



Wiluna Gold

Dewatering Discharge License Report (DDLR) Jan 2005 – Dec 2005

March 2006

AGINCOURT RESOURCES LIMITED

outback ecology

Dewatering Discharge License Report

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Executive Summary

Agincourt Resources, as the owner and operator of Wiluna Gold and Williamson Pit Mines, is submitting this report to satisfy the "Dewatering Discharge License Report" requirements outlined in DoE License No 5206/8. This report follows the annual Dewatering Discharge License report submitted in 2005.

Dewatering discharge to Lake Way from Wiluna Gold Mine is pumped from underground sumps to disused open pits for sediment removal. From the pit the water is pumped to the evaporation pond for further removal of sediment as well as evaporation. Water is then pumped from the evaporation pond to a tributary not far from the edge of Lake Way. The tributary enters Lake Way at the same place that West Creek enters the lake. The mouth of West Creek is used as a channel to discharge water onto the playa; Williamson pit discharges directly onto the playa from the causeway. The Wiluna Gold Mine pits are located on mining tenements M53/24-26,6,30,32,40,42,44,50,120,95,96,200,468 and L53/62, while the Williamson pit is located on M53/797.

Agincourt is licensed to draw from Williamson Pit and Wiluna Gold Mine a combined volume of 2,969ML per year (Williamson has a limit of 604ML and the Wiluna Gold Mine draw volume is limited to 2,365ML). In comparison the combined quantity of mine water discharged onto the Lake Way from Williamson Pit and Wiluna Gold Mine is 1,232ML, or 42% of the licensed draw volume.

The distribution of dewatering discharge from both Wiluna and Williamson Pits has remained within the predicted, localised footprints. Under dry lake conditions the observed impacts appear to be restricted to the formation of salt crust, and elevated salinity in the dewatering discharge footprints. The dewatering discharge footprints recorded elevated salinity and lower productivity than control sites, as expected. Levels of parameters tested as per conditions of the license were within guidelines levels, or can be attributed to local geology.

Since 1998, Agincourt Resources has contributed to a number of studies to determine the terrestrial and aquatic ecology of Lake Way, and monitor the potential impacts from dewatering discharge.

During the reporting period, Outback Ecology Services (OES) monitored the aquatic biology of Lake Way regionally and in the vicinity of discharge areas, to complement Agincourt Resources' water monitoring program. A variety of aquatic and terrestrial flora and fauna exist in the vicinity of the Wiluna Gold Mine and Williamson dewatering discharge points (outside the discharge footprints), and no impacts have been recorded to date. Data from ongoing studies will assist in the monitoring of dewatering discharges, in terms of quantity, quality and impact

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1.0 SITE DESCRIPTION

1.1 Location and Layout, Wiluna Operation, Lake Way

The Agincourt Resources Limited's ('Agincourt') Wiluna Gold Mine is located approximately 5km south of Wiluna, and nearby Lake Way is approximately 17km south east of Wiluna. The Wiluna Gold Mine discharges water from its underground operations at Wiluna, encompassing mining tenements M53/24-26,6,30,32,40,42,44,50,120,95,96,200,468 and L53/62. The Williamson pit is located within mining tenement M53/797 and is connected to the lake shore by a causeway located on M53/797 and 798. Dewatering discharge occurs at three discharge points on Lake Way. Wiluna Gold Mine discharge occurs via a 10 kilometre pipeline feeding into Lake Way at the same point as West Creek (**Plate 1, Figure 1**). The two Williamson discharge points are on the causeway approximately 1 and 1.5 kilometres west of the Williamson Open pit respectively (**Figure 2**). The primary discharge point discharges the mine dewatering water from Williamson Pit, while the backup discharge point is used only to discharge water accumulated in the causeway trench following periods of high rainfall. The Williamson pit is situated 4km from the western shore of Lake Way (**Figure 3**).

The Wiluna Gold Mine and Williamson Pit discharges occur under requirements outlined in DoE License No 5206/8.

The Williamson project area ('Williamson') is situated on the salt lake bed (**Plate 2**), and the surrounding district is characterised by gently undulating plains with mulga (*Acacia aneura*) and shrub steppe (*Hakea, Acacia* and *Triodia basedowii*) covering the sandy area (Beard 1990). The extensive salt lake systems in the region support halophyte communities (Agincourt 2004).

Plate 1 West Creek site for dewatering discharge into Lake Way

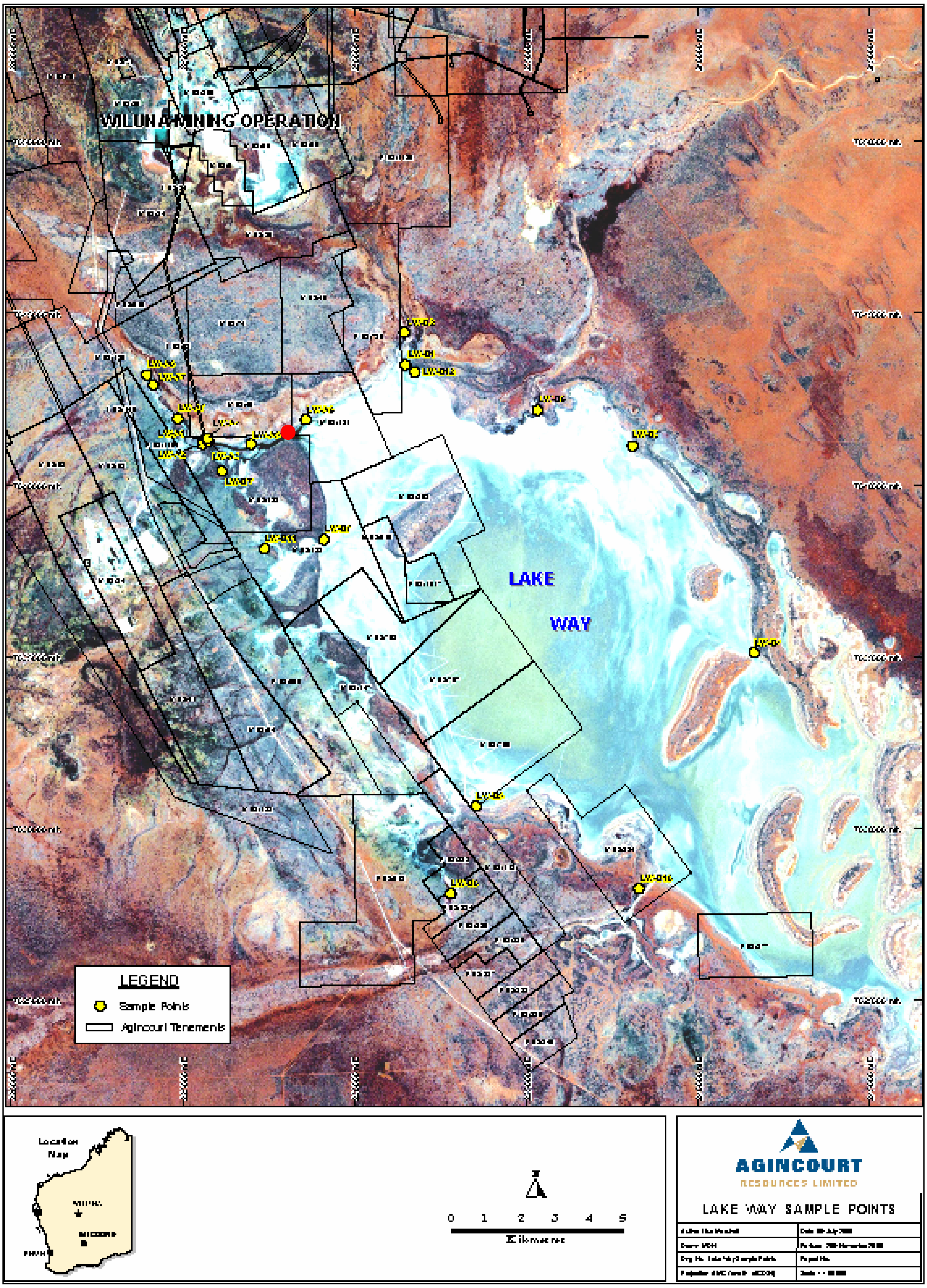

Figure 1 Wiluna Gold Mine and tenements on lake way, and dewatering discharge point for Wiluna Pit (red dot).

