SECTION 4

ENVIRONMENTAL ASSESSMENT

Snapper Mineral Sands Project
Environmental Assessment

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4 ENVIRONMENTAL ASSESSMENT

4.1 METEOROLOGY

4.1.1 Existing Environment

The Snapper Mine is located in a persistently dry, arid climatic zone. The nearest meteorological stations operated on behalf of the Commonwealth Bureau of Meteorology (BOM), which have continuous recorded temperature, wind speed, rainfall and evaporation data are:

- Broken Hill (Patton Street);
- Menindee Post Office;
- Lake Victoria Storage;
- Wentworth Post Office;
- Pooncarie Hotel; and
- Mildura Airport.

The location of these stations is shown on Figure 4-1 and details of each station provided in Table 4-1.

Meteorological data collected from various stations is summarised in Table 4-2 and discussed below. A meteorological station was also installed at the Ginkgo Mine site in June 2005 (Figure 4-1).

Temperature

Table 4-2 indicates that regional temperatures are warmest from November to March and coolest from May to September. Average daily maximum temperature records indicate that January is typically the hottest month and July the coldest (Table 4-2).

Wind Speed and Direction

Representative windroses for the Snapper Mine area were generated using data from the Ginkgo Mine meteorological station and Commonwealth Scientific and Industrial Research Organisation (CSIRO) prognostic modelling data (Appendix G). Annual and seasonal windroses for the Ginkgo Mine are illustrated on Figure 4-2.

The windroses indicate a predominance of winds from the south and south-east during summer. Winds from the north-east, north and north-west are more common during autumn and spring and are common during winter.

The annual windrose (Figure 4-2) indicates the dominance of southerly and south-southeasterly winds over the year.

Rainfall

Average monthly rainfall data recorded at stations in the region indicate that, generally, the month of October has the highest average rainfall (Table 4-2).

Generally the rainfall records indicate moderate seasonality, with higher average monthly rainfall totals being recorded in the winter-spring months (Table 4-2). An annual average rainfall of approximately 240-290 mm at the Snapper Mine site is inferred (Table 4-2).

Table 4-1
BOM Station Locations and Recording Periods

Station Name	Station Number	Location Relative to the Snapper Mine	Period of Record (Years)
Broken Hill (Patton Street)	047007	Approximately 170 km north	115
Menindee Post Office	047019	Approximately 110 km north-east	128
Lake Victoria Storage	047016	Approximately 100 km south-west	82
Wentworth Post Office	047053	Approximately 70 km south-west	136
Pooncarie Hotel	047033	Approximately 40 km east	125
Mildura Airport	076031	Approximately 85 km south-west	58

Source: BOM (2006a, 2006b, 2006c, 2006d, 2006e).

