2.24	1.2	0.0	3.4	-1.70	0	0		
130	10/05/87	0	2.8	168000	0.7		0.0	1.79	1.8		1.96	1.2	0.0	3.2	-1.37	0	0		
131	11/05/87	0	3.4	204000	0.7		0.0	1.72	1.7		2.38	1.2	0.0	3.6	-1.86	0	0		
132	12/05/87	0	3.4	204000	0.7		0.0	1.72	1.7		2.38	1.2	0.0	3.6	-1.86	0	0		
133	13/05/87	0	1.4	84000	0.7		0.0	1.94	1.9		0.98	1.2	0.0	2.2	-0.24	0	0		
134	14/05/87	14.4	3.8	228000	0.7		14.4	1.68	16.1		2.66	1.2	10.5	14.4	1.68	1	1		
135	15/05/87	0	2.8	168000	0.7		0.0	1.79	1.8		1.96	1.2	0.0	3.2	-1.37	1	2		
136	16/05/87	0	2.4	144000	0.7		0.0	1.83	1.8		1.68	1.2	0.0	2.9	-1.05	1	3		
137	17/05/87	0.8	2.8	168000	0.7		0.8	1.79	2.6		1.96	1.2	0.0	3.2	-0.57	0	0		
138	18/05/87	0.4	0.2	12000	0.7		0.4	2.07	2.5		0.14	1.2	-0.9	0.4	2.07	1	1		
139	19/05/87	0	3.2	192000	0.7		0.0	1.74	1.7		2.24	1.2	0.0	3.4	-1.70	1	2		
140	20/05/87	0	2.4	144000	0.7		0.0	1.83	1.8		1.68	1.2	0.0	2.9	-1.05	1	3		
141	21/05/87	0	0.6	36000	0.7		0.0	2.03	2.0		0.42	1.2	0.0	1.6	0.41	1	4		
142	22/05/87	0	1.4	84000	0.7		0.0	1.94	1.9		0.98	1.2	0.0	2.2	-0.24	1	5		
143	23/05/87	0	2	120000	0.7		0.0	1.87	1.9		1.4	1.2	0.0	2.6	-0.73	1	6		
144	24/05/87	0	3	180000	0.7		0.0	1.76	1.8		2.1	1.2	0.0	3.3	-1.54	0	0		
145	25/05/87	0	2.6	156000	0.7		0.0	1.81	1.8		1.82	1.2	0.0	3.0	-1.21	0	0		
146	26/05/87	0	4	240000	0.7		0.0	1.65	1.7		2.8	1.2	0.0	4.0	-2.35	0	0		
147	27/05/87	6	5.6	336000	0.7		6.0	1.48	7.5		3.92	1.2	0.9	6.0	1.48	1	1		
148	28/05/87	0.8	0.2	12000	0.7		0.8	2.07	2.9		0.14	1.2	-0.5	0.8	2.07	1	2		
149	29/05/87	0	2	120000	0.7		0.0	1.87	1.9		1.4	1.2	0.0	2.6	-0.73	1	3		
150	30/05/87	0	0.6	36000	0.7		0.0	2.03	2.0		0.42	1.2	0.0	1.6	0.41	1	4		
151	31/05/87	0	1.9	114000	0.7		0.0	1.88	1.9		1.33	1.2	0.0	2.5	-0.65	1	5		
152	01/06/87	0	1.6	96000	0.55		0.0	1.92	1.9		0.88	1.2	0.0	2.1	-0.16	1	6		
153	02/06/87	0	0.8	48000	0.55		0.0	2.00	2.0		0.44	1.2	0.0	1.6	0.36	1	7		
154	03/06/87	0	0.8	48000	0.55		0.0	2.00	2.0		0.44	1.2	0.0	1.6	0.36	1	8		
155	04/06/87	0	1.4	84000	0.55		0.0	1.94	1.9		0.77	1.2	0.0	2.0	-0.03	1	9		
156	05/06/87	0	2.4	144000	0.55		0.0	1.83	1.8		1.32	1.2	0.0	2.5	-0.69	1	10		
157	06/06/87	0	1	60000	0.55		0.0	1.98	2.0		0.55	1.2	0.0	1.8	0.23	1	11		
158	07/06/87	0	2.4	144000	0.55		0.0	1.83	1.8		1.32	1.2	0.0	2.5	-0.69	1	12		
159	08/06/87	0	2.8	168000	0.55		0.0	1.79	1.8		1.54	1.2	0.0	2.7	-0.95	1	13		
160	09/06/87	0	1.4	84000	0.55		0.0	1.94	1.9		0.77	1.2	0.0	2.0	-0.03	0	0		