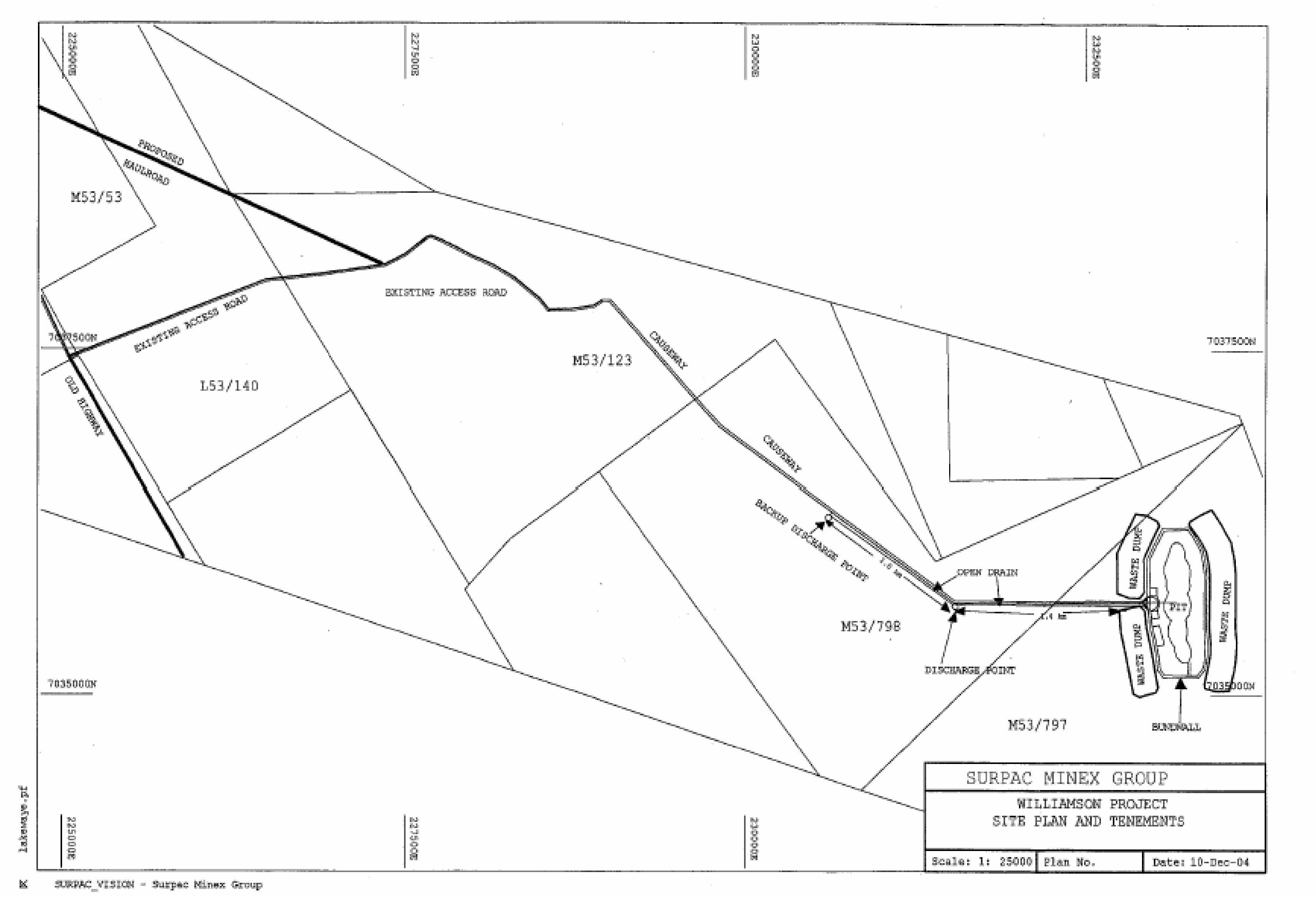

Figure 2 **Williamson Pit, primary and backup discharge points**

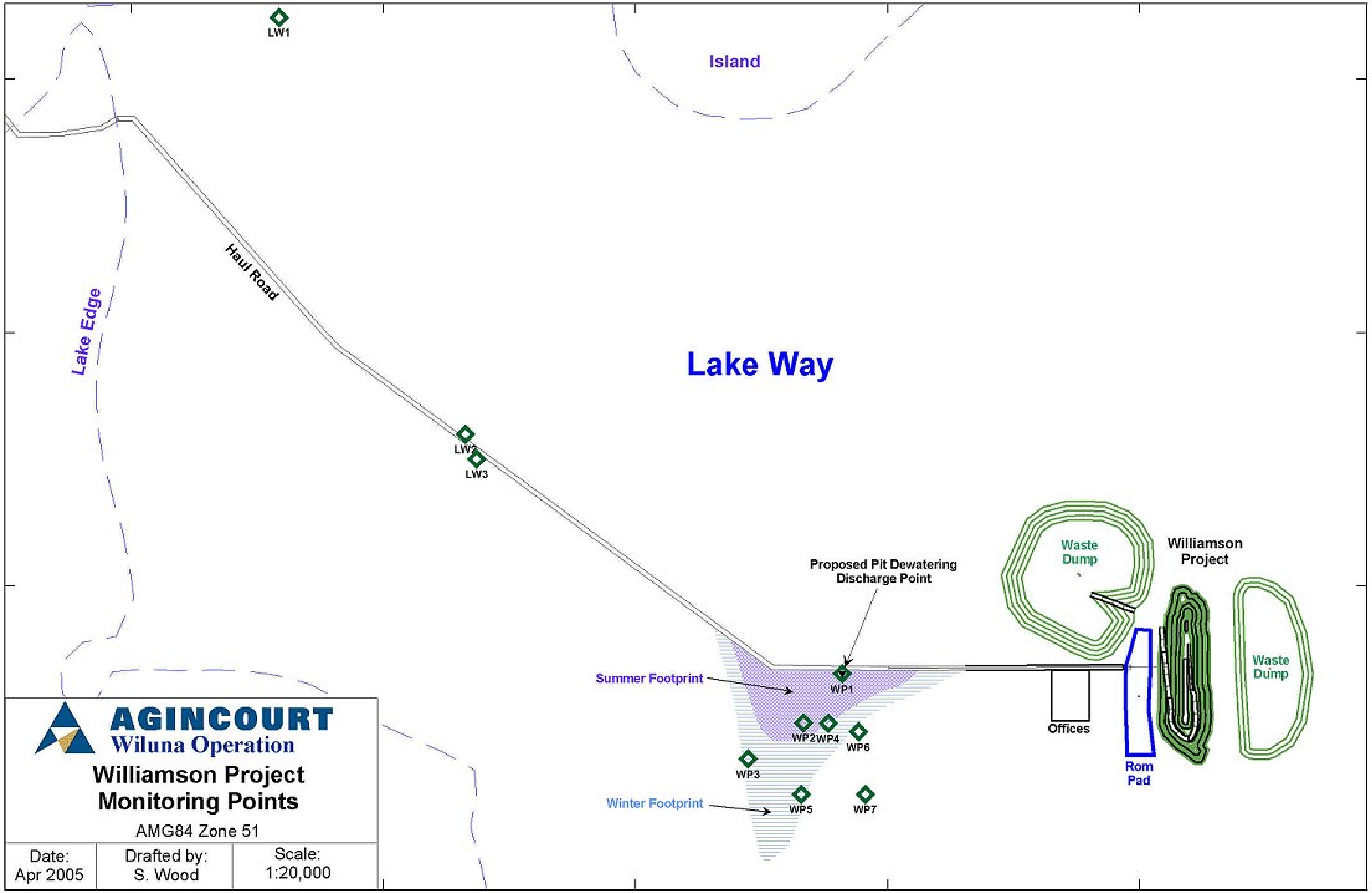

Figure 3 Williamson Pit, biological monitoring points

Plate 2 Satellite view of Williamson project area and dewatering discharge on Lake Way

1.2 Catchment, Drainage and Topographical Data

Lake Way is an episodic salt lake, approximately 270 km^2 in size. It is one of the most northern lakes in the palaeodrainage system known as 'Salinaland' (Timms, 1992). This system is believed to be the remains of palaeorivers, changed over time through erosion and climatic extremes. Sporadic high rainfall causes overflow from surrounding lakes, specifically Lake Violet, into Lake Way. The majority of catchment inflow to Lake Way comes from the north of the lake (**Figure 4**). Storms of approximately 1.2 year frequency (50 to 80 mm in a day) have intensities that are sufficient to generate runoff in the Gum, Cockatoo, Negara and Kukabubba creek tributary systems which impact on Lake Way (KH Morgan and Associates (Morgan), 2005). In times of sufficient flooding, this water flow continues from Lake Way via surface outflow of the palaeoriver southeast to Lake Maitland, with long term outflow through the Nullabor Plain into the Great Australian Bight.

The tributaries flowing into Lake Way from the "Wiluna" land system pass through gently undulating plains with areas of mulga shrubland (Acacia aneura) and shrub steppe (Hakea, Acacia and Triodia basedowii) that cover the sandy region (Beard, 1990), interspersed with salt flats and creek zones supporting large halophyte communities (Agincourt 2004).