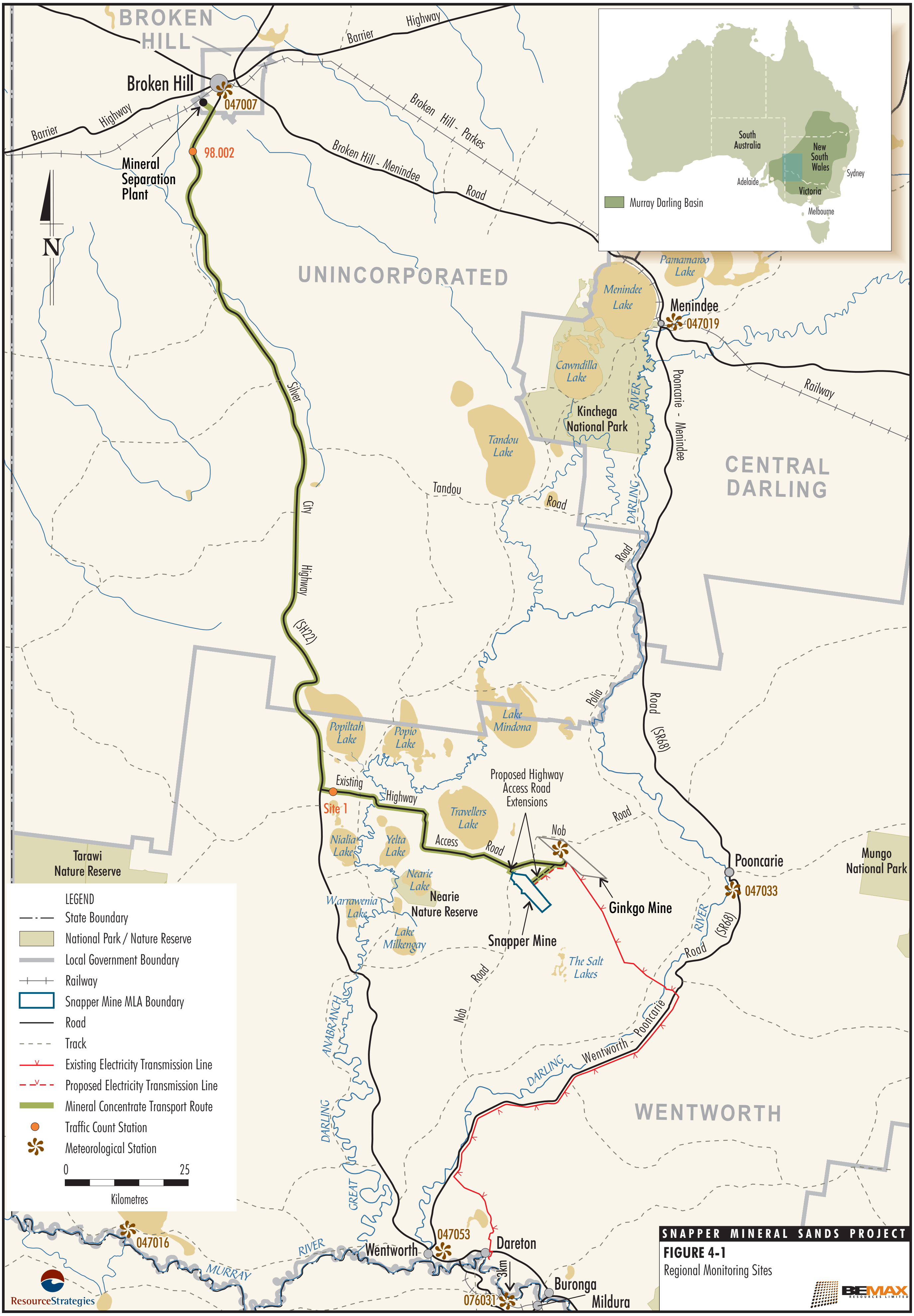

FIGURE 4-1
Regional Monitoring Sites

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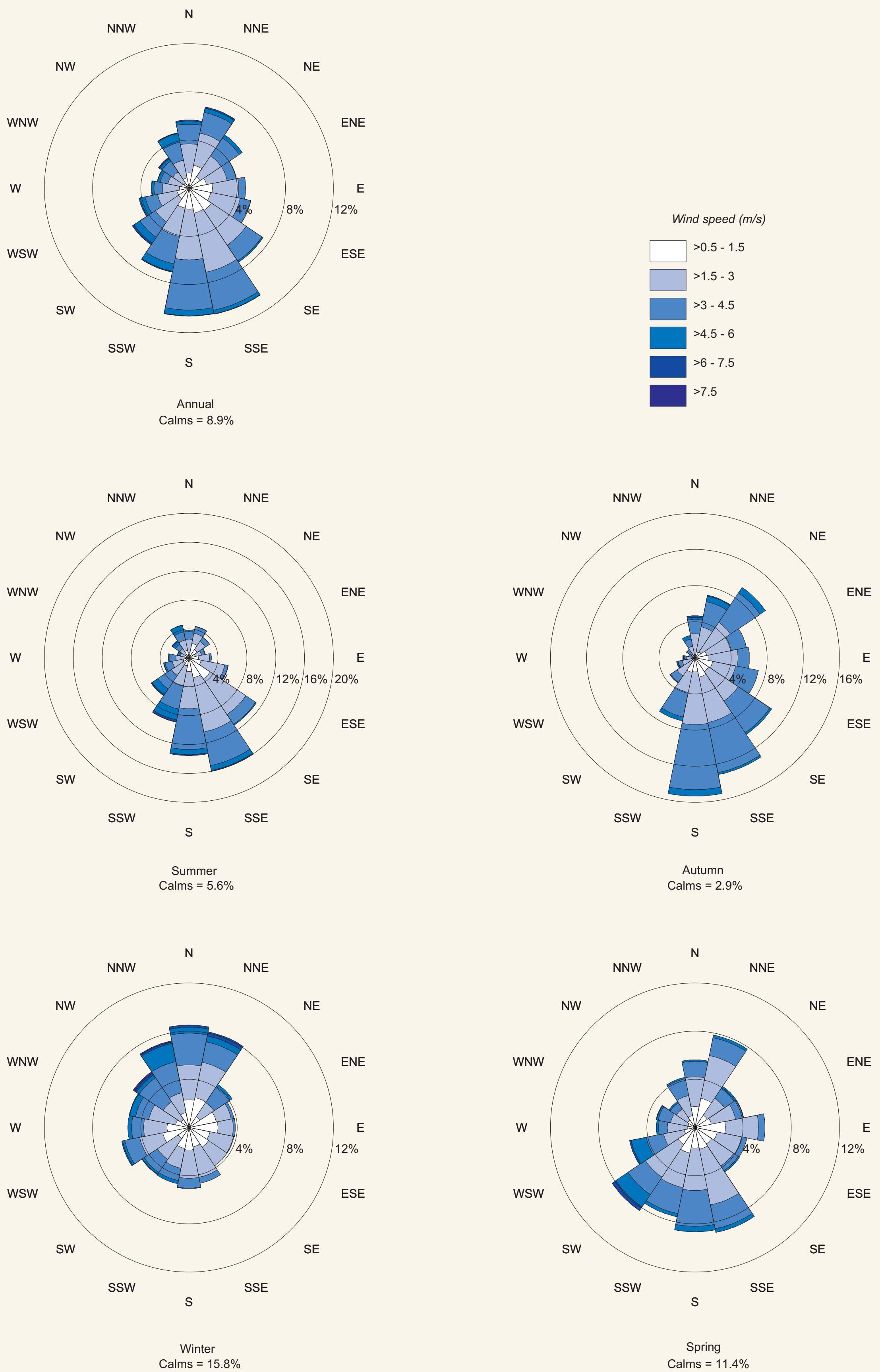
Table 4-2
Meteorological Data Summary