161	10/06/87	1	1.6	96000	0.55		1.0	1.92	2.9		0.88	1.2	0.0	2.1	0.84	1	1		
162	11/06/87	1	1	60000	0.55		1.0	1.98	3.0		0.55	1.2	0.0	1.8	1.23	1	2		
163	12/06/87	5	1.8	108000	0.55		5.0	1.89	6.9		0.99	1.2	2.8	5.0	1.89	1	3		
164	13/06/87	0.2	3.2	192000	0.55		0.2	1.74	1.9		1.76	1.2	0.0	3.0	-1.02	1	4		
165	14/06/87	0	2.4	144000	0.55		0.0	1.83	1.8		1.32	1.2	0.0	2.5	-0.69	1	5		
166	15/06/87	0.2	1.6	96000	0.55		0.2	1.92	2.1		0.88	1.2	0.0	2.1	0.04	1	6		
167	16/06/87	0	1.2	72000	0.55		0.0	1.96	2.0		0.66	1.2	0.0	1.9	0.10	1	7		
168	17/06/87	0	1.4	84000	0.55		0.0	1.94	1.9		0.77	1.2	0.0	2.0	-0.03	1	8		
169	18/06/87	0	1.6	96000	0.55		0.0	1.92	1.9		0.88	1.2	0.0	2.1	-0.16	1	9		
170	19/06/87	0.8	0.6	36000	0.55		0.8	2.03	2.8		0.33	1.2	-0.7	0.8	2.03	1	10		
171	20/06/87	2.6	1.8	108000	0.55		2.6	1.89	4.5		0.99	1.2	0.4	2.6	1.89	1	11		
172	21/06/87	10.2	1.4	84000	0.55		10.2	1.94	12.1		0.77	1.2	8.2	10.2	1.94	1	12		
173	22/06/87	4.8	1.6	96000	0.55		4.8	1.92	6.7		0.88	1.2	2.7	4.8	1.92	1	13		
174	23/06/87	0	2.2	132000	0.55		0.0	1.85	1.9		1.21	1.2	0.0	2.4	-0.56	1	14		
175	24/06/87	1.8	1.6	96000	0.55		1.8	1.92	3.7		0.88	1.2	-0.3	1.8	1.92	1	15		
176	25/06/87	3.2	2.8	168000	0.55		3.2	1.79	5.0		1.54	1.2	0.5	3.2	1.79	1	16		
177	26/06/87	1.8	0.8	48000	0.55		1.8	2.00	3.8		0.44	1.2	0.2	1.8	2.00	1	17		
178	27/06/87	2	2.6	156000	0.55		2.0	1.81	3.8		1.43	1.2	0.0	2.6	1.18	1	18		
179	28/06/87	0.2	1.8	108000	0.55		0.2	1.89	2.1		0.99	1.2	0.0	2.2	-0.10	1	19		
180	29/06/87	0	1.4	84000	0.55		0.0	1.94	1.9		0.77	1.2	0.0	2.0	-0.03	1	20		
181	30/06/87	0	1.2	72000	0.55		0.0	1.96	2.0		0.66	1.2	0.0	1.9	0.10	1	21		
182	01/07/87	0	1.2	72000	0.55		0.0	1.96	2.0		0.66	1.2	0.0	1.9	0.10	1	22		
183	02/07/87	0	1.2	72000	0.55		0.0	1.96	2.0		0.66	1.2	0.0	1.9	0.10	1	23		
184	03/07/87	0	1.8	108000	0.55		0.0	1.89	1.9		0.99	1.2	0.0	2.2	-0.30	1	24		
185	04/07/87	0	0	0	0.55		0.0	2.09	2.1		0	1.2	0.0	1.2	0.89	1	25		
186	05/07/87	0	1	60000	0.55		0.0	1.98	2.0		0.55	1.2	0.0	1.8	0.23	1	26		
187	06/07/87	0	1.4	84000	0.55		0.0	1.94	1.9		0.77	1.2	0.0	2.0	-0.03	1	27		
188	07/07/87	0	1.2	72000	0.55		0.0	1.96	2.0		0.66	1.2	0.0	1.9	0.10	1	28		
189	08/07/87	0	1.6	96000	0.55		0.0	1.92	1.9		0.88	1.2	0.0	2.1	-0.16	1	29		
190	09/07/87	0	1.2	72000	0.55		0.0	1.96	2.0		0.66	1.2	0.0	1.9	0.10	1	30		