Figure 4 Map of Lake Way showing direction of surface water flow (blue arrows)

1.3 Climate/Meteorological Data

The climate of the Wiluna area is described as desert (rainfall <250mm per annum), with summer and winter rain (Beard, 1990). The area typically experiences low rainfall and extreme temperatures. Mean temperatures range from 5.3 to 37.8 degrees Celsius, with temperatures ranging from -2.3 to 46.9 degrees Celsius (Bureau of Meteorology, 2006). The mean annual rainfall at Wiluna is approximately 250mm per year (**Table 1**), with occasional above-average rainfalls from tropical cyclones (Shire of Wiluna Online, 2006).

Table 1 Meteorological characteristics recorded in Wiluna region

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean	33.1	35.2	35.6	27.0	25.7	26.0	15.4	10.3	4.5	6.4	8.9	18.0	246.1
Highest Monthly	231.9	271.6	234.9	527.1	142.0	108.5	149.0	67.4	71.1	88.6	63.8	161.4	
Lowest Monthly	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Highest Daily	82.3	124.6	76.2	56.2	69.2	68.3	73.5	42.4	25.6	78.2	37.4	112.8	124.6
Mean Monthly Evaporation	334.8	260.4	235.6	162.0	111.6	86.0	80.6	111.6	168.0	238.7	273.0	303.8	2346.0

Rainfall recorded in Wiluna from January 2005 to December 2005 was a total of 140.2mm (**Table 2**). This amount is well below the yearly average, with May 2005 being the only month with rainfall in excess of the monthly average.

Table 2 Annual Rainfall, recorded from January 2005 to December 2005 in Wiluna Region (BOM, 2006)

Month	Total Rainfall
Jan-05	4.0
Feb-05	1.4
Mar-05	5.2
Apr-05	2.6
May-05	53.2
Jun-05	8.6
Total 6 mths	75.0
Jul-05	21.6
Aug-05	19.6
Sep-05	0.0
Oct-05	0.0
Nov-05	3.6
Dec-05	20.4
Total 6 mths	65.2
Total (2005)	140.2

2.0 DESCRIPTION OF THE RECEIVING ENVIRONMENT

2.1 Hydrology and Hydrogeology

Lake Way is commonly dry and salt-encrusted, but fills with fresh water after episodic rainfall events. Major flooding of Lake Way results with salinities decreasing possibly to as low as 5,000mgL^{-1} TDS (Morgan, 2005). It is common for the period following inundation to experience low rainfall, so that evaporation progressively reduces the lake volume to zero. This evaporation concentrates particles in the water, so that the latter stages of the drying cycle shows a progressive increase in water salinity. The hydroperiod, or the pattern of filling and drying of the lake, is a critical function of the biology, chemistry and physical characteristics of a wetland (Boulton and Brock, 1999).

At Lake Way there is a hypersaline, shallow water table with TDS concentrations approximately 240,000mg/L immediately below the surface of the lake playa (Morgan, 2002).

2.2 Flora and Fauna

Agincourt has funded a number of ecological studies since they began operations at Lake Way. Outback Ecology (OES) and Bennett Environmental Consulting have undertaken the majority of work in Lake Way, in addition to on site reports. Other independent, one-off studies have been completed by other organisations (ie WA Museum’s review of stygofauna).

2.2.1 Flora

The shoreline of Lake Way has a diversity of fringing vegetation in good condition (Bennett, 2002; Outback Ecology Services, 2004). This vegetation is subject to periodic inundation during large filling events and as such, must be able to cope with this inundation. Eight species from three families have previously been identified, with *Halosarcia* sp. (Samphires) being dominant. Halosarcias are able to colonise the shores of clay pans and salt lakes because of their tolerance to waterlogging, high salinity, or both. Different species have different preferences to these conditions, and as a consequence, halosarcias commonly display clear ‘zonation’, or separation due to habitat preferences (Datson, 2002). The most common *Halosarcia* species at Lake Way were *H. peltata* and *H. aff pruinosa*, which prefer the wetter, saltier forebeach area, and *H. undulata* and *H. indica* subsp. *bidens*, which are more common on the free-draining mid-beach to dune areas (Datson, 2002; OES, 2005).

2.2.2 Fauna

One of the most important roles salt lakes have in the global context is their role as feeding, refuge and breeding sites for many migratory and nomadic bird species (Williams 1998). OES has conducted a number of fauna studies on behalf of Agincourt. A baseline study of Lake Way in 2002 used a systematic trapping program at nine sites located in a range of vegetation associations around the lake edge, to trap and identify nine reptile species, one amphibian and one mammal species. Birds were surveyed opportunistically with 22 avian species identified. None of the species identified were considered priority one or rare species. Additional, more recent studies have focused on effective management of the lake to maintain the fauna diversity (OES, 2005).

2.2.3 Aquatic Ecology

OES have studied aquatic fauna in Lake Way with annual monitoring in 2004 and 2005 (OES, 2004, OES, 2005). These surveys have provided a 'snapshot' of ecological conditions at the time of sampling. Lake Way was partly inundated during the 2004 sample, and mostly dry during the 2005 sample. The limited data set shows variability in lake biota according to inundation. The aquatic ecology monitoring program tends to focus on sediment-dwelling biota and their resting stages, as the data is more comparable between wet and dry years.

Around 20 benthic (sediment-dwelling) algae, known as Benthic Microbial Communities (BMC's), have been identified in studies on the Lake Way playa. In baseline studies undertaken by OES in 2005, a total of five different diatom species (from the BMC's) were identified. All species recorded were common halotolerant taxa with samples dominated by *Navicula duerrenbergiana*, *Hantzschia amphioxys* and *Amphora coffeaeformis.*

OES have identified around six aquatic invertebrate taxa from four sites since the 2004 survey. Data is relatively limited; only one survey has occurred in a partial lake filling event (2004). In the most recent (May 2005) baseline survey of the Williamson Pit area, aquatic invertebrates were absent from sites with higher salinity, probably because the lake was mostly dry at the time of sampling. The *Parartemia* sp (fairy/brine shrimp) was the dominant taxa in Lake Way.

The aquatic species identified in the studies of Lake Way are typically salt-tolerant, and adapted to natural fluctuations in water quality and water level. These species can survive dry and/or saline conditions in salt lakes; as they produce resistant cysts that hatch in optimal conditions, lying dormant in the sediment until these conditions occur. This resistance and adaptability implies that the species may also be able to tolerate temporary increases in salinity due to dewatering discharge. Some species will only hatch when fresh water is present, but most are able to hatch in elevated water salinity, up to 50,000mg/L (OES, 2005). These conditions would occur when dry areas of the lake receive adequate rainfall, or when areas of pooled dewatering discharge are diluted by adequate rainfall (Campagna and John, 2003).

3.0 IMPACT ON RECEIVING ENVIRONMENT

3.1 Dewatering Discharge Volume

Williamson Pit and Wiluna Gold Mine are licensed to extract a combined dewatering volume of 2,969ML per year (Williamson Pit has a limit of 604ML and the Wiluna Gold Mine dewatering is limited to 2,365ML). The combined quantity of mine water discharged from Wiluna and Williamson Pits, in the twelve month period from January 2005 to December 2005, was 1,232ML, representing 42% of dewatering volume that Agincourt is licensed to extract over the time period. The amount discharged also represents 0.25% of the total estimated volumetric capacity of Lake Way (assuming the 27,000 hectare lake has an average depth of 1.5 metres) (Agincourt, 2004) (**Appendix A**).

The dewatering discharge flow rate to Lake Way varies according to the pit dewatering strategies. No water was discharged from Wiluna evaporation pond to the mouth of West Creek for January and February 2005, while the pump station was renewed. The pump station was fully operational during March, however the amount of dewatering discharge has been estimated as renewal of metering was only completed during this month.

Williamson Pit came into operation in July 2005, with no prior discharge.

Discharge from the Wiluna pit occurred at between of 26 – 72L/sec between March and December 2005. For Williamson Pit, the estimated flow rate for the first year of mining was 25 – 30L/sec (Agincourt, 2005), while the data from commencement of discharge in June 2005 shows an average rate of only 5.5 – 9.5L/sec.

In both wet and dry conditions, the dewatering discharges are localised, covering relatively small areas of the playa near the discharge outfalls. According to Morgan (2005), "Because of the extreme flatness of the lake bed, discharge water will rapidly either sink into the kopi silty surface and penetrate to the water level or, on saturation of the bed, will form a broad shallow sheet a few centimetres deep where it will rapidly evaporate under prevailing baric/temperature and wind conditions."

Observation shows that a combination of evaporation and infiltration into the saline groundwater system quickly dissipates any free water if discharge occurs in wet conditions. This means that the discharge rarely flows for distances greater than 3km (Agincourt, 2004).