Month	Relative Humidity Monthly Average (% mean)[1]								Average Daily Temperature (degrees Celsius [°C])									
	Wentworth Post Office		Mildura Airport		Menindee Post Office	Lake Victoria Storage	Broken Hill (Paton Street)		Wentworth Post Office		Mildura Airport		Lake Victoria Storage		Menindee Post Office		Broken Hill (Paton Street)	
	9 am	3 pm	9 am	3 pm	9 am	9 am	9 am	3 pm	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	44	25	52	28	45	57	44	28	32.9	17.1	32	16.5	31.8	16.4	34.2	18.3	32.7	18.4
February	49	27	56	31	50	60	48	30	32.3	16.8	31.5	16.4	31.6	16.4	33.5	18.0	32.2	18.2
March	55	31	61	34	55	64	51	32	29.2	14.5	28.2	13.8	28.4	14.0	30.5	15.0	28.9	15.5
April	65	40	69	40	61	70	58	39	23.9	10.5	23.5	10.1	23.4	10.5	25.5	10.6	23.9	11.7
May	76	49	82	51	72	80	69	48	19.4	7.9	18.9	7.5	18.9	7.8	20.7	7.4	19.1	8.5
June	84	56	88	57	79	85	76	54	16.1	5.8	16.0	5.2	15.6	5.8	17.2	4.8	15.6	6.2
July	82	54	86	55	79	84	73	49	15.6	4.9	15.3	4.3	15.2	5.3	17.0	4.0	15.1	5.3
August	74	47	79	48	71	78	64	41	17.6	6.0	17.1	5.3	17.0	6.1	19.2	5.2	17.2	6.3
September	63	38	68	41	60	71	54	34	21.1	8.1	20.3	7.3	20.3	8.2	22.9	8.0	21.0	8.8
October	53	33	58	35	52	64	47	30	24.5	10.8	23.6	9.7	23.6	10.6	26.4	11.2	24.9	11.7
November	47	28	54	30	48	60	43	27	28.3	13.4	27.3	12.3	27.3	13.2	30.0	14.4	28.6	14.6
December	44	26	51	28	44	57	42	27	31.1	15.7	30.0	14.8	30.2	15.3	32.8	16.8	31.3	17.1
Annual Average	61	38	67	40	60	69	56	37	24.3	10.9	23.7	10.3	23.6	10.8	25.7	11.0	24.2	11.9

Table 4-2 (Continued)
Meteorological Data Summary

Month	Average Rainfall (mm)						Average Daily Evaporation (mm)[2]	
	Pooncarie	Wentworth Post Office	Mildura Airport	Lake Victoria Storage	Menindee Post Office	Broken Hill (Paton Street)	Mildura Airport	Lake Victoria Storage
January	19.5	21.0	20.7	18.9	22.7	23.1	10.5	10.1
February	20.9	22.0	21.2	19.4	21.2	24.6	9.8	9.1
March	19.9	19.2	18.2	13.3	17.8	19.7	7.4	7.1
April	17.8	17.7	18.5	18.2	16.3	17.7	4.6	4.4
May	25.6	28.3	26.3	24.2	23.0	22.8	2.6	2.5
June	25.5	27.2	23.2	23.0	21.3	21.4	1.8	1.8
July	21.4	24.3	26.3	25.0	18.2	18.7	2.0	1.9
August	22.6	26.2	27.6	24.6	18.1	18.7	2.9	2.7
September	21.7	27.3	28.2	24.7	18.6	20.4	4.4	4.2
October	25.6	28.2	31.0	27.9	23.1	24.9	6.4	6.0
November	19.8	23.5	23.9	22.4	19.9	19.8	8.5	8.0
December	20.2	21.3	23.8	19.2	21.9	21.5	10.1	9.5
Annual Average Total	262.2	286.1	288.9	260.9	242.3	253.4	5.9	5.6

Source: BOM (2006a, 2006b, 2006c, 2006d, 2006e) and after Appendices A and G.
1 Afternoon records not available for Lake Victoria or Menindee Post Office.
2 Records available only for Mildura Airport and Lake Victoria.



