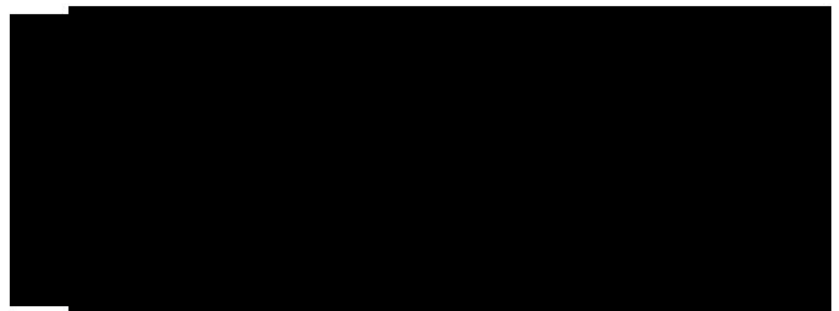


NUTRIENT AND IRRIGATION MANAGEMENT PLAN

Prepared for:

Abbott's Liquid Salvage
PO Box 453
ALBANY WA 6331

Report Date: 26 September 2007
Project Ref: ENVI2006/065



26 September 2007

Abbott's Liquid Salvage
PO Box 453
ALBANY WA 6331

[REDACTED]

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RE: Nutrient and Irrigation Management Plan

Please find attached the report entitled 'Nutrient and Irrigation Management Plan' prepared for the Abbott's Liquid Salvage. This report has been prepared to demonstrate the method with which Abbott's Liquid Salvage propose to reuse treated wastewater resulting from an annual waste acceptance volume of 20,000m³ through irrigation to a timber plantation.

For and on behalf of Coffey Environments Pty Ltd

[REDACTED]

Environmental Engineer

RECORD OF DISTRIBUTION

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ABBREVIATIONS

ANZECC	Australian and New Zealand Environment and Conservation Council
EC	Electrical Conductivity
mg/L	milligrams per litre
MW	Monitoring Well
NATA	National Association of Testing Authorities
SWL	Static Water Level
TDS	Total Dissolved Solid

1 INTRODUCTION

Abbott's Liquid Salvage (ALS) operate a liquid waste treatment facility at Plantagenet Location 4638, Albany Highway, Drome in the City of Albany. The facility accepts biological wastes, non-toxic salts and low strength wastewater for treatment through a series of controlled ponds. Since the commencement of operation in 2003, treated wastewater has been held on site in a storage pond. This Nutrient and Irrigation Management Plan (NIMP) has been prepared on behalf of ALS to demonstrate how they propose to reuse the treated wastewater from the liquid waste facility through irrigation.

Currently, the facility is licenced to accept 10,000m³ of liquid waste per year and during 2006, a volume close to this limit was received. Treatment through the pond system resulted in final treated effluent of relatively high quality, and as such, ALS would like to increase the licenced volume of treated wastewater permitted to be received to an annual total of 20,000m³. This report demonstrates how the wastewater quality will be monitored to ensure acceptable levels of treatment are maintained and how effluent disposal will be managed at the site.

The NIMP has been prepared in accordance with the Department of Environment's *Water Quality Protection Note WQ 33, Nutrient and Irrigation Management Plans, July 2006*. This plan details a recommended irrigation regime for the treated effluent originating from the ALS treatment operations such that:

- Nutrient loading rates will be in accordance with the Department of Environment's *Water Quality Protection Note, Irrigation with Nutrient Rich Wastewater, July 2006*;
- Wastewater flow does not leave the premises; and
- No ponding of wastewater will occur.

The plan also outlines a proposed environmental monitoring schedule to track the performance of the irrigation system and to measure any impacts on groundwater, surface water and the soil condition so that appropriate management measures can be implemented.

2 SUMMARY OF PROPOSAL

2.1 Irrigation of Treated Wastewater

ALS operate a liquid waste treatment facility and propose to utilise the treated wastewater resulting from an accepted waste volume of 20,000m³ to irrigate a *Eucalyptus globulus* (Tasmanian blue gum) plantation. The 4ha irrigated plantation is to be located to the west of the existing treatment facility, with irrigation through pressurised drip lines. A rainfed buffer and cut off drain will be constructed to surround the irrigation area providing safety measures to ensure the system does not impact on the local environment. Irrigation will be scheduled to occur primarily during the summer months, when the nutrient and moisture needs of the trees is the highest and during the winter months, water will be held onsite in a storage dam. ALS aim to commence irrigation over the 2007/2008 summer period.

2.2 Increase in Accepted Waste Volume of Facility

The maximum volume of waste licenced to be accepted at the ALS facility is 10,000m³. At this level the treatment system has been working very effectively resulting in large reductions in the levels of nutrients and BOD (Section 7.2). As such, ALS request that the licenced volume for acceptance be increased to 20,000m³. In order to manage the increased volume of waste, ALS will monitor the water quality through the system and have a number of contingencies in place to be implemented if/when certain threshold levels are reached. Treated wastewater will then be sustainably irrigated to a blue gum plantation.

3 PROJECT SETTING DESCRIPTION

3.1 Site Location

The site is located approximately 10km north of Albany on Plantagenet Location 4638, Albany Highway, Drome (as shown in Figure 1). The property is owned by Mr. Ray Gerovich, and is used for general agricultural purposes. A portion of the property on the southern boundary is leased to Abbott's Liquid Salvage for the purpose of wastewater treatment and contains a series of waste water treatment ponds designed for this use. The property and the associated lease area are shown in Figure 2. The liquid waste treatment system consists of three anaerobic treatment ponds, two facultative ponds and one storage dam. The proposed irrigation area also lies within the existing lease boundary.

3.2 Overview of Present Operations

The land leased by Abbott's Liquid Salvage is used for the purpose of treating liquid waste material. The site is currently operated under the Department of Environment and Conservation Licence Number 7827/3 (File Number L84/01). A copy of the licence is included in Appendix A. This current licence commenced on 20 January 2005 and expires on 19 January 2010, with the facility licenced to accept a maximum waste quantity of 10,000m³ per year. The types of waste permitted to be accepted are outlined in Table 1.