At Williamson Pit, the predicted summer and winter footprints were determined in hydrological studies of the local area (Morgan 2005, **Figure 3**). Since commencement of dewatering discharge in 2005 from two locations, the actual dewatering discharge footprint appears to match closely with the predicted footprint (compare **Figure 3** with white salt crusting evident in **Plate 2**). A tail stemming from the discharge footprint in a westerly direction can be seen in **Plate 2.** This has occurred when the dewatering discharge is mixed with storm water following a period of above average rainfall. On these occasions substantial dilution of the dewatering discharge by storm water is expected to lower the average salinity of water in the footprint and the tail, reducing the impact of the discharged water (Bond, 2005). This implies that there have been no unexpected impacts in terms of discharge footprint, from the Williamson dewatering discharge.

3.2 Dewatering Discharge Quality

Assessment of water quality in Lake Way, to determine the impact of dewatering discharges on the ecosystem, involves comparison of the discharge data with a reference data set. The ANZECC 2000 Guidelines state that good management of a water body "can only be based on detailed information about the ecosystem being protected," and to identify physical and chemical stressors, the preferred approach is to "derive trigger values following the order: use of biological effects data, then local reference data (mainly physical and chemical stressors), and finally (least preferred) the tables of default values provided in the Guidelines".

Given that the ANZECC guidelines are not relevant to salt lake ecosystems, a set of local reference values for water and sediment quality from un-impacted lake areas has been collected through ongoing local and regional monitoring programs conducted by both Agincourt and OES (**Appendix B**).

Pit dewatering discharge has been monitored monthly over the reporting period, at two locations, for a variety of parameters as specified in DEP license (5206/8). According to this license,

- Water quality from the Wiluna Gold Mine discharge should be monitored monthly for total dissolved solids (TDS), pH, arsenic and total suspended solids (TSS).
- Bi-annual analysis of water for heavy metals As, Cd, Cr, Cu, Pb, Ni, Zn, Sb, Mn, Co, Se, and B as also completed, with the number of parameters tested exceeding the requirements of the license.
- Water quality from the Williamson Pit discharge should be monitored monthly (TDS, TSS, pH, Cl and As) and quarterly (metals, suite 2); the monitoring program has addressed these requirements.

Monthly samples were taken from the Wiluna Gold Mine's discharge pipeline and Williamson Pit discharge on to the lake playa. Water samples were taken for analysis to SGS (NATA registered laboratory) for Total Dissolved Solids (TDS), pH and Arsenic (As) and Total Suspended Solids (**Table 6**). Additional parameters were analysed quarterly at the sites surrounding the Williamson Pit discharge footprint (**Figure 3**), and bi-annually at sites surrounding West Creek (**Figure 7, Table 8**)

Condition W15 (b) of the DoE Licence states that the suspended solids in mine water discharged to Lake Way via West Creek (i.e. from Wiluna discharge) should not exceed 80mg/L. Over the reporting period levels of TSS in discharge via West Creek was significantly less than this stipulated requirement, with the maximum reading being recorded in September 2005 of 24.8 mg/L (**Appendix C, Table 6**).

The pH of water discharged at both sites was consistent throughout the reporting period, with readings within the control site ranges and ANZECC (2000) recommendations.

Comparison of levels cations and anions at the dewatering discharge points and control sites shows variability in the concentrations of a number of water quality parameters (**Table 4**). While some cations and anions at Williamson discharge were greater than suggested control levels, the concentration is likely to be diluted rapidly due to intermixing with the water of Lake Way. It should also be noted that control site data is limited, therefore that the interpretation of data is limited. Further collection and collation of control site data is required to validate the full range of values expected in natural conditions.

The only heavy metal parameter measured at a level higher than the guidelines was that of Arsenic. The following graphs (**Figure 5**) show the trends for individual sampling sites solutions since the sampling program commenced in 1998. The guideline value is plotted on the same graph for comparison purposes. Not all sites are shown because some sites are usually dry so no solution samples are obtained.

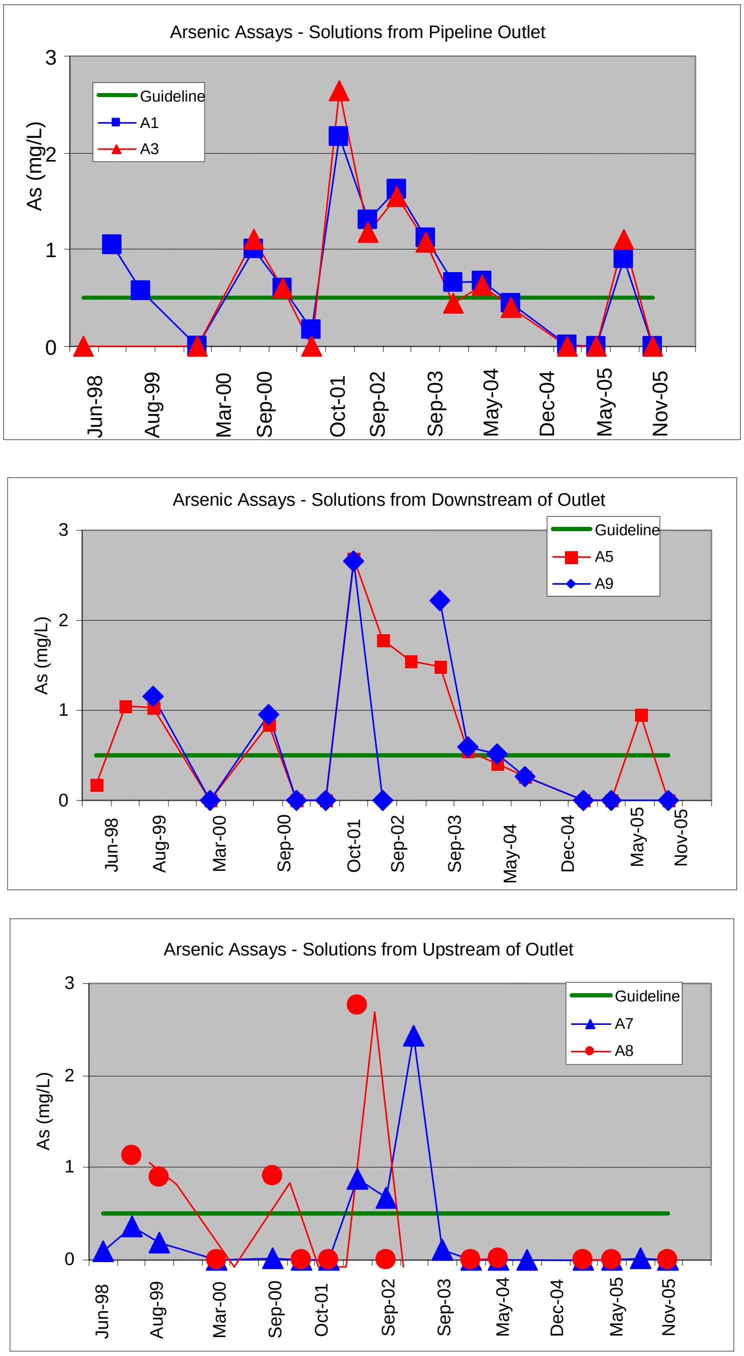

Figure 5 Solution Assays - Arsenic (mg/L)- Active Areas

There was a peak in arsenic levels in April 2002, but this peak was also evident in the background areas so it is likely that these high readings are due to a laboratory error. It was stated in the 2003 report that if future readings supported this supposition the readings for April 2002 would be omitted from calculations. The trend has certainly lowered, however a smaller peak can be seen over the course of the 2005 reporting period which has not been reflected in the results taken from control sites. These results and trend will be reviewed in the next report, and additional assessment of the anomalies will occur if appropriate.

Chromium levels were higher than ANZECC (2000) guidelines at a number of sites, for both months tested. Of the sites tested LW-A1 continued to have high readings of Chromium when compared with previous studies completed by OES (2004). Sites LW-A5, LW-A7 and LW-A8 also had readings higher than quality guidelines in both months tested, indicating major fluctuations in Chromium levels around the lake, as sites LW-A7 and LW-A8 (on the eastern shore) have previously been highlighted in studies by OES (2004) as have the lowest reported levels of Chromium. As with Arsenic levels, it is highly likely that Chromium concentrations reflect local geology, naturally accounting for fluctuations in the measured Chromium levels at specific sites.

3.3 Sediment Quality

3.3.1 Wiluna Gold Mine Discharge at West Creek

As stipulated in 15(d) of the DoE license 5206/8 sites surrounding Lake Way and the West Creek discharge point were analysed for Arsenic bi-annually. The graphs displayed below show the trends for individual sampling sites levels of Arsenic in sediments since the sampling program commenced in 1998 (**Figure 6**)The 'background' value is plotted on the same graph as a guideline.