Wet Weather Storage Requirements for Rainfall Year 1987

Water balance approach has been adapted from the nominated area method outlined in *Environment & Health Protection Guidelines* (1998) and is based on the following equation:

Precipitation + Wastewater applied = Evapotranspiration + Percolation + Runoff

Surface Area of storage	A	m2	60000			
Wastewater Flow to Effluent	Q	L/day	1,150,000		RAINDAYS	**96**
Design Percolation Rate	R	mm/hr	0.05		TOTAL RF	**461.6**
Land Area	L	m2	**550,000**			

Parameter	Day	Precipitation	Evaporation	Evap from Storage	Crop Factor	**Inputs**	Precipitation	Effluent Irrigation	Total Inputs	**Outputs**	Evapotranspiration	Percolation	Runoff	Total Outputs	**Storage**	Days of non irrigation	Cumulative days of non irrigation	Maximum Number of non irrigation days	**Storage Volume Required**
Symbol	D	P	E	Es	C		P	W	IN		ET	B	Run	OUT	S				
Formula	-	-	-	E x A			-	(Q-Es)/L	(P + W)		E x C	R/7	if P>E, (P-ET-B), 0	ET + B + Run	IN - OUT	IF (S during any of past 3 days >0,1, 0)			(Max Days x Q) /1000
Units		mm/day	mm/day	L/day			mm/day	mm/day	mm/day		mm/day	mm/day		mm/day	mm/day	days	days	days	m3
191	10/07/87	0	1.2	72000	0.55		0.0	1.96	2.0		0.66	1.2	0.0	1.9	0.10	1	31		
192	11/07/87	0.4	2.8	168000	0.55		0.4	1.79	2.2		1.54	1.2	0.0	2.7	-0.55	1	32		
193	12/07/87	0	1.8	108000	0.55		0.0	1.89	1.9		0.99	1.2	0.0	2.2	-0.30	1	33		
194	13/07/87	0	2.3	138000	0.55		0.0	1.84	1.8		1.265	1.2	0.0	2.5	-0.63	0	0		
195	14/07/87	0	1.6	96000	0.55		0.0	1.92	1.9		0.88	1.2	0.0	2.1	-0.16	0	0		
196	15/07/87	0	2	120000	0.55		0.0	1.87	1.9		1.1	1.2	0.0	2.3	-0.43	0	0		
197	16/07/87	0.6	4.6	276000	0.55		0.6	1.59	2.2		2.53	1.2	0.0	3.7	-1.54	0	0		
198	17/07/87	0	3.4	204000	0.55		0.0	1.72	1.7		1.87	1.2	0.0	3.1	-1.35	0	0		
199	18/07/87	0	2.8	168000	0.55		0.0	1.79	1.8		1.54	1.2	0.0	2.7	-0.95	0	0		
200	19/07/87	0	3	180000	0.55		0.0	1.76	1.8		1.65	1.2	0.0	2.9	-1.09	0	0		
201	20/07/87	1.6	1	60000	0.55		1.6	1.98	3.6		0.55	1.2	-0.2	1.6	1.98	1	1		
202	21/07/87	3.6	2.4	144000	0.55		3.6	1.83	5.4		1.32	1.2	1.1	3.6	1.83	1	2		
203	22/07/87	0.2	1	60000	0.55		0.2	1.98	2.2		0.55	1.2	0.0	1.8	0.43	1	3		
204	23/07/87	0.4	1	60000	0.55		0.4	1.98	2.4		0.55	1.2	0.0	1.8	0.63	1	4		
205	24/07/87	0	1.6	96000	0.55		0.0	1.92	1.9		0.88	1.2	0.0	2.1	-0.16	1	5		
206	25/07/87	0	2.8	168000	0.55		0.0	1.79	1.8		1.54	1.2	0.0	2.7	-0.95	1	6		
207	26/07/87	0	0.7	42000	0.55		0.0	2.01	2.0		0.385	1.2	0.0	1.6	0.43	1	7		
208	27/07/87	0	1.8	108000	0.55		0.0	1.89	1.9		0.99	1.2	0.0	2.2	-0.30	1	8		
209	28/07/87	7.4	3	180000	0.55		7.4	1.76	9.2		1.65	1.2	4.6	7.4	1.76	1	9		
210	29/07/87	2	1.8	108000	0.55		2.0	1.89	3.9		0.99	1.2	-0.2	2.0	1.89	1	10		
211	30/07/87	0.4	1.6	96000	0.55		0.4	1.92	2.3		0.88	1.2	0.0	2.1	0.24	1	11		
212	31/07/87	0	1.4	84000	0.55		0.0	1.94	1.9		0.77	1.2	0.0	2.0	-0.03	1	12		
213	01/08/87	0	2.8	168000	0.65		0.0	1.79	1.8		1.82	1.2	0.0	3.0	-1.23	1	13		