Table 1: ALS Acceptable Liquid Waste Categories

Category Group No.	Category Group Name	Category No.	Description
1	Biological Wastes	1.01	• Animal Wastes – small goods, and animals slaughtered for quarantine purposes
		1.02	• Septage wastes – wastes from apparatus for the treatment of sewage
		1.03	• Grease wastes - wastes resulting from food preparation processes
		1.04	• Vegetable oils and derivatives and other wastes (excluding wastes referred to in categories 1.01, 1.02, 1.03 and 1.05)
		1.05	• Sewage waste from the reticulated sewage system (ie Water Corporation)
13	Inorganic Chemicals other than Inorganic Chemicals referred to in Category Groups 9 – 12.	13.15	• No toxic salts
14	Low Strength Wastewater	14.01	• Industrial wash waters
		14.02	• Storm water
		14.03	• Pond water
		14.04	• Fire debris and wash water (may vary)

The wastewater treatment system consists of three anaerobic ponds in parallel, followed by two facultative ponds in series. All ponds are lined with synthetic liner material in accordance with *Water Quality Protection Note 26, Liners for Containing Pollutants, using Synthetic Membranes (June, 2005)*. The design drawings for the treatment system are included in Appendix B. All treatment ponds were constructed and commissioned in 2003.

The original works approval application for the facility (Wood and Grieve, August 2001) indicated that treated effluent was to be disposed to an onsite evaporation pond. Since the original proposal was approved, ALS have realised the opportunities that exist to reuse the treated effluent through irrigation. As a result, the 3.0ha Stage 1 evaporation pond has been replaced with a smaller, and deeper storage dam to hold treated water. The storage dam was constructed in 2005 and has a clay liner to minimise any seepage to groundwater and has a surface area of 8,900m². Allowing for a 0.5m freeboard, the dam has a depth of 1.8m and a holding capacity of 15,600m³. Since the commencement of operations, all treated wastewater has been held onsite in the storage dam or lost to evaporation, and as such there have been no discharges to the environment.

3.3 Past Land Use

Prior to the construction of the wastewater treatment facility, the site was used for general agricultural purposes and is zoned rural under the local Town Planning Scheme. The portion of the leased area that is not used for water treatment is still used for agriculture. This includes a mixture of cropping and livestock, including the grazing of free range pigs.

Fertiliser applications have been consistent with general broad acre agricultural land uses, with exact details of applications not available. Soil investigations undertaken by Soil Management Consultants (Jan 2006) indicated that the nutrient status of phosphorus and potassium in the soil in the vicinity of the proposed irrigation area were very low.

It should be noted that the site is located adjacent to the northern boundary of the Water Corporation Tree Farm (Figure 2) property which operates a broad scale effluent irrigation operation to grass beds and plantation blue gums.

3.4 Existing Site Vegetation

Until July 2007, the proposed irrigation area has been used for broad acre farming practices and as such has been totally cleared of all native vegetation. The vegetation consisted of pasture comprised of clover and grasses. As the opportunity to establish a new blue gum plantation only occurs during the winter months, ALS have ripped, mounded and planted the proposed irrigation area and buffer to the east of the wastewater treatment ponds. The trees appear to be establishing and progressing well.

A stand of native vegetation exists to south of the treatment ponds, as shown in Figure 2. This vegetation is significantly degraded, with little to no understory due to the grazing of livestock. The establishment of the irrigation area does not involve the clearing of any native vegetation.

3.5 Meteorological Data

Meteorological data is collected by the Bureau of Meteorology at Albany Airport, located 2.2km east of the ALS site. Due to the close proximity of the Bureau of Meteorology collection point, data collected will give an excellent representation of meteorological conditions at the ALS site. Rainfall and evaporation data used throughout this NIMP is summarised in Table 2.

Table 2: Meteorological Data for Albany Airport

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Rainfall (mm)	24.2	23.3	31.8	56	95.2	103.2	122.5	109.3	87.2	74.6	45.1	26.6	799
Median Rainfall (mm)	13.1	19.6	24.8	55.2	92.4	100.2	116.4	102.8	77.1	64	40.2	18.2	804
90th Perc. Rainfall (mm)	66.4	50.2	71.8	111.3	147.9	133.2	172.4	151.2	133.3	127.5	73.9	66.4	959
Monthly Evap. (mm)	207.7	170.8	151.9	99	68.2	54	58.9	68.2	84	108.5	138	182.9	1392

3.6 Site Topography

The irrigation area is located on a flat plateau. The elevation over the leased area varies between 68.8 to 69.5m AHD, providing a gradient of approximately 1:300. The contours over the site shown in Figure 3 show the very flat nature of the land. Any overland flow within the proposed irrigation area would generally flow from north to south.

3.7 Sensitive Environments

The site is located within the Torbay Catchment at the head of the Seven Mile Creek sub-catchment, approximately 700m upstream of the Water Corporation's wastewater holding dam. The proposed irrigation area is not situated within a potential water supply area, and will not impact on any environmentally significant natural bushland or other sensitive environments.

4 SOILS DESCRIPTION

4.1 Soil Strata and Landforms

Soils in the irrigation area typically consist of shallow surface sandy loams to a depth of around 0.2m, over around 0.8m of laterite gravel which overlies mottled white clays. A geotechnical investigation was undertaken within the proposed irrigation area by Wood and Grieve Engineers which involved the excavation of 14 test pits as part of the original Works Approval Application for the facility. Relevant details of the investigation are included in Appendix C. In addition, an investigation was completed by Soil Management Consultants to determine the suitability of the soil for irrigation of wastewater in January 2006. This report is also included in Appendix C.

The nature of the soils and the location of the site suggest that the site poses no acid sulphate soils risk. There is no fill or amendment currently on or proposed for the site.