From the three graphs of 'active' areas it can be seen that historically, the only sediments that have arsenic assays above background levels are the samples LW-A1 and LW-A3. These are the sediment samples taken from 50 metres upstream and 50m downstream of the pipeline discharge, and have definitely been impacted by fines settling out from mine water. This occurrence of fines in the mine water ceased many years ago due to a change in the dewatering strategy (pumping the water via a pit rather than settling ponds) and it is noted that the trend since then has been downward, especially for LW-A1. It is highly likely that arsenic is naturally high in Lake Way therefore the concentrations probably reflect local geology (OES, 2004).

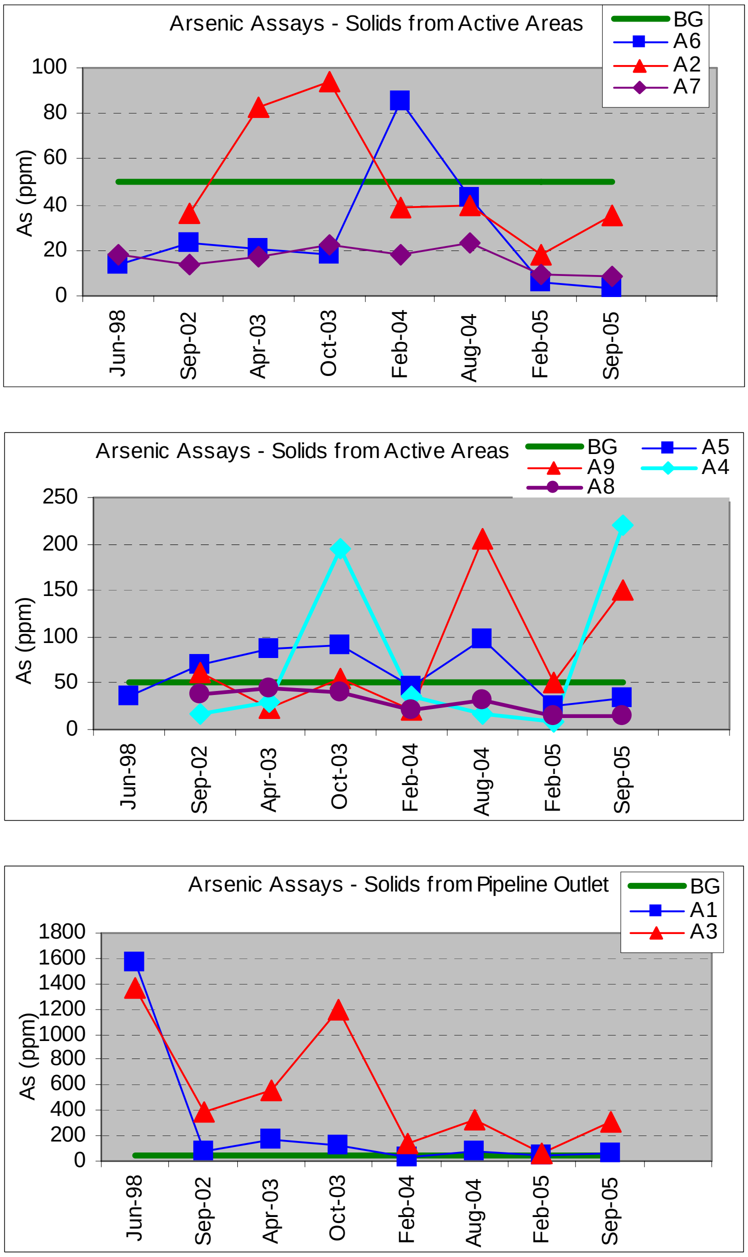

Figure 6 Sediment Assays - Arsenic (where ppm equals mg/kg) - Active Areas

3.3.2 Williamson Pit Discharge

Baseline assessments for sediment quality at sites surrounding the Williamson pit discharge footprint were carried out prior to July when dewatering began (OES, 2005). Additional sediment assessments will be completed in May 2006 as stipulated in 16(a) of DoE license, in compliance with the "Monitoring schedule for Williamson Project".

3.4 Salt Balance

In natural cycles, the rate of salt accumulation is controlled by the flow rate of water containing salt to the lake surface, via rainfall and runoff. Evaporation in the region typically exceeds rainfall, therefore accumulation of salt occurs. On an equivalent area basis, the production of dewatering salt will be much higher than the natural accumulation rate, by the sum of evaporative effects from rain, stormflow inundation from the adjoining tributaries and from upflow of groundwater (Morgan, 2005).

During the assessment period a total of 904ML was discharged via the Pipeline on to Lake Way, at the mouth of West Creek (**Table 3**) at an average salt concentration of 132,222 mg/L. The average salt load to the lake bed was 13,200 tonnes per month, equating to 119,000 tonnes over the nine months that dewatering discharge occurred.

For Williamson Pit, according to predictions (Morgan, 2005): “Chemical analysis indicates that of the estimated 359,510 tonnes of salt to be discharged to the lake surface, approximately 324,000 tonnes will be highly soluble sodium and potassium chloride salts which will rapidly, with rain and flood, disperse into the sub-lake groundwater which is already at a salinity level of the discharge water (ie 285,000mgL^{-1}). Approximately 35,000 tonnes of salt will remain as less soluble precipitates such as gypsum and will become part of the naturally aggrading lake bed or be moved by wind ablation to the sand dune areas.”

Over the reporting period (since commencement of discharge in July 2006), the Williamson Pit discharged 142ML onto Lake Way at an average salt concentration of 283,333 mg/L. This is equivalent to a total salt loading of only 40,233 tonnes – considerably less than the original estimate of 359,000 tonnes.

This implies that for the combined discharge amount from Wiluna and Williamson discharge of 1045ML, approximately 160,000 tonnes of salt was deposited onto the lake surface during the reporting period. This deposited salt either developed the salt crust via evaporation, or was lost to subsurface brine via infiltration (with vertical movement of ~30 - 50cm of sediments occurring due to rainfall or evaporation processes).

Morgan (2005) states that; “Discharge water will only spread out on the lake bed when the dry lake bed sediment becomes saturated and discharge water outflow rate exceeds the rate of displacement of hypersaline water in the lake bed sediments. Therefore, the actual volume of solids that are left behind will be considerably less than the above figures quoted for total salts in the discharge water. This is also expected to occur for the Wiluna Gold Mine discharge. Displacement of lake sediment water by discharge water of similar salinity will result in hydraulic re-adjustment with no material impact on lake hydrology or hydrochemistry.”

3.5 Assessment of Impact to Ecosystems

The impacts of dewatering discharge quality are monitored by considering changes or differences in water and sediment quality and the potential for ecological impacts. Agincourt has commissioned a number of studies that assisted with the assessment of impact on the lake ecosystem.

3.5.1 Summary of Key findings

3.5.1.1 Flora

Dewatering discharge at Lake Way may result in the fringing flora (*Halosarcia* sp) becoming submerged and/or subjected to higher than normal salinity. The combined effects of salinity and water logging could potentially result in the death in some species of Halosarcia (Datson, 2002).

Wind-driven movement of surface water (seiching) and internal drainage may cause dewatering discharge to pool and be redistributed in a particular area of a lake. If that area is near the shore of the lake, the fringing flora nearest the edge of the pooled discharge may be impacted by above-average salinity and water logging conditions.

According to surveys completed, there is currently no evidence that the Wiluna Gold Mine or Williamson Pit dewatering discharges have impacted fringing flora at Lake Way. This is primarily because the dewatering discharges are focused on the lake playa away from the lake fringe, and/or because the internal drainage patterns have restricted the distribution of dewatering discharge.

While flooding events may pose a risk to flora if saline dewatering discharge is mobilised, the likely flooding scenarios for Lake Way suggest significant dilution of salts. Studies of the lake in 2004 after a partial filling (minor rainfall) event showed that surface water salinity was in the order of 50,000mgL^{-1} to 92,000mgL^{-1} TDS (OES, 2004).

Major storm events (one in ten to twenty years) are expected to result in major flooding of Lake Way with local salinities decreasing possibly to as low as 5000mgL^{-1} TDS. If water abutted the edge of the lake in these conditions, it is likely that salinity would be low enough to avoid adverse effects on the fringing vegetation.

3.5.1.2 Fauna

In terms of aquatic biota, algal and invertebrate taxa previously recorded from the surface sediment in Lake Way were all halotolerant (salt tolerant) species. Like many inland salt lakes in Western Australia, productivity in Lake Way appears to be confined to the deeper, peripheral littoral zones of the playa.

In the Williamson Pit baseline (pre-discharge) survey (2005), higher invertebrate numbers were recorded at the deeper causeway sites, rather than the (then proposed) Williamson Pit sites near the centre of the lake, because the latter are elevated and tend not to collect water to facilitate aquatic life cycles.