Source: Holmes Air Sciences, 2007

SNAPPER MINERAL SANDS PROJECT

FIGURE 4-2

Annual and Seasonal Wind Roses for the Ginkgo Mine - April 2005 to March 2006

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Relative Humidity

Relative humidity records from all sites indicate higher humidity in winter and lower humidity in summer (Table 4-2).

Evaporation

The annual average evaporation at the Ginkgo Mine is estimated to be approximately 2,475 mm (Appendix A). Table 4-2 shows that evaporation rates differ markedly between summer and winter.

4.1.2 Meteorological Monitoring

An automated meteorological monitoring station would continue to be operated at the Ginkgo Mine site to record temperature, relative humidity, net solar radiation, rainfall, wind speed, wind direction and sigma theta (the rate of change of wind direction).

Meteorological monitoring would form a component of the Snapper Mine environmental monitoring programmes.

4.2 LAND RESOURCES

4.2.1 Existing Environment

Topography and Landuse

The land within the Snapper Mine area shows limited relief and comprises generally flat to undulating sandplains covered by a combination of grasslands, low woodland and shrublands. Elevations range from approximately RL 60 m AHD in the south-eastern and north-western MLA area to approximately RL 80 m AHD in the centre of the MLA area (Figure 1-2).

Landuse in the vicinity of the Snapper Mine comprises pastoral leasehold lands that are used for light intensity rangeland grazing. The Snapper Mine area is located on four pastoral properties ("Carstairs", "Trelega", "Manilla" and "Aston") (Figure 1-3).

Improvements have been made to some of the land in the MLA area (e.g. fences and surface water collection tanks).

Geology

Relevant geology is discussed in Section 2.1.

Landforms, Soils, Rural Land Capability and Agricultural Suitability of the Snapper Mine Area

A landform and soil assessment of the MLA area was conducted as part of the Rehabilitation Materials Assessment (Appendix H). The soils of the MLA area, like much of the NSW Western Division, have not been mapped by the DLWC. Soil Conservation Service of NSW (1985) land system mapping (1:250,000 scale) covers the Snapper Mine area.

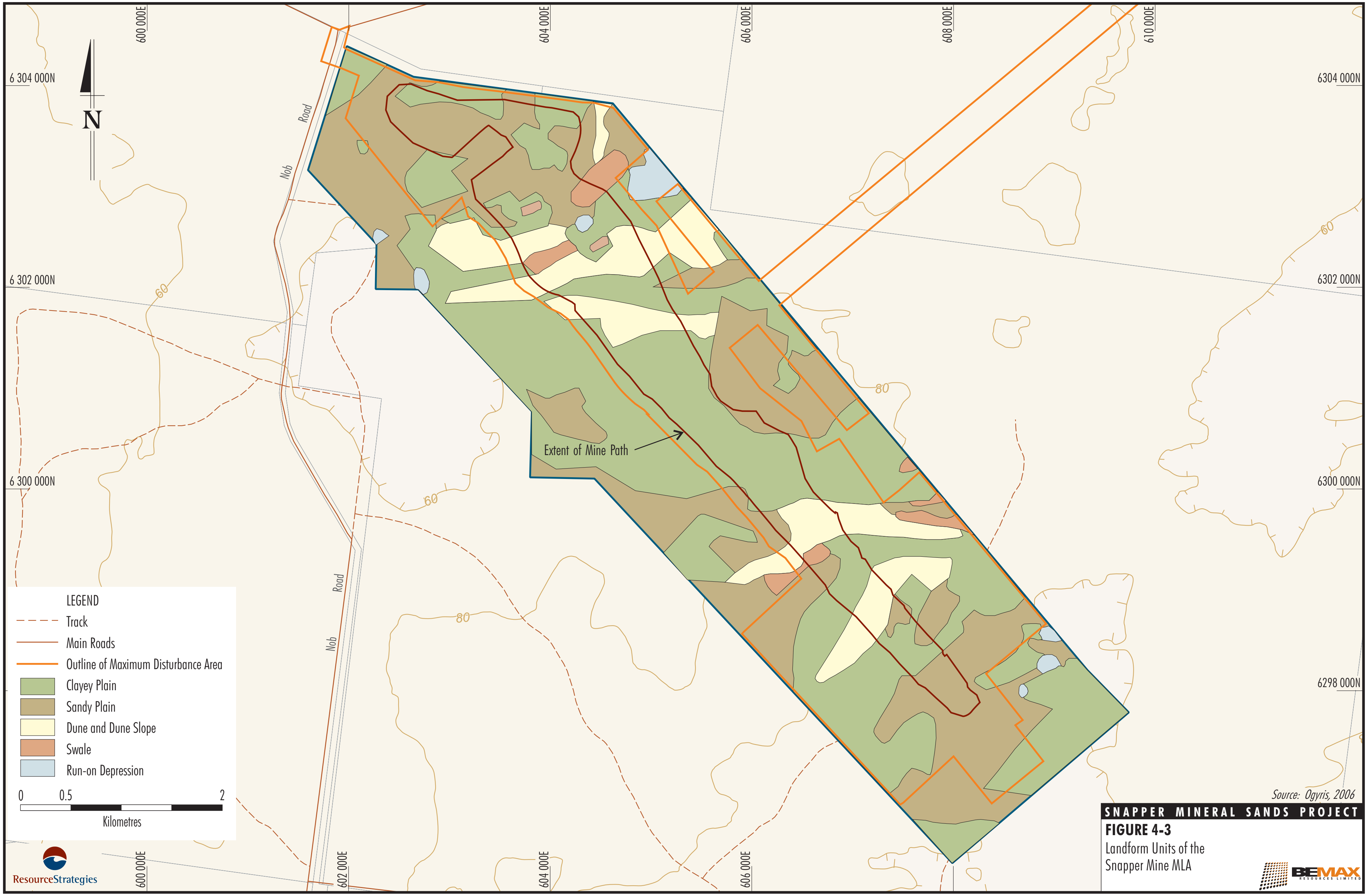
The Snapper Mine area falls predominantly within the Trelega sandplain land system. The features of the Trelega sandplain land system are provided below (Soil Conservation Service of NSW, 1985):