214	02/08/87	0.8	2.6	156000	0.65		0.8	1.81	2.6		1.69	1.2	0.0	2.9	-0.28	0	0		
215	03/08/87	0.8	2.2	132000	0.65		0.8	1.85	2.7		1.43	1.2	0.0	2.6	0.02	1	1		
216	04/08/87	0.2	2	120000	0.65		0.2	1.87	2.1		1.3	1.2	0.0	2.5	-0.43	1	2		
217	05/08/87	0	2.2	132000	0.65		0.0	1.85	1.9		1.43	1.2	0.0	2.6	-0.78	1	3		
218	06/08/87	0.6	2.2	132000	0.65		0.6	1.85	2.5		1.43	1.2	0.0	2.6	-0.18	0	0		
219	07/08/87	0.4	1.2	72000	0.65		0.4	1.96	2.4		0.78	1.2	0.0	2.0	0.38	1	1		
220	08/08/87	0	1.3	78000	0.65		0.0	1.95	1.9		0.845	1.2	0.0	2.0	-0.10	1	2		
221	09/08/87	0	1.7	102000	0.65		0.0	1.91	1.9		1.105	1.2	0.0	2.3	-0.40	1	3		
222	10/08/87	0	1.2	72000	0.65		0.0	1.96	2.0		0.78	1.2	0.0	2.0	-0.02	0	0		
223	11/08/87	2.4	3	180000	0.65		2.4	1.76	4.2		1.95	1.2	0.0	3.2	1.01	1	1		
224	12/08/87	0	3.2	192000	0.65		0.0	1.74	1.7		2.08	1.2	0.0	3.3	-1.54	1	2		
225	13/08/87	8.6	1.6	96000	0.65		8.6	1.92	10.5		1.04	1.2	6.4	8.6	1.92	1	3		
226	14/08/87	20.4	1	60000	0.65		20.4	1.98	22.4		0.65	1.2	18.6	20.4	1.98	1	4		
227	15/08/87	0	1.2	72000	0.65		0.0	1.96	2.0		0.78	1.2	0.0	2.0	-0.02	1	5		
228	16/08/87	0	1.4	84000	0.65		0.0	1.94	1.9		0.91	1.2	0.0	2.1	-0.17	1	6		
229	17/08/87	0	2.2	132000	0.65		0.0	1.85	1.9		1.43	1.2	0.0	2.6	-0.78	0	0		
230	18/08/87	0	2	120000	0.65		0.0	1.87	1.9		1.3	1.2	0.0	2.5	-0.63	0	0		
231	19/08/87	1	1.8	108000	0.65		1.0	1.89	2.9		1.17	1.2	0.0	2.4	0.52	1	1		
232	20/08/87	0	3	180000	0.65		0.0	1.76	1.8		1.95	1.2	0.0	3.2	-1.39	1	2		
233	21/08/87	0	1.8	108000	0.65		0.0	1.89	1.9		1.17	1.2	0.0	2.4	-0.48	1	3		
234	22/08/87	0	2	120000	0.65		0.0	1.87	1.9		1.3	1.2	0.0	2.5	-0.63	0	0		
235	23/08/87	0	3.2	192000	0.65		0.0	1.74	1.7		2.08	1.2	0.0	3.3	-1.54	0	0		
236	24/08/87	0	3	180000	0.65		0.0	1.76	1.8		1.95	1.2	0.0	3.2	-1.39	0	0		
237	25/08/87	0	3.2	192000	0.65		0.0	1.74	1.7		2.08	1.2	0.0	3.3	-1.54	0	0		
238	26/08/87	0	1.6	96000	0.65		0.0	1.92	1.9		1.04	1.2	0.0	2.2	-0.32	0	0		
239	27/08/87	0	4.6	276000	0.65		0.0	1.59	1.6		2.99	1.2	0.0	4.2	-2.60	0	0		
240	28/08/87	23.4	1.4	84000	0.65		23.4	1.94	25.3		0.91	1.2	21.3	23.4	1.94	1	1		
241	29/08/87	0.4	0.6	36000	0.65		0.4	2.03	2.4		0.39	1.2	0.0	1.6	0.84	1	2		
242	30/08/87	1.2	2.2	132000	0.65		1.2	1.85	3.1		1.43	1.2	0.0	2.6	0.42	1	3		
243	31/08/87	8.8	2	120000	0.65		8.8	1.87	10.7		1.3	1.2	6.3	8.8	1.87	1	4		
244	01/09/87	0.8	3	180000	0.75		0.8	1.76	2.6		2.25	1.2	0.0	3.5	-0.89	1	5		
245	02/09/87	0	2	120000	0.75		0.0	1.87	1.9		1.5	1.2	0.0	2.7	-0.83	1	6		
246	03/09/87	0	2.4	144000	0.75		0.0	1.83	1.8		1.8	1.2	0.0	3.0	-1.17	0	0		
247	04/09/87	0	2.6	156000	0.75		0.0	1.81	1.8		1.95	1.2	0.0	3.2	-1.34	0	0		
248	05/09/87	0	2	120000	0.75		0.0	1.87	1.9		1.5	1.2	0.0	2.7	-0.83	0	0		
249	06/09/87	4.8	1	60000	0.75		4.8	1.98	6.8		0.75	1.2	2.9	4.8	1.98	1	1		
250	07/09/87	0.4	1.2	72000	0.75		0.4	1.96	2.4		0.9	1.2	0.0	2.1	0.26	1	2		
251	08/09/87	0	2.6	156000	0.75		0.0	1.81	1.8		1.95	1.2	0.0	3.2	-1.34	1	3		