4.2 Phosphorus Retention Indices (PRI)

Phosphorus Retention Indices (PRI) provide a measure of the phosphorus holding capacity of soils. Topsoil samples were collected by Soil Management Consultants in December 2005 and were analysed for phosphorus retention with results presented in Table 3.

Table 3: PRI for Topsoil Samples

Topsoil Sample Location	1	2	3
PRI	437	179	109
PRI Rating	Very High	Very High	High

As shown in the Table 3, the phosphorus retention rating for the topsoil samples range from 'Very High' to 'High' across the site. This suggests that the soils have a suitable phosphorus retention capability for the irrigation of treated wastewater.

4.3 Soil Permeability

Soil permeability is a measure of the rate at which water flows through a soil profile. Permeability is important in onsite effluent disposal investigations as it provides an indication of whether water discharged from a treatment system will infiltrate immediately into the soil, or will remain on the surface and cause ponding or potentially surface runoff.

Soil permeability within the irrigation area was measured using the *AS1547:2000* approved Talsma-Hallam permeameter. This method is a constant head test, whereby water that runs out of an unlined test hole is replenished at the same rate from a reservoir, keeping the level of water in the hole constant (i.e. constant head). Field records were taken to measure the loss of water from the reservoir over time, which were then used to calculate the coefficient of permeability (K_{sat}) for the particular soil profile.

Results of the test suggested that the infiltration rate of water into the soil profile is relatively low, in the order of 0.01m/day. Based on the soil classifications in *AS1547:2000*, the soil is defined as Category 6 – medium to heavy clays with a recommended design irrigation rate (DIR) of 15mm/week. The results of the field measurements are provided in full in Appendix D.

5 WATER RESOURCE DESCRIPTION AND USE PLAN

5.1 Natural Waterways, Bores and Dams

The proposed irrigation area is at the top of the catchment for Seven Mile Creek. This creek forms part of the Torbay catchment, draining south to the Torbay Inlet. The head the Seven Mile Creek is formed by the Water Corporation wastewater holding dam which lies approximately 700m south of the proposed irrigation area (Figure 1). No surface streams or drainage lines pass through the ALS treatment or disposal areas. There are a number of agricultural dams in the vicinity of the proposed irrigation area, which are not expected to be impacted by the disposal of wastewater.

5.2 Land Subject to Seasonal Flooding

As the irrigation site is located at the top of the Seven Mile Creek catchment, the flow in local creeks and streams is seasonal and of relatively low volume. Consequently, the risk of flooding due to inundation resulting from rainfall runoff on the site is very low.

Due to the relatively flat nature of the site and the low permeability, after periods of heavy rain, when the precipitation rate exceeds the infiltration rate of the soil, surface runoff and or ponding is likely to occur. ALS will regulate the timing and duration of irrigation events to ensure that irrigation does not occur during periods of excess soil moisture. This will be monitored through visual observations and the use of a soil moisture probes. In addition, a cut off drain and vegetated buffer will be established to ensure any surface or subsurface runoff does not leave the site. The details of these measures are discussed further in Section 9.1.

5.3 Groundwater Description

Geotechnical investigations undertaken in 2001 by Wood and Grieve included the excavation of five test pits within the proposed irrigation area. Groundwater was not intersected in any of the pits which varied in depth from 2.0m to 4m.

ALS installed five groundwater monitoring bores surrounding the wastewater treatment facility prior to the commencement of operations in 2003 (Figure 3). Groundwater level data has been collected regularly during quarterly monitoring events. The groundwater levels during the most recent sampling event in September 2007 are shown Table 4, with the depth to groundwater ranging between 11.5m and 13m below ground level. As such, the minimum separation distance as specified in *WQPN 33, Nutrient and Irrigation Management Plans* between the irrigation surface and the groundwater table of 2m can easily be achieved.

Table 4: September 2007 Groundwater Levels

	MW1	MW2	MW3	MW4	MW5
Depth to Ground Water (mBGL)	11.6	11.9	11.5	11.6	13.0

Samples from each of the monitoring bores have been regularly collected by ALS in accordance with the current licence conditions to monitor any potential groundwater impacts resulting from the operation of the treatment system. Samples have been analysed for:

- pH;
- Nutrients (nitrate-nitrogen, total nitrogen, total phosphorus);
- Biochemical oxygen demand (BOD);
- Oil and grease; and
- Total dissolved solids (TDS).

Laboratory results from the 2007 sampling are including in Appendix E. The pH of all samples have consistently recorded levels between 5.0 and 5.5 indicating that the groundwater in the area is slightly acidic in nature.

Table 5 provides a summary of the nutrient levels found in the groundwater during 2007 and the relevant ANZECC and ARMCANZ (2000) guideline limits for comparison purposes.

Table 5: 2007 Groundwater Sampling Results

SAMPLE ID	Total Nitrogen (mg/L)		Total Phosphorus (mg/L)	
	Feb	June	Feb	June
MW1	1.63	1.02	<1.0	<1.0
MW2	1.07	<1.0	<1.0	<1.0
MW3	<1.0	<1.0	<1.0	<1.0
MW4	<1.0	<1.0	<1.0	<1.0
MW5	<1.0	<1.0	<1.0	<1.0
ANZECC Guideline Limit - Protection of Aquatic Ecosystems*	1.5		0.06	

* ANZECC & ARMCANZ, 2000 "Southwest Australian Aquatic Ecosystems - Wetlands"

As shown in the table above, the ANZECC and ARMCANZ (2000) guideline levels for total nitrogen was only slightly exceeded in MW1 in February 2007. All other bores show concentrations below the limit. Slight elevations in nutrient levels are likely to be a result of a long history of agricultural activities in the area. Total phosphorus levels were all reported as being lower than 1.0mg/L, and as such, can not be directly compared with the guideline limit. Analysis was performed to the required detection but was rounded for reporting purposes. The laboratory has been requested to supply amended result providing the precision. Amended results will be available in early October, and will be forwarded to the Department of Environment and Conservation if requested.