> *Trelega: level to slightly undulating sandplains and swales of loamy solonised brown soils. Aligned low dunes and low rises of deep brownish sands and calcareous red earths; relief to 3 m. Moderate to dense belah, scattered wilga, mallee and rosewood; dense to scattered pearl and black bluebushes; abundant porcupine grass on dunes; short grasses and forbs.*

The landforms of the Snapper Mine MLA area were mapped by Ogyris (2006) (Appendix H). The six landform units which were identified are shown on Figure 4-3 (the approximate percentage of the Snapper Mine MLA area covered by each landform is also provided):

- dunes (10%);
- dune slopes (10%);
- sandy plains (30%);
- clayey plains (40%);
- swales (5%); and
- run-on depressions (5%).

A detailed discussion of the soil sampling programme and the soil profile and geochemistry for each of these landform units is presented in Appendix H.



SNAPPER MINERAL SANDS PROJECT

FIGURE 4-3
Landform Units of the Snapper Mine MLA

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Soils of the Snapper Mine Area

Topsoil depths across the Snapper Mine path vary from approximately 20 cm to 105 cm. The shallowest topsoils occur on clayey plain landforms (average 30 cm depth). Dune, dune slope and sandy plain landform units have greater topsoil depths, generally in the range of 40 to 70 cm (Appendix H).

The MLA area topsoils have inherently low nutrient status which has been further depleted by land management practices (i.e. grazing). The topsoils generally have low to moderately high free lime content, are generally non-sodic and have low soil conductivity and pH. A discontinuous calcium carbonate layer is important in defining the depth of topsoil. Where present, this carbonate layer is located immediately beneath the topsoil horizon (Appendix H).

Subsoil material varies across the Snapper Mine path. Subsoils generally have high soil conductivity, high pH, high sodicity or ESP and high boron levels (Appendix H). Carbonate subsoils have generally low to moderate conductivity levels and low boron levels with moderate to good drainage characteristics (Appendix H).

Agricultural Suitability of the Snapper Mine Area

The Snapper Mine area is classified as Class 4 in accordance with the five class system (Riddler, 1996), which classifies land according to its productivity for a wide range of agricultural activities. This is based on soil and landuse information presented in Appendix H.

Class 4 agricultural suitability is defined as:

> *Land suitable for grazing but not cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be high seasonally but the overall level of production is low as a result of a number of major constraints, both environmental and edaphic* (Cunningham *et al*., undated).

Climatic and physical limitations preclude the establishment of improved pastures on Snapper Mine MLA area soils.

Rural Land Capability of the MLA Area

Rural land capability classification is based on a standard NSW eight class system. This system is based on the assessment of biophysical characteristics categorising land in terms of its general limitations such as erosion hazard, climate and slope. Land is classed based on the limitations to a particular type of landuse (Emery, 1985). Using relevant soil and landuse information from Appendix H, the only class identified in the MLA area is Class VI.

Class VI Capability is defined as:

> *Land not capable of being cultivated but suitable for grazing with soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. This class may require some structural works* (Cunningham *et al.*, undated).

Land Contamination

As described in Section 3.3.4, a Preliminary Land Contamination Assessment (BEMAX, 2007) has been undertaken for the Snapper Mine in accordance with the requirements of SEPP 55.

Potentially contaminated sites identified within the Snapper Mine area comprised one site, *viz.* the historic “Kertne Nob” outstation which includes a refuse dump containing vacuum oil drums (BEMAX, 2007). The outstation is not located within the proposed disturbance areas. No cattle or sheep dips were reported to have been constructed in the area (*ibid.*). WSC have advised of no records or reports of land contamination incidents associated with any of the properties within the Snapper Mine area (*ibid.*). No evidence of illegal dumping was evident in recent aerial photographs (*ibid.*).