252	09/09/87	0	2.8	168000	0.75		0.0	1.79	1.8		2.1	1.2	0.0	3.3	-1.51	1	4		
253	10/09/87	0	3.5	210000	0.75		0.0	1.71	1.7		2.625	1.2	0.0	3.8	-2.12	0	0		
254	11/09/87	0	3.8	228000	0.75		0.0	1.68	1.7		2.85	1.2	0.0	4.1	-2.37	0	0		
255	12/09/87	0	2.7	162000	0.75		0.0	1.80	1.8		2.025	1.2	0.0	3.2	-1.43	0	0		
256	13/09/87	0	2.8	168000	0.75		0.0	1.79	1.8		2.1	1.2	0.0	3.3	-1.51	0	0		
257	14/09/87	0	3.4	204000	0.75		0.0	1.72	1.7		2.55	1.2	0.0	3.8	-2.03	0	0		
258	15/09/87	0	3.6	216000	0.75		0.0	1.70	1.7		2.7	1.2	0.0	3.9	-2.20	0	0		
259	16/09/87	0	2.4	144000	0.75		0.0	1.83	1.8		1.8	1.2	0.0	3.0	-1.17	0	0		
260	17/09/87	0	3.4	204000	0.75		0.0	1.72	1.7		2.55	1.2	0.0	3.8	-2.03	0	0		
261	18/09/87	0	3.2	192000	0.75		0.0	1.74	1.7		2.4	1.2	0.0	3.6	-1.86	0	0		
262	19/09/87	0	3	180000	0.75		0.0	1.76	1.8		2.25	1.2	0.0	3.5	-1.69	0	0		
263	20/09/87	0	6.6	396000	0.75		0.0	1.37	1.4		4.95	1.2	0.0	6.2	-4.78	0	0		
264	21/09/87	0	5.4	324000	0.75		0.0	1.50	1.5		4.05	1.2	0.0	5.3	-3.75	0	0		
265	22/09/87	0	4.2	252000	0.75		0.0	1.63	1.6		3.15	1.2	0.0	4.4	-2.72	0	0		
266	23/09/87	0	4.4	264000	0.75		0.0	1.61	1.6		3.3	1.2	0.0	4.5	-2.89	0	0		
267	24/09/87	0	4	240000	0.75		0.0	1.65	1.7		3	1.2	0.0	4.2	-2.55	0	0		
268	25/09/87	0	4.6	276000	0.75		0.0	1.59	1.6		3.45	1.2	0.0	4.7	-3.06	0	0		
269	26/09/87	0	4.6	276000	0.75		0.0	1.59	1.6		3.45	1.2	0.0	4.7	-3.06	0	0		
270	27/09/87	0	6.2	372000	0.75		0.0	1.41	1.4		4.65	1.2	0.0	5.9	-4.44	0	0		
271	28/09/87	0	9.2	552000	0.75		0.0	1.09	1.1		6.9	1.2	0.0	8.1	-7.01	0	0		
272	29/09/87	0	8.8	528000	0.75		0.0	1.13	1.1		6.6	1.2	0.0	7.8	-6.67	0	0		
273	30/09/87	3.6	3.4	204000	0.75		3.6	1.72	5.3		2.55	1.2	-0.2	3.6	1.72	1	1		
274	01/10/87	1	2	120000	0.85		1.0	1.87	2.9		1.7	1.2	0.0	2.9	-0.03	1	2		
275	02/10/87	0	4	240000	0.85		0.0	1.65	1.7		3.4	1.2	0.0	4.6	-2.95	1	3		
276	03/10/87	0	4	240000	0.85		0.0	1.65	1.7		3.4	1.2	0.0	4.6	-2.95	0	0		
277	04/10/87	0	4	240000	0.85		0.0	1.65	1.7		3.4	1.2	0.0	4.6	-2.95	0	0		
278	05/10/87	0.8	4.6	276000	0.85		0.8	1.59	2.4		3.91	1.2	0.0	5.1	-2.72	0	0		
279	06/10/87	0	5.2	312000	0.85		0.0	1.52	1.5		4.42	1.2	0.0	5.6	-4.10	0	0		
280	07/10/87	0.4	7	420000	0.85		0.4	1.33	1.7		5.95	1.2	0.0	7.2	-5.42	0	0		
281	08/10/87	0	6.2	372000	0.85		0.0	1.41	1.4		5.27	1.2	0.0	6.5	-5.06	0	0		
282	09/10/87	0	4.4	264000	0.85		0.0	1.61	1.6		3.74	1.2	0.0	4.9	-3.33	0	0		
283	10/10/87	0	5.8	348000	0.85		0.0	1.46	1.5		4.93	1.2	0.0	6.1	-4.67	0	0		
284	11/10/87	0	5	300000	0.85		0.0	1.55	1.5		4.25	1.2	0.0	5.5	-3.90	0	0		
285	12/10/87	0.4	8.2	492000	0.85		0.4	1.20	1.6		6.97	1.2	0.0	8.2	-6.57	0	0		
286	13/10/87	0	4.8	288000	0.85		0.0	1.57	1.6		4.08	1.2	0.0	5.3	-3.71	0	0		
287	14/10/87	0	4.2	252000	0.85		0.0	1.63	1.6		3.57	1.2	0.0	4.8	-3.14	0	0		
288	15/10/87	0	7	420000	0.85		0.0	1.33	1.3		5.95	1.2	0.0	7.2	-5.82	0	0		
289	16/10/87	7.8	4.4	264000	0.85		7.8	1.61	9.4		3.74	1.2	2.9	7.8	1.61	1	1		