BOD levels in MW1 reported concentrations of 8.4mg/L in February and 5.7mg/L June. All other records were below the detection limit of 2mg/L. The elevation in MW1 has been noted and will continue to be monitored. TDS levels ranged from 1,000mg/L to 1,200mg/L in all bores during 2006, which is considered typical of background levels.

5.4 Sensitive Water Resources

The treatment plant and the irrigation area are located within the Seven Mile Creek catchment, near the boundary of the Marbelup Creek catchment. The Marbelup catchment has been identified as a potential future drinking water supply catchment, and as such has potential land use restrictions. There are no licenced users of water resources in the area.

6 MANAGEMENT OF INCREASED WASTE VOLUME

6.1 Water Quality Monitoring

To manage the increase in accepted waste volume to 20,000m³, ALS propose to undertake regular monitoring to ensure that the final effluent continues to be of a quality suitable for use through irrigation in accordance with this NIMP. Monthly samples of the irrigation water will be collected and sent to a qualified laboratory for analysis of total nitrogen and total phosphorus and compared with the threshold levels defined in this document. If the thresholds are exceeded, all irrigation will cease until the water quality is reduced to below the allowable limit and actions will be implemented to improve the level of treatment. It should be noted that the threshold levels proposed are significantly higher than the concentrations found in the treated wastewater samples collected to date (see Section 7.2), and it is anticipated that these levels will not be reached through the increase in volume to 20,000m³. Table 6 summarises the water quality monitoring commitments ALS propose to implement to ensure water quality remains suitable for irrigation. This monitoring will be undertaken in addition to the sampling schedule proposed to as part of the ongoing management of the nutrient and irrigation management plan (see Section 11).

Table 6: Irrigation Water Quality Monitoring Commitment

Parameter	Sampling Frequency	Maximum Threshold Value	Action to be Taken if Threshold Exceeded
Total Nitrogen	Monthly	50mg/L	Recirculation of wastewater to aerobic pond 1 and installation of aeration units.
Total Phosphorus	Monthly	10mg/L	Chemical treatment to reduce P levels (ie. addition of alum)
Salinity	Monthly	-	

A total nitrogen threshold of 50mg/L has been set as the maximum to permit irrigation to occur. In the event that this level is exceeded, ALS will implement the contingency to recirculate wastewater from the storage dam to facultative pond 1 and commence using aerators. Irrigation will not commence until the levels have been reduced to below the threshold values, and sustained for at least one week. ALS currently own two 1.1kW aerators which are available to be installed in the first facultative treatment pond. Tether posts have been fixed to allow these to be secured. Specifications of the aerators is provided in Appendix F. Infrastructure is currently in place to allow the recirculation to occur. Aeration through the use of aerators will assist in the reduction in the total nitrogen levels in the wastewater. In the event that the two 1.1kW aerators do not sufficiently reduce the nitrogen levels, additional aerators (higher rating) will be sourced and installed. ALS are committed to undertaking the sourcing of additional aeration in the event that it is required.

If total phosphorus levels rise above 10mg/L, irrigation will be stopped and water in the treatment pond will be chemically dosed using alum (or similar approved treatment) to reduce phosphorus concentrations. This is a proven method for the reduction of phosphorus in wastewater. Irrigation will not commence until levels below 10mg/L are sustained for at least one week.

The level of salinity in the wastewater also impacts on the suitability for irrigation, and as such, salinity in the form of electrical conductivity (EC) will be monitored on a monthly basis in the irrigation water. Management of salinity is further discussed in Section 7.2.2.

Due to the low level of BOD found in samples collected to date, it is not deemed necessary to be included in the monthly sampling program. As noted in Section 11, BOD samples will be collected quarterly. However if odour levels are observed to be increasing, then the sampling frequency will be increased to a monthly basis.

Laboratories will be requested to return sample analysis results within two weeks of receiving the samples to ensure that the lag time for actions to be implemented in the event that the threshold values are reached will be minimised.

6.2 Odour Management

As shown in Figure 2, the nearest residence to the facility is located approximately 1km to the west of the site. Since the commencement of operations in 2003, ALS are only aware of one complaint regarding odour originating from the site. It is not anticipated that there will be an increase in the odour emissions as a result of the increase in the total waste volume received. In the event that odour emissions do increase, inspections will be undertaken to determine the likely source of the odour. If the odours are originating from the anaerobic ponds, a range of odour control measures will be considered, including the installation of covers on the ponds. If the source of the odours is the facultative ponds aerators will be installed to accelerate the BOD reduction. Buffer distances surrounding the facility meets with the separation distance guidelines provided by the Environmental Protection Authority (June 2005) in Separation Distances between Industrial and Sensitive Land Uses.

6.3 Irrigation

ALS propose to irrigate a 4ha area for the purpose of growing plantation blue gums to meet the disposal requirements associated with operating the wastewater treatment system receiving 20,000m³ per year. The location of the proposed irrigation area, with respect to the liquid waste treatment facility is shown in Figure 4. Irrigation will primarily occur during the summer months using a drip irrigation system. The timing will be scheduled to meet the water and nutrient demands of the vegetation. Further details regarding the proposed irrigation design and schedule are detailed in Section 7. The establishment of the irrigation system will not require any additional persons to be resident at the site.

7 IRRIGATION

7.1 Irrigation Water Quantity

The volume of treated wastewater available for irrigation will vary on an annual basis depending on the volume of waste received and the rainfall and evaporation statistics for a particular year. As shown in Table 7, based on the current licence limit of 10,000m³ of waste, in an average rainfall year the volume of treated effluent available for irrigation is relatively low. This shows how the facility has operated since 2003 utilising evaporation for disposal and hence not requiring any discharge to the environment.

This document demonstrates how irrigation can be managed to satisfactorily dispose of effluent from both an average rainfall and a high rainfall (1 in 10) year for an annual waste volume of 20,000m³. The total annual irrigation volumes and the corresponding irrigation rates over a 4ha area are summarised in Table 7. Full details of the water balance calculations are provided in Appendix G.