4.2.2 Potential Impacts

The Snapper Mine has the potential to alter:

- topography and landscape features;
- soils and erosion potential;
- landuse/capability;
- soil properties due to contamination by past agricultural landuses;

- soil properties due to contamination through the handling and disposal of backloaded MSP process wastes;
- soil properties due to contamination through the use of saline slurried overburden;
- soil salinity levels through the application of saline water for dust suppression;
- soil properties due to other contamination sources; and
- the level of bushfire hazard.

These potential impacts are described in the following subsections. Measures to mitigate these potential impacts are provided in Section 4.2.3.

Topography and Landscape Impacts

The main modifications to the existing topography that would result from the Snapper Mine comprise:

- mining and subsequent backfilling of the mine path;
- the initial overburden emplacements;
- the initial sand residue dam;
- initial water supply dam and water treatment dams;
- the final depressions that would remain following cessation of mining in the location of the final dredge pond and water disposal dam; and
- other minor landform alterations associated with construction of Snapper Mine roads, ETL, and erosion and sediment control measures.

The relatively small scale of the overburden emplacements and dams (i.e. up to 20 m high) and the mining method, which involves backfilling the majority of the mine path as mining proceeds, effectively limit the scale of topographic or landform change associated with the Snapper Mine.

In the context of the broad, flat to gently undulating topography of the Snapper Mine area, the landform alterations outlined above represent a minor modification to the existing topography.

Soils and Erosion Potential

Potential impacts of the Snapper Mine on soils relate primarily to:

- alteration of soil structure beneath stockpile areas and roads;
- increased erosion and sediment movement due to increased exposure of soils during clearance and construction activities; and
- alteration of physical and chemical soil properties (e.g. structure, fertility, microbial activity) during soil stripping and stockpiling.

Landuse/Capability

Stock would be excluded from the Snapper Mine operation area and stock fences would be modified as necessary. As described in Section 5, rehabilitation of Snapper Mine landforms would target an agreed final landuse following discussions with regulatory authorities and landholders. Final landuse would be likely to include areas suitable for light intensity grazing as well as areas where stock exclusion may be preferred so as to enhance native flora and fauna habitat. The final depressions (at the location of the final dredge pond and water disposal dam) would remain as permanent topographic basins.

The proposed use of the HAR for HMC transport and other Snapper Mine traffic would potentially increase stock losses from vehicle strike.

Land Contamination – Past Landuse

The Preliminary Land Contamination Assessment (BEMAX, 2007) did not identify any areas of land contamination in the Snapper Mine disturbance area. Notwithstanding, there is some potential that minor areas of soil contamination could occur (e.g. in the vicinity of isolated dumped oil drums or pesticide containers).

Land Contamination – Backloaded MSP Process Waste

As described in Section 2.4.9, MSP process waste would be backloaded to the Snapper Mine for disposal. As described in Section 2.6.2, the backloaded MSP process waste includes radioactive material (monazite) blended with the other MSP process waste materials. Assuming similar physical and chemical properties to the Ginkgo Mine backloaded MSP process waste, the backloaded MSP process waste transported to the Snapper Mine would be classified as hazardous under the POEO Act and the *Environmental Guidelines: Assessment, Classification & Management of Liquid and Non-liquid Wastes* (DEC, 2004b), and radioactive under the RC Act (Appendix I).

Potential contamination of land with backloaded MSP process waste could occur in the event of (Appendix I):

- inadequate containment of the backloaded MSP process waste in a haulage contractor vehicle;
- a road accident involving a haulage contractor vehicle loaded with backloaded MSP process waste; and
- inadequate containment of backloaded MSP process waste at the Snapper Mine prior to its disposal on the sand residue beach (Section 2.4.9).

The uncontrolled release of backloaded MSP process waste during any of the above scenarios could potentially cause land contamination in the absence of management measures. The heavy nature of monazite (specific gravity between 4.6 and 5.4) reduces its susceptibility to suspension in air, and would therefore limit the potential for dispersal and the likely extent of land contamination (Appendix I).

In the event of a road accident, there would be limited radiological consequences (due to the limited dispersion capabilities and specific activity of the backloaded MSP process waste) and any major impacts would arise primarily from the physical impact of the vehicles (Appendix I).

Section 4.15 summarises the results of the PHA (Appendix K) conducted for the Snapper Mine and identifies sources of potential risk to the environment (including land contamination). In addition, the potential hazards and risks associated with the handling and disposal of backloaded MSP process waste at the Snapper Mine have been assessed in a Process Waste Materials Risk Assessment (Appendix I).