290	17/10/87	0.4	7.5	450000	0.85		0.4	1.27	1.7		6.375	1.2	0.0	7.6	-5.90	1	2		
291	18/10/87	0	3.5	210000	0.85		0.0	1.71	1.7		2.975	1.2	0.0	4.2	-2.47	1	3		
292	19/10/87	8.4	6.4	384000	0.85		8.4	1.39	9.8		5.44	1.2	1.8	8.4	1.39	1	4		
293	20/10/87	7	3.6	216000	0.85		7.0	1.70	8.7		3.06	1.2	2.7	7.0	1.70	1	5		
294	21/10/87	0.4	4.4	264000	0.85		0.4	1.61	2.0		3.74	1.2	0.0	4.9	-2.93	1	6		
295	22/10/87	0	5.2	312000	0.85		0.0	1.52	1.5		4.42	1.2	0.0	5.6	-4.10	1	7		
296	23/10/87	0	7	420000	0.85		0.0	1.33	1.3		5.95	1.2	0.0	7.2	-5.82	0	0		
297	24/10/87	0	8	480000	0.85		0.0	1.22	1.2		6.8	1.2	0.0	8.0	-6.78	0	0		
298	25/10/87	0	6.6	396000	0.85		0.0	1.37	1.4		5.61	1.2	0.0	6.8	-5.44	0	0		
299	26/10/87	0	8	480000	0.85		0.0	1.22	1.2		6.8	1.2	0.0	8.0	-6.78	0	0		
300	27/10/87	0	6.8	408000	0.85		0.0	1.35	1.3		5.78	1.2	0.0	7.0	-5.63	0	0		
301	28/10/87	0	8	480000	0.85		0.0	1.22	1.2		6.8	1.2	0.0	8.0	-6.78	0	0		
302	29/10/87	0	10.2	612000	0.85		0.0	0.98	1.0		8.67	1.2	0.0	9.9	-8.89	0	0		
303	30/10/87	0	8.2	492000	0.85		0.0	1.20	1.2		6.97	1.2	0.0	8.2	-6.97	0	0		
304	31/10/87	0	7.6	456000	0.85		0.0	1.26	1.3		6.46	1.2	0.0	7.7	-6.40	0	0		
305	01/11/87	0	9.6	576000	0.95		0.0	1.04	1.0		9.12	1.2	0.0	10.3	-9.28	0	0		
306	02/11/87	0	10.6	636000	0.95		0.0	0.93	0.9		10.07	1.2	0.0	11.3	-10.34	0	0		
307	03/11/87	0	14	840000	0.95		0.0	0.56	0.6		13.3	1.2	0.0	14.5	-13.94	0	0		
308	04/11/87	1.8	8.4	504000	0.95		1.8	1.17	3.0		7.98	1.2	0.0	9.2	-6.21	0	0		
309	05/11/87	0	9	540000	0.95		0.0	1.11	1.1		8.55	1.2	0.0	9.8	-8.64	0	0		
310	06/11/87	0	7.2	432000	0.95		0.0	1.31	1.3		6.84	1.2	0.0	8.0	-6.73	0	0		
311	07/11/87	0	7.8	468000	0.95		0.0	1.24	1.2		7.41	1.2	0.0	8.6	-7.37	0	0		
312	08/11/87	0	7	420000	0.95		0.0	1.33	1.3		6.65	1.2	0.0	7.9	-6.52	0	0		
313	09/11/87	11.1	5.6	336000	0.95		11.1	1.48	12.6		5.32	1.2	4.6	11.1	1.48	1	1		
314	10/11/87	0	6.8	408000	0.95		0.0	1.35	1.3		6.46	1.2	0.0	7.7	-6.31	1	2		
315	11/11/87	0	9.8	588000	0.95		0.0	1.02	1.0		9.31	1.2	0.0	10.5	-9.49	1	3		
316	12/11/87	0	9.1	546000	0.95		0.0	1.10	1.1		8.645	1.2	0.0	9.8	-8.75	0	0		
317	13/11/87	0	8.1	486000	0.95		0.0	1.21	1.2		7.695	1.2	0.0	8.9	-7.69	0	0		
318	14/11/87	0	7.8	468000	0.95		0.0	1.24	1.2		7.41	1.2	0.0	8.6	-7.37	0	0		
319	15/11/87	0	6.2	372000	0.95		0.0	1.41	1.4		5.89	1.2	0.0	7.1	-5.68	0	0		
320	16/11/87	0	8	480000	0.95		0.0	1.22	1.2		7.6	1.2	0.0	8.8	-7.58	0	0		
321	17/11/87	0.8	9.6	576000	0.95		0.8	1.04	1.8		9.12	1.2	0.0	10.3	-8.48	0	0		
322	18/11/87	0	7.6	456000	0.95		0.0	1.26	1.3		7.22	1.2	0.0	8.4	-7.16	0	0		
323	19/11/87	0	10.4	624000	0.95		0.0	0.96	1.0		9.88	1.2	0.0	11.1	-10.12	0	0		
324	20/11/87	8.8	13.6	816000	0.95		8.8	0.61	9.4		12.92	1.2	0.0	14.1	-4.71	0	0		
325	21/11/87	0	6	360000	0.95		0.0	1.44	1.4		5.7	1.2	0.0	6.9	-5.46	0	0		
326	22/11/87	0	6	360000	0.95		0.0	1.44	1.4		5.7	1.2	0.0	6.9	-5.46	0	0		
327	23/11/87	0	7.6	456000	0.95		0.0	1.26	1.3		7.22	1.2	0.0	8.4	-7.16	0	0		