Table 7: Annual Irrigation to 4ha Irrigation Area

Accepted Waste Volume		Average Rainfall Year	90 th Percentile Annual Rainfall Year
10,000m ³	Total Volume	2,092kL	4,969kL
	Irrigation Depth	52mm	124mm
20,000m ³	Total Volume	12,092kL	14,969kL
	Irrigation Depth	302mm	374mm

Based on a receiving volume of the 20,000m³, the volume of water to be disposed through irrigation is 12,092kL in an average year and 14,969kL in a 1:10 wet year. This equates to a total irrigation rate of 302mm/year and 374mm/year respectively over a 4.0ha area. It should be noted that water balance calculations assume that the storage dam is not pumped dry until the end of the summer period (i.e. end of April), and as such, evaporation continues over a 12 month cycle.

7.2 Irrigation Water Quality

Samples have been collected by ATA Environmental from the final stages of the wastewater treatment pond to demonstrate the levels of nutrients, BOD, salts, heavy metals, oil/grease and microbial contamination in the water proposed for irrigation. The levels of these parameters have been used to assess the suitability of the water for irrigation. The following sections discuss each of the water quality criteria with respect to the relevant environmental guidelines. Results are provided for SW4 and SW5, reflecting the water quality in the final treatment pond and the storage dam respectively. The sample location points are shown in Figure 3. Copies of the laboratory certificates for each set of sampling results in included in Appendix H.

7.2.1 Nutrients and BOD

Biological Wastes (Category No. 1), which comprise the bulk of the material received at the ALS facility typically has very high levels of nutrients (including nitrogen and phosphorus) and biochemical oxygen demand (BOD). Throughout the treatment process, including the anaerobic and the facultative ponds, a significant reduction in the concentrations of nutrients and BOD have been achieved. Table 8 shows typical reductions in nutrient and BOD concentrations through the treatment system.

Table 8: Nutrients and BOD Levels through Treatment System

	Sample Date	Untreated	SW2	SW3	SW4	SW5
Total Nitrogen	6 Oct 2005	370	160	60	15	2.4
	26 Apr 2006	-	790	9.8	9.5	3.2
	20 Dec 2006	-	-	-	13	6.4
Total Phosphorus	6 Oct 2005	280	34	14	7.2	0.74
	26 Apr 2006	-	66	14	4.8	0.26
	20 Dec 2006	-	-	-	2.8	1.3
BOD	26 Apr 2006	-	160	30	26	<5
	20 Dec 2006	-	-	-	21	12

The above analytical results show that as the liquid waste moves through the treatment system, the levels of total nitrogen, total phosphorus and BOD are all significantly reduced. Concentrations of nutrients in the final treated wastewater are all relatively low indicating the treatment system is operating with a high degree of efficiency. The total nitrogen and phosphorus levels in the proposed irrigation water (SW5) are significantly lower than the maximum threshold limits set for irrigation.

7.2.2 Salinity

The salinity of treated wastewater will impact on the suitability of the water for use through irrigation. Salinity can be measured in a range of forms, with EC (electrical conductivity), measured in deciSiemens per metre (dS/m), a common and accurate method of measurement. Most of the salts that are added to soil through irrigation remain in the soil when the moisture is used by plants or evaporated from the surface. Excess salt can adversely affect both soil properties and plant growth, with problems arising when salt accumulates to a concentration that reduces the ability of the trees to extract water from the soil (CSIRO, 1999).

The quantity of salt that accumulates in the soil depends on the balance between the amount applied in the effluent and the quantity leaving the root zone through leaching. If the amount of irrigation is matched closely with the water requirements of the trees, salt will accumulate in the root zone. Rainfall and subsequent leaching during the non-irrigation season will reduce the amount stored.

Salinity concentrations of the wastewater in SW4 and SW5 are provided in Table 9. As treated water has never been extracted from the ponds, the salinity levels are likely to be elevated due to the concentration of salts in the wastewater over the four years since the commencement of operations. As a result, the salinity levels found in the wastewater samples may not necessarily provide an accurate representation of the likely character of the effluent. Once irrigation commences, and the dam is emptied at the end of each summer period, the salinity levels should establish at a relatively seasonal pattern over time.

Table 9: Salinity Levels in Treated Wastewater

	Sample Date	SW4	SW5
Salinity (dS/m)	26 Apr 2006	2.6	2.2
	20 Dec 2006	2.7	5.1

Due to the scheduling of irrigation through the summer months only, it is likely that sufficient flushing will occur over winter to remove any build up of salts in the soil. As the exact concentrations of salts in the irrigation water is not known, the salinity levels in the irrigation wastewater will have to be monitored on a regular basis, in conjunction with the soil salinity within the irrigation area to ensure suitability for long term irrigation. If it is found that additional freshwater is required to dilute the treated effluent or to leach salt through the soil profile through irrigation, water collected in the runoff dam will be available for this purpose.

7.2.3 Heavy Metals

Heavy metals in excessive concentrations in irrigation water are potentially toxic to soil biota. The following table provides the concentrations of a range of metals in the treated effluent from samples collected in December 2006, and results are compared with the Water Quality Guidelines for Irrigation and General Water Use detailed in *ANZECC and ARMICANZ (2000) – Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Table 10: Heavy Metal Concentration in Irrigation Water (Dec 2006)

	Detection Limit	Sample Locations		Guideline Limits	
		SW4	SW5	LTV	STV
	mg/L	mg/L	mg/L	mg/L	mg/L
Aluminium	0.1	<0.1	2.9	5	20
Arsenic	0.001	<0.001	0.008	0.1	2
Cadmium	0.002	<0.002	<0.002	0.01	0.05
Chromium	0.01	<0.01	0.02	0.1	1
Copper	0.01	0.01	<0.01	0.2	5
Manganese	0.01	<0.01	0.01	0.2	10
Nickel	0.01	0.03	0.01	0.2	2
Lead	0.01	<0.01	<0.01	2	5
Zinc	0.01	<0.01	<0.01	2	5

LTV – Long term trigger values is the maximum concentration of contaminant in the irrigation water which can be tolerated assuming 100 years of irrigation.