Land Contamination – Slurried Overburden

An assessment of the risks to the success of rehabilitation and revegetation of the Snapper Mine site associated with overburden slurrying using saline groundwater is provided in Appendix H. The potential impacts on vegetation identified in the risk assessment from the use of slurried overburden in the rehabilitated profile include:

- capillary rise increasing salinity levels within the primary root zone (PRZ) of the non-slurried material;
- leakage or loss of saline water or lateral salt movement (seepage) within the slurried overburden along the mine path and in the initial slurried overburden emplacement to rehabilitated and/or revegetated areas;
- salts contained within the slurried material becoming airborne once the material has dried; and
- failure of clay lining/capping in initial slurried overburden emplacement.

Land Contamination – Saline Water

The use of saline water as a dust suppressant on haul roads, trafficked areas and regularly used minor roads would potentially increase the salinity of the surface soils in these areas.

Land Contamination – Other

Section 4.15 summarises the results of the PHA conducted for the Snapper Mine (Appendix K) and identifies sources of potential risk to the environment. The primary potential land contamination risks have been identified as fires or spills associated with diesel and lubricant transport, storage and usage, and from spills or leakages of saline sand residues or groundwater.

Bushfire Hazard

Fires moving on or off the mine area would present potentially serious impacts to surrounding pastoral properties and to Snapper Mine personnel and equipment. The degree of potential impact would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel (e.g. grasses and native vegetation).

Potential Cumulative Impacts

Similar potential land resource impacts have been identified for the Snapper and Ginkgo Mines (e.g. minor topographic impacts, potential for soil alteration and land contamination). However, these impacts would be localised in nature (i.e. largely contained within mining areas) and would be minor when considered at a regional scale. With the application of appropriate mitigation and management measures as outlined in Section 4.2.3 and the Ginkgo EIS (BEMAX, 2001a), and progressive rehabilitation (Section 5), the potential for significant cumulative land resource impacts for the two mining operations is considered to be low.

4.2.3 Mitigation Measures and Management

Topography and Landscape Impacts

Progressive rehabilitation would be used to integrate constructed landforms with the surrounding landscape. Rehabilitation strategies proposed for the Snapper Mine are detailed in Section 5.

Section 4.3 discusses additional measures for mitigating potential impacts on visual character.

Soils and Erosion Potential

The primary objectives of Snapper Mine erosion control measures would be to control soil erosion and sediment generation from areas disturbed by mining and construction activities.

Specific mitigation measures to control soil erosion and sediment migration would include:

- minimising surface disturbance and restricting access to undisturbed areas;
- progressive rehabilitation/revegetation of the mine path;
- rehabilitation/revegetation of mine infrastructure areas at the earliest practicable stage; and
- the use of evaporation/sediment sumps to contain runoff from disturbed areas.

The erosion and sediment control measures for the Snapper Mine would be developed and documented in a SWMP. The SWMP is described in Section 4.5.3.

Stripping of topsoil to the appropriate depth would be guided by the landform type and depth to the carbonate layer to maximise topsoil recovery and minimise soil losses (Appendix H). Subsoil and overburden material would be stripped and stockpiled separately (Section 2.4.2) for use during rehabilitation (Section 5).

Landuse/Capability

The proposed staged development and rehabilitation of the mine would limit the area of land disturbed at any one time. Lease or landuse compensation agreements would be negotiated with directly affected landholders.

Final landuse would be likely to include areas suitable for light intensity grazing as well as areas where stock is excluded to enhance native flora and fauna habitat. Management of soil resources and progressive rehabilitation would allow re-establishment of species appropriate to light intensity grazing and flora and fauna habitat.

BEMAX would negotiate with landholders along the HAR to provide reimbursement at current market value for stock lost due to Snapper Mine vehicle strike.

Land Contamination – Past Landuse

During development of the Snapper Mine, if areas that were potentially subject to localised land contamination (e.g. dumped fuel and chemical storage containers) are identified, soil samples from these areas would be collected and analysed. If necessary, appropriate management measures would be developed which may include the placement of materials excavated from these areas at depth in the Snapper Mine backfilled mine path. The Preliminary Land Contamination Assessment (BEMAX, 2007) concluded that with this contingency measure, the Snapper Mine site is suitable for a landuse change from agriculture to the development of the Snapper Mine.

Land Contamination – Backloaded MSP Process Wastes

The process waste materials produced at the MSP would be transported from the MSP via the mineral concentrate transport route to the Snapper Mine in accordance with the *Code of Practice for the Safe Transport of Radioactive Material, 2001* (Australian Radiation Protection and Nuclear Safety Agency [ARPANSA], 2001).

As stated in Section 2.4.8, the transport of mineral concentrate from the Ginkgo Mine site to the MSP is currently being undertaken in accordance with the Ginkgo Mine and MSP TCC (BEMAX, 2006b) and the Ginkgo Mine and MSP THMP (BEMAX, 2006c). The Ginkgo Mine and MSP THMP (BEMAX, 2006b) and the Ginkgo Mine and MSP TCC (BEMAX, 2006b) include the requirements of the *Code of Practice for the Safe Transport of Radioactive Material, 2001* (ARPANSA, 2001) including:

- storage requirements;
- labelling, placarding and documentation requirements;

- radiation monitoring (including monitoring radiation doses received by personnel associated with the haulage fleet);
- driver instruction requirements;
- emergency response procedure; and
- waste material tracking system requirements.