It was expected that the Wiluna and Williamson dewatering discharge footprints will record higher salinities than other areas in the lake, and hence, these footprints would be less productive. The limited 2004 and 2005 data sets support this, and the active breeding and abundance of the *Parartemia* in other areas of the lake suggest that dewatering discharge impacts are effectively restricted to the localized to the discharge footprints. Subsequently, there appears to be no impact of dewatering discharge on the avian fauna of Lake Way (OES, 2005).

Assessment of the lake in full inundation conditions is required to validate the theoretical dilution of discharge-sourced salt (as mentioned in 3.5.1.2), to allow effective breeding of aquatic biota.

3.5.2 Significance of Lake Way to Declared Rare or Priority Flora and Fauna – Ecological Studies

A previous investigation by OES (2002) on the western shore of Lake Way concluded that no rare, threatened or endangered fauna species were recorded from the area, although there were priority species present.

Stygofauna have been recorded on the northern end of Lake Way in calcrete and cavernous formations. In studies undertaken by Morgan (2002) it was found that there are no developments of calcrete or cavernous formations within six kilometres of the Wiluna mine sites, and that the dewatering operations will not impact the existing stygofauna habitats.

A number of significant waterbird species potentially occur at Lake Way (Bancroft and Bamford, 2004), and are protected under international treaties including China Australia Migratory Bird Agreement (CAMBA), the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals), and the Japan Australia Migratory Bird Agreement (JAMBA). These species include Great Egret (Ardea alba), Common Sandpiper (Actitis hypoleucos) and the Red-necked Stint (Calidris ruficollis) (OES, 2005). Agincourt commissioned a study with OES in 2005 to develop effective management guidelines for waterbirds of Lake Way, in line with the new Williamson Pit dewatering discharge coming online in July 2005. The current biological monitoring program shows that there is no evidence of impacts to waterbirds on Lake Way.

3.5.3 Summary

The level of impact of dewatering discharge on the Lake Way ecosystem is largely affected by climatic conditions. Impacts, in terms of elevated salinity and lower productivity on the playa, appear to be restricted to a localized area in the vicinity of the dewatering discharge outfalls, within the discharge footprint. For the new Williamson Pit, the actual and predicted sizes and shapes of the dewatering discharge footprint are aligned, and the pre-discharge survey showed this area was naturally of low productivity.

At other Goldfields salt lakes (i.e. Lake Carey), dewatering discharge impacts are more noticeable during dry conditions, but appear to be temporarily ameliorated in wet conditions. This is also likely to be the case in Lake Way. Survey of the lake in fully inundated conditions would verify this.

Historical discharge sites on other large salt lakes in WA show evidence of “recovery” in terms of sediment and water chemistry, and biodiversity, following adequate inundation and flushing. The nature and time frame of “recovery” requires further clarification for dewatering discharge sites on Lake Way.

To date, the localized impacts have been restricted to the playa of Lake Way, with no evidence of dewatering discharge impacts to terrestrial flora in the vicinity of the discharge points.

4.0 CONCLUSION

Agincourt is committed to the monitoring of dewatering discharge and lake ecology on the Lake Way system. The following conclusions have been made thus far:

1. Agincourt's collection of water quality and quantity data has complied with the requirements set out in DoE License No. 5206/8
    a. For the Wiluna discharge at the mouth of West Creek
        1. A monthly analysis of water quality was completed for total dissolved solids, pH, arsenic and total suspended solids, and the volume of water discharged was determined, as stipulated in the license;
        2. Total suspended solids levels were well below the required level of 80mg/L;
        3. Bi-annual analysis of lake water (when water levels permitted) for heavy metals was exceeded with a number of additional parameters being tested;
    b. For the Williamson pit discharge
        1. A monthly analysis for total dissolved solids, pH, arsenic, chloride and total suspended solids was undertaken as stipulated in the license;
        2. Quarterly assessment of additional parameters was undertaken as per stipulated requirements;
    c. Results were within guideline levels as stipulated by ANZECC (2000)
2. The distribution of dewatering discharge from both Wiluna and Williamson Pits has remained within the predicted, localised footprints;
3. Under dry lake conditions the observed impacts appear to be restricted to the formation of salt crust, and elevated salinity in the dewatering discharge footprints;
4. The dewatering discharge footprints recorded elevated salinity and lower productivity than control sites, as expected;
5. A variety of aquatic and terrestrial flora and fauna exist in the vicinity of the dewatering discharge points (outside the discharge footprints) at Wiluna Gold Mine and Williamson Pit, and no impacts have been recorded to date;
6. Data from ongoing studies will assist in the monitoring of dewatering discharges, in terms of quantity, quality and impact

5.0 REFERENCES

Agincourt Resources (2004) Briefing document. Agincourts lake Way Project. February 2004. Agincourt Resources, Wiluna, Western Australia

Agincourt Resources (2005) Notice of Intent: Wiluna Operations, Williamson Project. Agincourt Resources, Wiluna, Western Australia

Agincourt Resources (2005) Addendum to Notice of Intent, Williamson Project. Agincourt Resources, Wiluna, Western Australia

AGC Woodward Clyde (1992) Process Water Supply Study in Lake Way Area - For WMC Services Pty Ltd (Vol. 1-2).

ANZECC (2000). Australian and New Zealand Environment and Conservation Council, Australian Water Quality Guidelines for Fresh and Marine Waters.

Bancroft, W. and Bamford, M. (2004) Review of the Wetland Avifauna of Lake Way. M.J. and A.R. Bamford, Consulting Ecologists, Kingsley, Western Australia.

Batley, G.G., Humphrey, C.L. Apte, S.C. and Stauber, J.L. (2003) A guide to the application of the ANZECC/ARMCANZ Water quality guidelines in the Minerals Industry. ACMER

Beard, J.S. (1990). Plant life of Western Australia. Kangaroo Press. Pty Ltd.

Bennett (2002). Vegetation areas impacted by construction of a causeway for exploration drilling at Lake Way Wiluna Gold Mine. Bennett Environmental Consulting Pty Ltd, Gooseberry Hill, Western Australia.

Berkman, D.A. (1989) Field Geologist's Manual, Third Edition. The Australasian Institute of Mining & Metallurgy.

Bond, K (2006) Personal Communication via email, April 2006

Boulton, A.J. and Brock, M.A. (1999). Australian Freshwater Ecology – Process and Management. Cooperative Research Centre for Freshwater Ecology. Gleneagles Publishing. Australia

Bureau of Meteorology (2006, daily updates) [Online]. Available: http://www.bom.gov.au/index.shtml [2006, 23 March]

Dames and Moore (1996a) Letter: Predicted Flows for Windich Creek.

Datson, B (2002) Samphires in Western Australia – a field guide to Chenopodiacea Tribe Salicornieae. Department of Conservation and Land Management, Perth WA

Great Central Mines Limited (1998) Harmless Discharge to Land - Mine Water Discharge to Lake Way, June 1998.

John, J (2003) The Biology and Chemistry of Temporary Waters. Presented at the Workshop on Water Quality Issues in Final Voids, Salt Lakes and Emphemeral Streams in May 2003. ACMER, Perth.

John Consulting Services (1992) Wiluna Gold Mine Water Management – Environmental Considerations, February 1992.

Morgan (1998) Lake Way Palaeochannel, Unpublished Report, June 1998.

Morgan (2002) Hydrogeological Impact Development of the Williamson Pits Lake Way for Newmont Wiluna Operations, March 2002

Morgan (2005) Answers: Draft notice of intent queries for Williamson Pit for Agincourt Resources Limited, February 2005.

Morgan (2005) – Possible Dilution Factors for Lake Way. 16 February 2005

OES (2002) Lake Way Baseline Fauna Studies. Report written by Outback Ecology Services, 2002, prepared for Agincourt Resources.

OES (2004) Lake Way Baseline Study. Report written by Outback Ecology Services, June 2004 prepared for Agincourt Resources.

OES (2005) Waterbird Management Guidelines for Lake Way. Report written by Outback Ecology Services, August 2005, prepared for Agincourt Resources

Shire of Wiluna Online (2006, 20 Sep 04 – last update) [Online]. Available: http://www.wiluna.wa.gov.au/ [2006, 21 March)

Taiti, S. and Humphreys, W.F. (2001) New Aquatic Oniscidea (Crustacea:Isopoda) from groundwater calcretes of Western Australia

Williams, W.D. (1998) Diversity and Evolution of the fauna of dryland wetlands, Guidelines of Lake Management, Vol 6. Management of inland saline waters. International Lake Environment Committee, United Nations Programme.