STV – Short term trigger values in irrigation water is the maximum concentration of contaminant in the irrigation water which can be tolerated for a shorter period of time (20 years) assuming the same maximum irrigation load as for LTV.

All metal concentrations in SW4 and SW5 were found to be below both the short and long term trigger values for irrigation water, and as a result water quality is deemed suitable for use through irrigation to plantation timber based on metal concentrations.

7.2.4 Fouling

Oil and grease can cause concerns when considering irrigation as the preferred method for wastewater disposal due to the potential clogging of pipes, dripper heads and the soil pores. The concentrations of oil and grease in the treated wastewater is summarised in Table 11.

Table 11: Oil and Grease Concentration in Irrigation Water

	Sample Date	Detection Limit	SW4	SW5
		mg/L	mg/L	mg/L
Oil and Grease	7 Oct 2005	10	<10	<10
	20 Dec 2006	5	11	17

As ALS propose to utilise a filter as part of their irrigation system, the concentration of oil and grease in the final wastewater is likely to be further reduced to ensure suitability for irrigation using drippers.

7.2.5 Microbial Contamination

Historically, a range of coliforms have been used as indicators and accordingly guidelines measured in faecal/thermotolerant coliforms are still commonly used. The ANZECC & ARMCANZ (2000) publication "Australian and New Zealand Guidelines for Fresh and Marine Water Quality" provides trigger values for thermotolerant coliforms in irrigation waters. These values are summarised in Table 12.

Table 12: Trigger Values for Thermotolerant Coliforms in Irrigation Waters

Intended Use	Levels of Thermotolerant Coliforms
Raw human food crops in direct contact with irrigation water (e.g. via sprays, irrigation of salad vegetables)	<10cfu/100mL
Raw human food crops not in direct contact with irrigation water (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); or crops sold to consumers cooked or processed	<1,000cfu/100mL
Pasture and fodder for dairy animals (without holding period)	<100cfu/100mL
Pasture and fodder for dairy animals (with withholding period of 5 days)	<1,000cfu/100mL
Pasture and fodder (for grazing animals except pigs and dairy animals, i.e. cattle, sheep and goats)	<1,000cfu/100mL
Silviculture, turf, cotton etc (restricted public access)	<10,000cfu/100mL

As noted in Table 12, the maximum concentration allowable for the reuse of treated wastewater through irrigation to plantation trees is <10,000cfu/100mL if the site has access restricted to the public. Table 13 provides the levels of coliforms detected in samples collected from the final treatment pond and the storage dam on 20 December 2006. The levels detected were well below the allowable levels for irrigation to silviculture.

Table 13: Microbial Concentration in Irrigation Water

Microbial Indicator	SW4	SW5
	cfu/100mL	cfu/100mL
Total Coliforms	200	200
Thermotolerant Coliforms	200	200
E Coli	12	26

7.3 Irrigation Area

Treated effluent is proposed to irrigate a 4.0ha area located to the east of the existing storage dam. This area is situated where the evaporation ponds were proposed to be located in the original works approval. The proposed irrigation area is defined on Figure 4.

The irrigation area is intended to be surrounded by a rain fed blue gum buffer, with a width of 25m on the southern site and 10m on the other remaining boundaries (Figure 4). The purpose of the buffer is to act as a safety measure to uptake any irrigation water that may have migrated from the irrigation area.

7.4 Irrigation Design

Irrigation will utilise pressure release drippers located at ground level following the ripped and mounded tree lines. This form of irrigation has found to be effective at the adjacent Water Corporation tree farm site. The use of drip irrigation ensures that there is no risk of spray drift to adjacent properties. Water will be filtered to ensure that blockage of the dripper nozzles is kept to a minimum. Detailed irrigation design will be undertaken by irrigation consultants. A maintenance program will be provided as part of the detailed irrigation design and implemented to ensure the system continues to operate to design.

7.5 Irrigation Schedule

Irrigation rates will vary throughout the year depending on the climatic conditions and soil moisture, with the majority of irrigation to occur between the months of October and April. Table 14 shows an indicative schedule for the 4ha irrigation area indicating how the total irrigation volume resulting from a typical 1:10 wet year (14,969m³) could be managed. The below schedule does not include any irrigation for the five month high rainfall period from May to September. During this time all water will be held in the storage dam on the site.

TABLE 14: INDICATIVE IRRIGATION SCHEDULE

	Days	Irrigation	Irrigation	Irrigation Volume
		mm/wk	mm/month	m ³
January	31	20	89	3543
February	28	20	80	3200
March	31	15	66	2657
April	30	2	9	343
May	31	0	0	0
June	30	0	0	0
July	31	0	0	0
August	31	0	0	0
September	30	0	0	0
October	31	5	22	886
November	30	10	43	1714
December	31	15	66	2657
TOTAL			375	15000

Irrigation rates are less than the 15mm/week design irrigation rate (DIR) determined as a result of the permeability testing at the site for all months excluding January and February. As the soil has been ripped and mounded, and trees planted adjacent to the irrigation point, the actual infiltration rate is likely to be significantly higher than that of the in-situ soil initially tested. Based on this modified soil profile, and the irrigation occurring during the summer period when natural soil moisture is low a DIR of 20mm/week is deemed suitable for the site. Inspections will be undertaken during irrigation events and if surface ponding is found to occur, irrigation will be stopped and the irrigation rates and schedule modified to ensure effluent infiltrates immediately into the soil.

7.6 Winter Storage Dam

As noted in Section 7.5, ALS propose to have capacity to hold treated wastewater onsite during the winter months, and irrigate during the drier months when uptake by the trees will be greatest. Water balance calculations were undertaken to determine the storage dam capacity requirements to hold all water onsite from the start of May until end of September each year. Calculations were based on a 1 in 10 wet year, plus provision for a 1 in 20 year 72 hour duration storm event. Full copies of the calculations are provided in Appendix G. The required capacity based on 20,000m³ of liquid waste received was 16,521m³.