328	24/11/87	0.2	9.6	576000	0.95		0.2	1.04	1.2		9.12	1.2	0.0	10.3	-9.08	0	0		
329	25/11/87	0	10	600000	0.95		0.0	1.00	1.0		9.5	1.2	0.0	10.7	-9.70	0	0		
330	26/11/87	0	10	600000	0.95		0.0	1.00	1.0		9.5	1.2	0.0	10.7	-9.70	0	0		
331	27/11/87	0	7.6	456000	0.95		0.0	1.26	1.3		7.22	1.2	0.0	8.4	-7.16	0	0		
332	28/11/87	0	8.9	534000	0.95		0.0	1.12	1.1		8.455	1.2	0.0	9.7	-8.54	0	0		
333	29/11/87	0	7.7	462000	0.95		0.0	1.25	1.3		7.315	1.2	0.0	8.5	-7.26	0	0		
334	30/11/87	0	11.2	672000	0.95		0.0	0.87	0.9		10.64	1.2	0.0	11.8	-10.97	0	0		
335	01/12/87	3.6	10	600000	1		3.6	1.00	4.6		10	1.2	0.0	11.2	-6.60	0	0		
336	02/12/87	9	9.8	588000	1		9.0	1.02	10.0		9.8	1.2	0.0	11.0	-0.98	0	0		
337	03/12/87	0	5	300000	1		0.0	1.55	1.5		5	1.2	0.0	6.2	-4.65	0	0		
338	04/12/87	0	8.4	504000	1		0.0	1.17	1.2		8.4	1.2	0.0	9.6	-8.43	0	0		
339	05/12/87	0	7.4	444000	1		0.0	1.28	1.3		7.4	1.2	0.0	8.6	-7.32	0	0		
340	06/12/87	0	12	720000	1		0.0	0.78	0.8		12	1.2	0.0	13.2	-12.42	0	0		
341	07/12/87	0	11.4	684000	1		0.0	0.85	0.8		11.4	1.2	0.0	12.6	-11.75	0	0		
342	08/12/87	0	9.8	588000	1		0.0	1.02	1.0		9.8	1.2	0.0	11.0	-9.98	0	0		
343	09/12/87	0	10	600000	1		0.0	1.00	1.0		10	1.2	0.0	11.2	-10.20	0	0		
344	10/12/87	0	9.6	576000	1		0.0	1.04	1.0		9.6	1.2	0.0	10.8	-9.76	0	0		
345	11/12/87	1.1	11.5	690000	1		1.1	0.84	1.9		11.5	1.2	0.0	12.7	-10.76	0	0		
346	12/12/87	0	11.8	708000	1		0.0	0.80	0.8		11.8	1.2	0.0	13.0	-12.20	0	0		
347	13/12/87	0	11.2	672000	1		0.0	0.87	0.9		11.2	1.2	0.0	12.4	-11.53	0	0		
348	14/12/87	0	12.4	744000	1		0.0	0.74	0.7		12.4	1.2	0.0	13.6	-12.86	0	0		
349	15/12/87	0	13.4	804000	1		0.0	0.63	0.6		13.4	1.2	0.0	14.6	-13.97	0	0		
350	16/12/87	2.6	11.4	684000	1		2.6	0.85	3.4		11.4	1.2	0.0	12.6	-9.15	0	0		
351	17/12/87	0.6	11.4	684000	1		0.6	0.85	1.4		11.4	1.2	0.0	12.6	-11.15	0	0		
352	18/12/87	0	14.8	888000	1		0.0	0.48	0.5		14.8	1.2	0.0	16.0	-15.52	0	0		
353	19/12/87	0	9.2	552000	1		0.0	1.09	1.1		9.2	1.2	0.0	10.4	-9.31	0	0		
354	20/12/87	0.2	11.8	708000	1		0.2	0.80	1.0		11.8	1.2	0.0	13.0	-12.00	0	0		
355	21/12/87	6.8	9	540000	1		6.8	1.11	7.9		9	1.2	0.0	10.2	-2.29	0	0		
356	22/12/87	0	6.2	372000	1		0.0	1.41	1.4		6.2	1.2	0.0	7.4	-5.99	0	0		
357	23/12/87	0	9.8	588000	1		0.0	1.02	1.0		9.8	1.2	0.0	11.0	-9.98	0	0		
358	24/12/87	0	9	540000	1		0.0	1.11	1.1		9	1.2	0.0	10.2	-9.09	0	0		
359	25/12/87	0	16.4	984000	1		0.0	0.30	0.3		16.4	1.2	0.0	17.6	-17.30	0	0		
360	26/12/87	0	10	600000	1		0.0	1.00	1.0		10	1.2	0.0	11.2	-10.20	0	0		
361	27/12/87	0	11.2	672000	1		0.0	0.87	0.9		11.2	1.2	0.0	12.4	-11.53	0	0		
362	28/12/87	16.6	10.4	624000	1		16.6	0.96	17.6		10.4	1.2	5.0	16.6	0.96	1	1		
363	29/12/87	12.2	2	120000	1		12.2	1.87	14.1		2	1.2	9.0	12.2	1.87	1	2		
364	30/12/87	1	3	180000	1		1.0	1.76	2.8		3	1.2	0.0	4.2	-1.44	1	3		
365	31/12/87	0	6.2	372000	1		0.0	1.41	1.4		6.2	1.2	0.0	7.4	-5.99	1	4		
																1	5		