Appendix A
Historical Dewatering Discharge Quantity

Table 3 Total Dewatering Discharge onto Lake Way from Wiluna and Williamson Pits

Month	Dewatering Discharge (KL)	
	Wiluna	Williamson Pit
Jan-05	0	0
Feb-05	0	0
Mar-05	186624	0
Apr-05	101392	0
May-05	69523	0
Jun-05	69336	23836
Jul-05	69972	25263
Aug-05	109377	24234
Sep-05	135007	18426
Oct-05	156273	16427
Nov-05	69275	14383
Dec-05	123885	18996
Total	1090664	141565
Total Discharge		**1232229**

Appendix B

Control Site Locations and Ranges

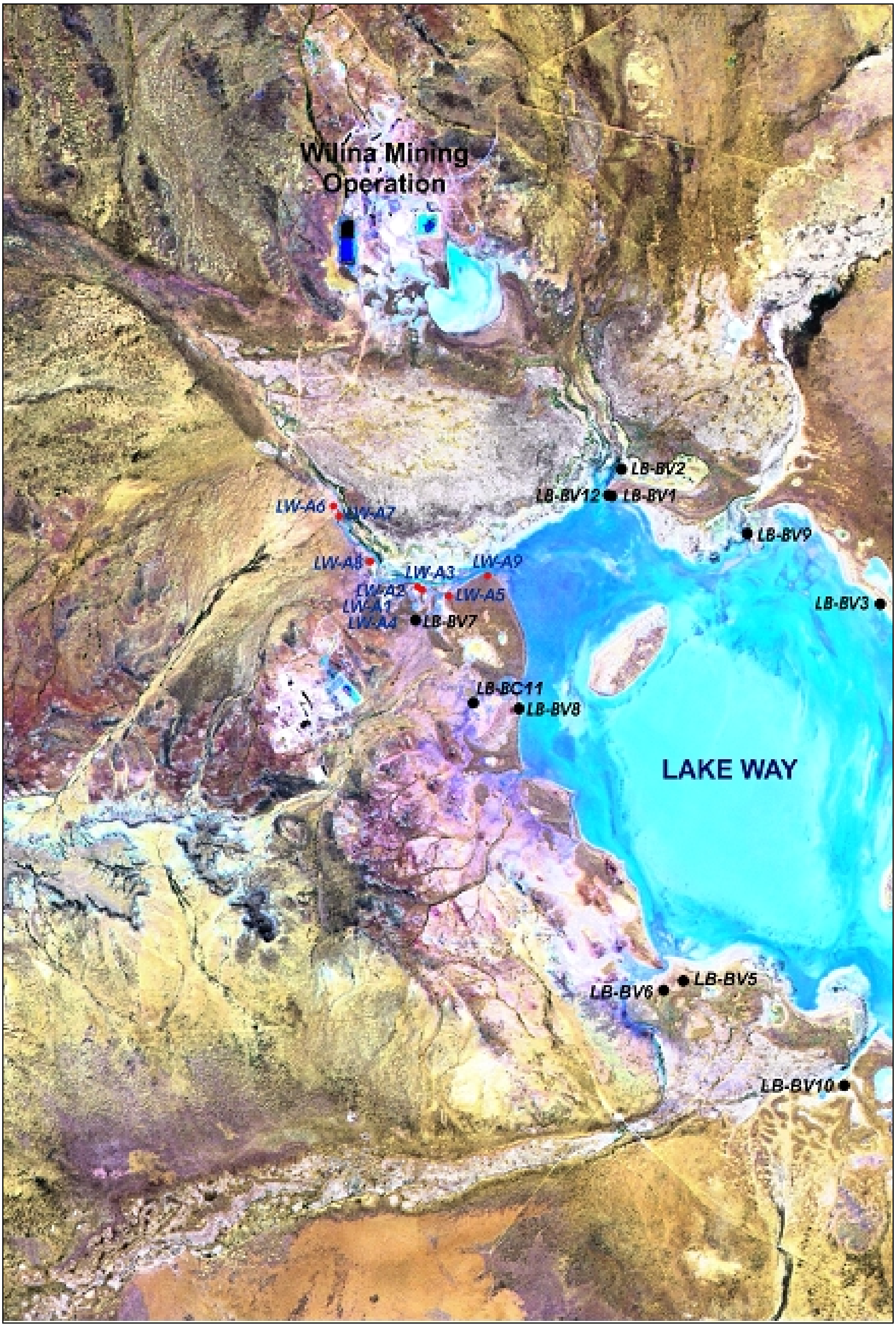

Figure 7 Location of Lake Way Control Sampling Sites

Table 4 Water Quality Ranges Lake Way Playa/Creek with ANZECC (2003) Marine Trigger Values (as at 2nd March, 2006) Lake Way values obtained from Agincourt and OES surveys of control sites, since 2000

Parameter*	Playa	Upper Quartile	N playa	Creek	Upper Quartile	N Creek	ANZECC Trigger Values**
Arsenic	BD – 0.63	0.018	9	BD – 2.76	0.6025	28	ID
Boron	0.11 – 9.41	1.3	13	0.1 – 37.17	17.5	47	ID
Barium	0.07 – 0.089	0.07	2				
Berelium	BD	BD	2				
Calcium	454 - 1100	1045	10	740 – 860	830	2	-
Cadmium	BD – 0.04	0.025	18	BD – 1.1	0.025	47	0.036
Chlorophyll a	BD – 0.0072	0.0024	5	BD	BD	2	-
Chlorine	28500 – 85800	72 325	10	15000 – 69000	55500	2	ID
Cobalt	BD	BD	13	BD – 0.96	0.25	47	0.15
Chromium	BD – 0.25	0.25	18	BD – 0.49	0.25	47	0.085
Copper	BD – 0.25	0.25	18	BD – 0.9	0.25	47	0.008
Iron	BD	0.05	5				
Bicarbonate	24 – 82	78	10				
Mercury	BD	BD	18	BD – 0.001	0.0002	47	0.0014
Potassium	1500 - 6300	5165	10				
Magnesium	1040 - 6120	4963	10				
Manganese	BD – 0.482	0.25	13	BD – 3.68	0.25	47	ID
Sodium	13500 – 54400	48650	10				
Nickel	BD – 0.5	0.25	18	BD – 4.4	0.25	47	0.56
Lead	BD – 0.27	0.25	18	BD – 13	0.25	47	0.012
pH (pH units)	5.6 – 8.82	7.15	10	6.8 – 9.6	6.95	2	
Tin	BD – 0.85	0.05	13	BD – 2.5	0.09	47	
Selerium	BD – 0.18	0.052	18	BD – 1.722	0.1	47	
Sulphate	11000 – 15700	15400	10				
Strontium	7.56 – 11.8	11.7	2				
TDS	10560 –229800	184250	10	2 700–260000	105000	2	
Total N	4.8 – 18.8	14.1	5				
Total P	0.14 – 2.6	0.52	5				
Uranium	BD – 0.015	0.005	2				
WAD CN	BD	BD	5				
Zinc	BD – 0.7	0.25	13	BD – 1	0.25	47	0.043

* All units are in mg/L unless otherwise stated

**Trigger values for marine water for protection of 80% of species

Table 5 Sediment Quality Ranges Lake Way Playa/Creek compared with ANZECC (2003) Trigger Values (as at 2nd March, 2006) Lake Way values obtained from Agincourt and OES surveys of control sites, since 2000

Parameter*	Playa	Upper Quartile	N Playa	Creek	Upper Quartile	N Creek	ANZECC Trigger Value**
Arsenic	2.8 – 67	19.25	40	BD – 85	23	100	20
Boron	10 – 165	66	40	23 – 340	178.8	86	
Calcium	1000 - 6100	2518	14	3900 - 4400	4275	2	
Cadmium	BD – 1	0.5	40	BD – 1.2	0.25	97	1.5
Chlorine	12000 - 54000	18575	14	19000-76000	61750	2	
Cobalt	BD – 17	7.9	40	BD – 48	12.3	92	
Chromium	BD – 785	173	40	9 – 1960	196.3	101	80
Copper	7 – 112	22.3	40	5 – 108	24.3	101	65
Bicarbonate	220 - 5500	2495	6	5700 - 6200	6075	2	
Mercury	BD	BD	6	BD	BD	2	0.15
Potassium	990 – 5000	1305	14	1600 – 4100	3475	2	
Magnesium	640 – 3700	1263	14	2200 – 4500	3925	2	
Manganese	24 – 525	211.8	40	77 – 979	266.5	99	
Sodium	8 000 – 40000	11905	14	13000–48000	39250	2	
Nickel	BD – 63	23.3	40	BD – 165	25.3	99	21
Nitrate	BD	BD	6	BD	BD	2	
Lead	BD – 24	9	40	BD – 53	11	100	50
pH (pH units)	7.5 – 8.6	8.2	14	8.2 – 8.6	8.5	2	
Antimony	BD – 8	2.5	40	BD – 11	4	109	2
Selerium	BD – 10	2.5	14	BD – 27	0.875	91	
Tin	BD	BD	8				
Sulphate	9500 – 53000	45350	8	22000-43000	37750	2	
Strontium	31 – 1030	754.3	8				
TOC	BD – 1.2	1.2	8				
Total N	190 – 750	370	14	2800 – 3800	3550	2	
Total P	12 – 290	180	14	310 - 350	340	2	
TSS	22000–150000	79600	14	52000-69000	64750	2	
WAD CN	BD	BD	6	BD	BD	2	
Zinc	Jul-61	29.3	40	8 - 156	39.5	99	200