The volume of the existing storage dam is approximately 15,600m³, and as such does not quite meet with the storage requirements for a 1 in 10 wet year, plus a 1 in 20 year 72 hour storm. In order to increase the capacity of the dam, earthworks will be undertaken at the end of the 2007/2008 dry season to ensure sufficient capacity for the 2008 winter. The dam will maintain a 0.5m freeboard above this 16,500m³ volume which will provide additional holding capacity in the case of an extreme event.

7.7 Soil Moisture Probes

Soil moisture probes will be used to monitor the amount of water throughout the soil profile. ALS will position two sets of soil moisture probes within the irrigation area. Indicative locations of the soil moisture probes are shown in Figure 4. These will be used to modify the irrigation frequency to ensure that soil moisture does not exceed the maximum levels. Probes will be placed at various depths throughout the soil profile to determine the impacts of irrigation and rainfall on the moisture profile of the soil. Soil moisture probes provide indicative values of soil moisture and the relative changes will be monitored to determine the optimum and maximum moisture levels for the site.

8 NUTRIENT APPLICATION

8.1 Nutrient Application Criteria

The Department of Environment's *Water Quality Protection Note 22– Irrigation with Nutrient Rich Wastewater (July 2006)* provides a framework for the permissible nutrient application rates for different soil types and receiving environments. The framework allocates a vulnerability category for a site depending on the potential for adverse environmental impacts to occur as a result of nutrient application through irrigation. Table 15 summarises the criteria for the vulnerability category classifications.

Table 15: Soil and Receiving Environment Vulnerability Categories

Characteristics of Irrigated Soils	Vulnerability of Downstream Surface Waters (within 1km)	Vulnerability Category
Coarse grained soils e.g. sands and gravels	Significant	A
	Low	B
Fine grained soils (PRI above 10) e.g. loams, clays, peat rich sediment	Significant	C
	Low	D

As the ALS irrigation area is located on clay soils with high PRI values and is not located within 1km of perennial surface waters, the vulnerability category for the site classified as Category D. The classification of the proposed site as Category D suggests that the site is highly suited to the purpose of irrigation of treated wastewater, and that a properly managed system will not pose any risk to the surrounding environment.

Based on the vulnerability category classification of a site, the Department of Environment recommends a maximum nutrient application rate for nitrogen and phosphorus. These values are provided in Table 16. As the site is classified as Category D, the maximum application rates for Inorganic Nitrogen is 480kg/ha/yr and for Reactive Phosphorous is 120kg/ha/yr.

Table 16: Nutrient Application Rates for Soil/Receiving Environment Vulnerability Categories

Vulnerability Category	Maximum Inorganic Nitrogen (as N)	Maximum Reactive Phosphorus (as P)
	Application Rate (kg/ha/yr)	Application Rate (kg/ha/yr)
A	140	10
B	180	20
C	300	50
D	480	120

To ensure that the ALS irrigation system does not exceed the maximum nutrient loading rates, the irrigation system has been conservatively designed to ensure that the limits for a Category C soil are met. As such, maximum nitrogen application to the area will be 300kg/ha/year and the maximum phosphorous application will be 50kg/ha/year.

8.2 Nutrient Application Rates

Treated wastewater from the liquid waste processing facility will be applied to a 4.0ha plantation timber area. The total irrigation volume resulting from a 20,000m³ waste volume in 1:10 wet year will be 14,969m³, or 3,742m³/ha.

As specified in Section 6.1 the maximum concentration of nutrients in the wastewater is proposed to be 50mg/L of total nitrogen and 10mg/L of total phosphorus. These are the threshold limits beyond which all irrigation will be halted. Based on these water quality parameters, and the proposed irrigation rates, the total nutrient loads to be applied to the irrigation area are shown in Table 17. The calculations used to determine the total nutrient loads are provided in Appendix G. No additional fertilisers are intended to be used on the irrigation area.

Table 17: Annual Nutrient Application Rates

Parameter	Nitrogen	Phosphorus
Irrigation Water Quality (mg/L)	50	10
Land Area Applied (ha)	4	4
Volume Irrigation Water Applied (m ³ /ha)	3742	3742
Total Annual Nutrient Applied (kg/ha/yr)	187	37
Category C Maximum Application Rates (kg/ha/yr)	300	50
% Maximum Load Applied	62%	74%

As shown in the table, for the 4ha irrigation area, the nitrogen loading of 187kg/ha/yr is 62% of the Category C maximum allowable limit. Phosphorus loading is forecast to be 37kg/ha/yr, which constitutes 74% of the annual limit.

8.3 BOD Loading

5-day Biochemical Oxygen Demand (BOD) is a measure of the amount of oxygen consumed by bacteria during the breakdown of organic matter over a five-day period. A high BOD level may accelerate the generation of sulphides in a system and thus potentially cause odour problems to arise.

The maximum allowable BOD application rate to an irrigation area is 30kg/ha/day (Water Quality Protection Note 22- July 2006). Treated water quality results to date have resulted in BOD levels in the order of 10mg/L. If this BOD level was maintained, the BOD loading to the irrigation area would be less than 0.5% of the allowable load. As a result, even if there is some elevation in the BOD level of the wastewater, it is unlikely that the guideline limit would be reached.

9 DRAINAGE CONTROLS

9.1 Irrigation Area Drainage

ALS will construct a cut-off drain on the northern perimeter of the irrigation area to prevent any surface water entering the effluent irrigation area. In addition, a cut off drain will be constructed along the southern boundary of the irrigation area to capture any flow from within the irrigation area. The location of the cut-off drains are shown on Figure 4. The drains will extend to an approximate depth of 0.5m below the ground surface to capture potential shallow lateral subsurface flow. The drains will be clay lined on the down stream side to ensure that all flow is captured and retained within the drain.