Annex E

Nutrient And Salt Balances

EC

Percolation cals for EC leaching requirements

	EC @50% yield reduction
Phalaris	11
Perennial Ryegrass	12.2
Couch	14.7
Lucerne	**8.8**

EC (irrigation water) / EC (50% lucerne yield reduction)
= 1.1/8.8
= 0.125

Annual effluent application (maximum)
= 0.125 x 1112m3/day x 365days / 550000m2
= 0.092 m

percolation required annually to leach salts out of root zone
= 92mm

annual average rainfall mm	461
annual average evaporation mm	1869

Due to deficit between evaporation and rainfall and to account for the possibility that seasonal rainfall may not provide the required 92mm to leach salts out of the root zone, additional irrigation depth can be required at least once per year to provide this leaching. Alternatively rainfall depth can be monitored through the year to assess whether this will provide the required leaching.

BOD LOADING

A = CQ x (1000 x Lc)
Lc = CQ x (1000 x A)

Area ha 55
CQ 1168860

Lc (BOD5) = 21.252 kg/ha/mth
= 0.7084 kg/ha/day

Nitrogen budget									
		Effluent Characteristics			Area Characteristics			Application rate	
		Ammonium	10.15		Pasture	0		Area	55
		Nox	11.23		Lucerne	55		ML/day	1.15
		Organic N	4.52		Trees	0		day/yr	365
		Total N	25.9		Total	192			
Year	Effluent Application (ML/ha)	N applied	N available	N in Lucerne	Lucerne net N export	Lucerne net N balance (Kg/ha)	Lucerne net N balance (tonnes)		
1	7.63181818	197.6641	136.1745	300	270	-133.8255	-7.36040075		
2	7.63181818	197.6641	143.0737	300	270	-126.9263	-6.98094675		
3	7.63181818	197.6641	146.5233	300	270	-123.4767	-6.79121975		
4	7.63181818	197.6641	149.9729	300	270	-120.0271	-6.60149275		
5	7.63181818	197.6641	149.9729	300	270	-120.0271	-6.60149275		
6	7.63181818	197.6641	149.9729	300	270	-120.0271	-6.60149275		
7	7.63181818	197.6641	149.9729	300	270	-120.0271	-6.60149275		
8	7.63181818	197.6641	149.9729	300	270	-120.0271	-6.60149275		
9	7.63181818	197.6641	149.9729	300	270	-120.0271	-6.60149275		
10	7.63181818	197.6641	149.9729	300	270	-120.0271	-6.60149275		
10 yr Totals		1976.641	1475.582	3000	2700	-1224.418	-67.3430165		
Average		197.6641	147.5582	300	270	-122.4418	-6.73430165		
Grand Total (tonnes)									
Yearly	-6.73430165								
10 yrs	-67.3430165								

	Data							Concentrations			Application Rates												
	Max plant uptake (N) (ref 1)	525	kg/ha/yr			Total N in Wastewater		25.9	mg/l		198	kg/ha/year										
	Irrigation Area	55	ha			Ammonia in Wastewater		10.15	mg/l		77	kg/ha/year										
	Total Irrigation Volume	419.75	ML/year	@1.15ML/d		Nitrates in Wastewater		5	mg/l		38	kg/ha/year										
	Application	7.63	ML/ha/year			Nitrites in Wastewater		6.23	mg/l		48	kg/ha/year										
						Organic Nitrogen		4.52	mg/l		34	kg/ha/year										

	Process	Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
1	Total Annual Application	(kg/ha/yr)	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198	198
2	Volatilisation Losses	(kg/ha/yr)	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77	77
3	Organic Fraction	(kg/ha)	34.5	48.3	72.4	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5
4	Available from Application	(kg/ha/yr)	85.7	106.4	116.8	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2
5	Carryover from previous year	(kg/ha/yr)	0	4	7	10	12	13	14	14	15	15	15	15	15	15	15	15	15	15	15	15
6	Uptake by plants	(kg/ha/yr)	86	110	124	130	132	133	134	135	135	135	135	135	135	135	135	135	135	135	135	135
7	Removed	(kg/ha/yr)	73	94	105	111	112	113	114	114	115	115	115	115	115	115	115	115	115	115	115	115
8	Held in Humus	(kg/ha)	13	24	33	39	43	46	48	49	50	50	50	50	51	51	51	51	51	51	51	51
9	Decay losses	(kg/ha/yr)	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10	Cumulative sorption	(kg/ha)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Leaching	(kg/ha/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

References

1 Based on 15 tonnes/ha/yr lucerne, 3.5% N - Table 4.2 DEC 2004

P balance DEC (2004) Method

Assume phosphorus saturation point

= 0.5 x average P sorption capacity from lab [EPA Effluent Guidelines 2005 p 44]

Lab data not available – use default DEC data p.47 Table 4.3 of 2000kg/ha to 1m depth:

Critical soil P sorption =2000kg/ha to 1 m

Soil depth = 1m

Soil density = 1.50 t/m3

Land area for irrigation = 55

Total P in applied effluent = 0.06 mg/L

Volume of effluent at 1.15 ML/d = 419.75 ML

Calculations:

Total P adsorbed before leaching;

= Crit P sorp capacity x soil density x soil depth x irrigation area

= 2000kg/10000m3x 1500kg/m3 x 550,000m2

= 0.2kg/m3 x 55 ha x 10000m2/ha

= 110 000 kg

Total orthophosphate in applied effluent per year

= 0.06 mg/L x 419,750,000 L

= 25.19 kg

Total P removed by Lucerne /ha/yr = 60 kg

Therefore total P removed by lucerne per 55 ha per year = 3300 kg

Site irrigation period:

= (110000 kg) / (25.19 kg/yr – 3300 kg/yr)

Plant uptake greater than wastewater input requirements resulting in negative answer; therefore model allowable life of soil/project using P additions due to wastewater alone:

= 110,000 kg / 25.19 kg/yr

= 4367 years.

Therefore Phosphorus addition via to soil irrigation is not a limiting factor in wastewater.

	Data							Concentrations			Application Rates											
	Max plant uptake (P) (ref 1)	60	kg/ha/yr			Total P in Wastewater		0.06	mg/l		0	kg/ha/year										
	Irrigation Area	55	ha								0	kg/ha/year										
	Total Irrigation Volume	419.75	ML/year								0	kg/ha/year										
	Application	7.63	ML/ha/year								0	kg/ha/year										
											0	kg/ha/year										

	Process	Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
1	Total Annual Application	(kg/ha/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Volatilisation Losses	(kg/ha/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Organic Fraction	(kg/ha)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	Available from Application	(kg/ha/yr)	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	Carryover from previous year	(kg/ha/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Uptake by plants	(kg/ha/yr)	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	Removed	(kg/ha/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Held in Humus	(kg/ha)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Decay losses	(kg/ha/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Cumulative sorption	(kg/ha)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Leaching	(kg/ha/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

References

1 Based on 15 tonnes/ha/yr lucerne, 0.4% P - Table 4.2 DEC 2004

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