* All units are in mg/kg unless otherwise stated

** Trigger values from ANZECC's Interim Sediment Quality Guidelines

Appendix C

Quality Dewatering Discharge and Sediment

Table 6 Monthly Dewatering Discharge Assessment

Parameter	Jan-05 to Mar-05 No	Apr-05 Wiluna Discharge	May-05 Wiluna Discharge	Jun-05 Wiluna Discharge	Jul-05 Wiluna Discharge	Jul-05 Williamson Discharge	Aug-05 Wiluna Discharge	Aug-05 Williamson Discharge
Arsenic	N/A	2	1.4	0.62	1.8	0.18	1.48	0.004
Chloride	N/A	N/A	N/A	N/A	N/A	140000	N/A	159000
TDS	N/A	155200	150000	101700	108800	260000	126000	270000
TSS	N/A	15	5	18.8	9.6	30	8	53
pH (pH units)	N/A	7.35	7.63	7.57	7.7	6.7	7.79	7.2

Parameter	Sep-05 Wiluna Discharge	Sep-05 Williamson Discharge	Oct-05 Wiluna Discharge	Oct-05 Williamson Discharge	Nov-05 Wiluna Discharge	Nov-05 Williamson Discharge	Dec-05 Wiluna Discharge	Dec-05 Williamson Discharge
Arsenic	0.83	0.006	1.02	0.1	1.05	0.004	0.38	0.035
Chloride	N/A	170000	N/A	160000	N/A	155000	N/A	150000
TDS	98500	260000	107200	300000	137800	320000	170000	290000
TSS	24.8	51	19.8	N./A	14.8	94	17.3	N/A
pH (pH units)	7.73	6.9	7.72	7	7.97	7	7.82	5.8

* units mg/L unless otherwise stated

Table 7 Quarterly and Half yearly Dewatering Discharge analysis

Parameter (mg/L)	Jul-05		Oct-05	Dec-05	
	Wiluna Discharge	Williamson Discharge	Williamson Discharge	Wiluna Discharge	Williamson Discharge
Aluminium	0.1	<0.1	N/A	<1	1
Antimony	N/A	<1	<0.1	N/A	<0.1
Barium	N/A	<2	<0.05	N/A	<0.05
Bicarbonate	240	26	35	300	55
Boron	4.2	1.2	1.2	2.6	4.2
Bromine	74	32	54	100	92
Cadmium	0.1	<0.05	<0.05	N/A	<0.05
Calcium	640	390	330	490	330
Carbonate	<1	<1	<1	<1	<1
Cation/Anion Balance	N/A	-0.0051	1.72	N/A	-0.18
Chlorine	70000	140000	160000	98000	150000
Chromium	<0.05	<0.05	<0.5	N/A	<0.5
Conductivity (*u* s/cm)	160000	230000	230000	200000	230000
Copper	<0.05	<0.05	<0.5	N/A	0.7
Fluoride	2	<0.1	<0.1	0	<0.1
Iron	<0.5	<0.5	1.2	<0.5	<0.5
Lead	<0.05	<0.05	<0.5	N/A	<0.5
Magnesium	4700	8300	11000	7200	10000
Manganese	0.05	N/A	1.6	N/A	11
Mercury	N/A	<0.0005	<0.0001	N/A	<0.0001
Nitrate	120.0	42.0	41.0	140.0	3.4
pH (pH units)	7.9	6.7	7.0	7.8	5.8
Phosphorus	N/A	<1	<0.3	N/A	0.6
Potassium	2400	7100	8600	3600	7400
Radium		0.783	0.487		0.8
Selenium	<0.005	<0.05	<0.005	N/A	<0.005
Silica	24	<20	22	<20	22
Silver	N/A	<0.1	<0.1	N/A	<0.1
Sodium	45000	82000	99000	65000	90000
Strontium	N/A	8.6	11	N/A	2.8
Sulphate	24000	28000	36000	39000	35000
Sum of Ions	N/A	265920	315010	N/A	292790
TDS	140000	260000	300000	170000	290000
Tin	N/A	<5	<0.1	N/A	<0.1
Tellurium	N/A	<0.1	<0.01	N/A	<0.01
Tungsten	N/A	27	<2	N/A	0.002
Zinc	<0.05	0.05	0.6	N/A	0.7
Uranium	N/A	0.005	0.004	N/A	<0.001

Table 8 Bi-annual water quality assessment for heavy metals at sites around Lake Way, Wiluna Pit Discharge

Sites	LWB01		LWB02		LWB03		LWB04		LWB05		LWB07		LWB08		LWB09		LWB10		Detection
Parameters (mg/L)	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Limit
Boron	170	340	150	180	46	29	30	42	75	76	N/A	38	36	32	N/A	140	N/A	270	5
Chromium	30	47	17	18	36	29	16	17	39	69	N/A	200	81	340	N/A	57	N/A	41	5
Zinc	19	22	8	9	15	7	7	10	13	24	N/A	22	18	22	N/A	34	N/A	16	5
Arsenic	9.3	29	8.1	5.2	3.7	3.3	6.2	3.9	5.9	5.9	N/A	15	15	24	N/A	7.1	N/A	17	0.5
Cadmium	<0.5	<0.4	<0.5	1.2	<0.5	<0.4	<0.5	<0.4	<0.5	<0.4	N/A	<0.4	<0.5	<0.4	N/A	<0.4	N/A	<0.4	0.5
Cobalt	8	19	7	16	<5	<5	<5	<5	<5	<5	N/A	5	5	5	N/A	5	N/A	<5	5
Copper	17	14	9	9	13	<5	8	7	12	16	N/A	19	19	20	N/A	19	N/A	12	5
Nickel	12	14	<5	6	6	<4	<5	5	8	15	N/A	17	15	17	N/A	11	N/A	6	5
Manganese	150	170	96	83	170	28	33	24	88	180	N/A	170	110	84	N/A	150	N/A	130	5
Lead	<5	<2	<5	<2	<5	<2	<5	<2	<5	2	N/A	<2	<5	5	N/A	4	N/A	2	5
Antimony	<3	6	<3	4	<3	<3	<3	<3	<3	4	N/A	6	<3	8	N/A	6	N/A	4	5
Selenium	9.8	2	10	2	<1	<1	<1	<1	<1	<1	N/A	<1	<1	<1	N/A	4	N/A	<1	1
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	<0.05	<0.05	<0.05	N/A	<0.05	N/A	<0.05	0.05

Sites	LWA1		LWA2		LWA3		LWA4		LWA5		LWA6		LWA7		LWA8		LWA9		Detection
Parameters (mg/L)	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Feb	Sep	Limit
Boron	35	38	53	N/A	83	N/A	630	110	61	35	25	<20	56	76	140	130	100	77	5
Chromium	220	270	110	N/A	91	N/A	36	100	100	320	93	130	95	130	120	290	67	120	5
Zinc	22	26	16	N/A	100	N/A	12	88	17	22	11	11	11	23	30	48	17	21	5
Arsenic	53	63	18	N/A	67	N/A	8.6	220	26	34	6.2	3.4	9.5	8.5	14	14	51	150	0.5
Cadmium	<0.5	<0.4	<0.5	N/A	1.3	N/A	<0.5	2.2	<0.5	<0.4	<0.5	<0.4	<0.5	<0.4	<0.5	<0.4	<0.5	<0.4	0.5
Cobalt	38	50	7	N/A	170	N/A	<5	320	16	26	<5	5	<5	9.7	13	10	82	49	5
Copper	16	20	17	N/A	52	N/A	9	45	16	15	11	10	12	21	23	25	13	21	5
Nickel	13	21	10	N/A	85	N/A	<5	75	10	15	<5	5	6	11	16	19	16	14	5
Manganese	180	220	180	N/A	3200	N/A	120	1500	95	130	110	120	91	160	430	320	280	110	5
Lead	6	5	<5	N/A	11	N/A	<5	10	6	4	<5	2	<5	4	15	21	<5	<2	5
Antimony	9	9	3	N/A	16	N/A	<3	17	6	8	<3	3	<3	5	<3	7	3	8	3
Selenium	<1	<1	<1	N/A	<1	N/A	<1	1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	1
Mercury	<0.05	<0.05	<0.05	N/A	<0.05	N/A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05