Flow from the cut off drains is to be collected in the runoff dam which will be located at the natural low point on the southern boundary of the site. The dam will be clay lined and have a minimum capacity of 6,000m³ which will hold at least one month of winter rainfall, and a 1:5 year 72 hour storm event (Australian Rainfall and Runoff 2000). In the event that the storage dam approaches capacity, the uncontaminated runoff collected from north of the irrigation area will be diverted to the roadside drainage area, and the runoff from within the irrigation area will continue to collect in the dam.

As the drip irrigation system will be designed and scheduled to minimise any ponding or surface run-off, it is predicted that water captured from within the irrigation area will be a result of a heavy rainfall event. Consequently, the water quality in the runoff dam is expected to be relatively fresh, low in nutrients and BOD, and hence odour issues from the collection dam are not expected to be an issue. Water quality in the runoff dam will be monitored on a quarterly basis with results reported to the Department of Environment and Conservation in the Annual Monitoring Report.

As the water in the runoff dam is expected to be of relatively good quality, the opportunity exists that it may be used to through irrigation to leach salts from the soil profile (if required). Irrigation from this dam has not been included in the water and nutrient balance calculations presented in this NIMP. In the event that it is required, nutrient loadings from the runoff dam irrigation will be calculated and included in environmental reports.

10 COMMUNITY CONSULTATION

ALS distributed a community information letter on 11 September 2007 informing key stakeholders of the proposed changes at the site. A copy of the letter is included in Appendix I. The letter was distributed to the following bodies:

- Neighbouring residents, including closest resident to the north and west;
- Water Corporation (owners of adjacent treated wastewater tree farm); and
- Torbay Catchment Group.

The letter outlined the proposal, with respect to the commencement of irrigation, and the increase in capacity of the site and details the measures that ALS propose to use to manage any potential impacts resulting from the changes. In addition, the opportunity was provided for stakeholders to give feedback or to request further information regarding the development. No comments have been received following distribution of the letter on 11 September 2007.

Copies of the Nutrient and Irrigation Management Plan will be distributed to the following regulatory bodies for information:

- Department of Water;
- City of Albany; and
- Department of Health.

Liaison has commenced with the Department of Health regarding the proposal and a number of conditions have been placed on the proposal due to the proximity of the proposed irrigation area to a free range pig operation. These include the establishment of an electric fence and a 5m buffer distance to the irrigation area. These conditions have been incorporated into the proposal. In addition, an "Application for Approval of a Recycled Water Reuse Scheme" has been submitted to the Department of Health and irrigation will not commence until approval has been received.

11 SITE MONITORING AND REPORTING

11.1 Additional Groundwater Monitoring Bores

In order to monitor any impact that the irrigation of treated effluent may have on the local groundwater, two additional groundwater monitoring bores will be installed on the site. The locations of the new bores MW6 and MW7 are shown on Figure 4. Samples will be collected as part of the quarterly monitoring to detect any changes in groundwater quality. Analysis will be undertaken at an approved laboratory, as is currently required by the existing licence. The parameters for which the samples will be tested are detailed in the following section.

11.2 Environmental Monitoring Program

Environmental monitoring is considered an important aspect of the ongoing success of the management of the increased volume of wastewater, and the reuse through irrigation. The proposed monitoring program will aim to accurately measure any potential impacts of the changes on the natural environment. Details of the environmental monitoring program are outlined in Table 18.

TABLE 18: ENVIRONMENTAL MONITORING PROGRAM

Monitoring Requirement	Monitoring Site	Frequency	Comment
Irrigation Water Volumes	Flow meter to Irrigation System	Daily	Daily irrigation volumes in kL/day and areas to which irrigation has taken place
Irrigation Water Quality	Irrigation water (Storage Dam)	Monthly	Total Nitrogen (TN); Total Phosphorus (TP); Electrical Conductivity (EC); Total Dissolved Solids (TDS); pH
Soil Sampling	Irrigation area	Monthly	Electrical Conductivity (EC)
Irrigation Water Quality	Irrigation water (Storage Dam)	Quarterly	Total Nitrogen (TN); Ammonium(NH ₄ ⁺); Nitrate (NO ₃); Total Phosphorus (TP); Filterable Reactive Phosphorus (FRP); Biochemical Oxygen Demand (BOD); Electrical Conductivity (EC); Total Dissolved Solids (TDS), Total Suspended Solids (TSS); pH
Runoff Dam Water Quality	Run-off Dam	Quarterly	Total Nitrogen (TN); Ammonium(NH ₄ ⁺); Nitrate (NO ₃); Total Phosphorus (TP); Filterable Reactive Phosphorus (FRP); Biochemical Oxygen Demand (BOD); Electrical Conductivity (EC); Total Suspended Solids (TSS); pH
Groundwater Sampling	Seven groundwater monitoring bores	Quarterly	Total Nitrogen (TN); Ammonium(NH ₄ ⁺); Nitrate (NO ₃); Total Phosphorus (TP); Biochemical Oxygen Demand (BOD); Oil and Grease, Electrical Conductivity (EC); Total Dissolved Solids (TDS); pH, and SWL
Soil Sampling	Irrigation area	Annually	Electrical Conductivity (EC), Phosphorus Retention Indices (PRI) using the Allan and Jeffery method
Soil Profile Monitoring	Irrigation area	Every three years	Phosphorus (P), Potassium (K), Sodium (Na)

12 CONCLUSIONS

This Nutrient and Irrigation Management Plan demonstrates the method by which Abbott's Liquid Salvage will manage their liquid waste facility to accept an increased waste volume of 20,000m³. It confirms that ALS will be able to reuse the treated effluent through irrigation to a blue gum plantation in a manner that is not detrimental to the environment. ALS are committed the continued operation of their liquid waste treatment facility in a manner that does not pose a risk to the local environment.

13 REFERENCES

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14 **DISCLAIMER**

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