The relevant Ginkgo Mine and/or MSP traffic and transport plans would be updated to include haulage activities relevant to the Snapper Mine prior to commencement of transport of hazardous materials from the MSP to the Snapper Mine.

In addition, prior to the commencement of operation at Snapper Mine, a Radiation Management Plan (RMP) would be developed in accordance with Section 2.7 of the *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (the Mining and Minerals Processing Code) (ARPANSA, 2005). The RMP would incorporate a Radioactive Waste Management Plan as required under Section 2.8 of the Mining and Minerals Processing Code (ARPANSA, 2005) as well as:

- a description of operation and control measures;
- a description of waste generating processes and waste;
- demonstration of access to professional expertise;
- details of radiation monitoring;
- details of appropriate equipment, staff, facilities and operation procedures;
- induction and training courses;
- reporting and periodic review procedures;
- emergency plans;
- baseline radiological information;
- description of the waste management system;
- radioactive waste monitoring; and
- a conceptual decommissioning plan.

In addition, a Snapper Mine Landfill Environmental Management Plan (LEMP) (based on the Ginkgo Mine LEMP [BEMAX, 2006f]) would be developed prior to the commencement of disposal activities and be relevant to the disposal of backloaded MSP process waste at Snapper Mine.

The Snapper Mine LEMP would be consistent with the Mining and Minerals Processing Code (ARPANSA, 2005) and would also generally meet the environmental goals listed in *Environmental Guidelines: Solid Waste Landfills* (EPA, 1996). The LEMP would include the following:

- a management programme;
- design and operation details of disposal areas;
- a monitoring system to monitor the movement of backloaded MSP process waste;
- monitoring of areas of high radiation potential (e.g. mineral concentrate stockpiles and backloaded MSP process waste stockpile, as well as monitoring of radiation doses received by personnel associated with the HMC treatment facility; and
- disposal techniques and handling practices.

The management measures for backloaded MSP process waste are described below:

- At the Snapper Mine, the backloaded MSP process waste would be deposited in a designated stockpile, adjacent to the mineral concentrate stockpiles. The designated stockpile would have an earthen bund on three sides fitted with sprinklers.
- Backloaded MSP process waste classified as hazardous would be removed from the designated stockpile and placed in a shore-based hopper, mixed with wastewater from the salt washing facility, then pumped to the primary gravity concentration unit via a slurry pipe, where it would be combined in a sump with sand residues. The combined sand residue and backloaded MSP process waste slurry would be deposited on the sand residue beach and/or with overburden and would be covered under a minimum of 10 m (up to 35 m) of overburden.
- Backloaded MSP process waste not classified as hazardous would be removed from the designated stockpile and placed on the sand residue beach and/or with overburden and would be covered under a minimum of 10 m (up to 35 m) of overburden.

Similar to the Ginkgo Mine, the management measures described above would provide for:

- the average concentration of radioactive material in the rehabilitated mine path (i.e. the landfilled mine path) to not exceed the average concentration of radioactive material in the original ore body;
- the radiation level of any material deposited in the mine path to not exceed 0.7 microGray per hour, measured 1 m vertically above the surface of the landfilled area; and
- no detectable increase from the natural background radiation level measured at the ground surface.

Land Contamination – Slurried Overburden and Saline Water Use

Capillary Rise

Management and mitigation measures to limit the potential effects of capillary rise would include:

- Slurried overburden material would be covered by at least 3 m of non-slurried material (including topsoil, subsoil and non-slurried overburden) or less should rehabilitation investigations (e.g. laboratory testwork, trials) indicate shallower depths do not increase the risks to revegetation posed by salinity.
- Stockpiled soils would be re-spread on final surfaces.
- Salt tolerant, endemic species would be utilised for revegetation.

Rehabilitation concepts which incorporate the above measures are presented in Section 5.

Leakage or Loss of Saline Water

Management measures to address lateral saline water movement are outlined in Section 4.4.3.

Measures to limit the potential risk of contamination of soil resources from the loss of saline slurried overburden (pipeline), saline sand residues or saline groundwater would include:

- The saline slurried overburden and sand residue pipeline would be located within a bunded corridor to contain any potential spills.
- Outside of the dredge pond area the process water pipeline would be located within a bunded corridor to contain any potential spills.
- The saline slurried overburden pipeline, sand residue pipeline, water supply pipeline, borefield and water management structures would be regularly inspected for signs of wear or damage.
- The initial sand residue dam and initial water dam would be managed to maintain suitable freeboard.
- Initial slurried overburden emplacement, dams and the mine path area would be regularly inspected to monitor for lateral saline seepage.

Airborne Salt Movement

Given the presence of salts within the entrained groundwater, slurried overburden and sand residues would exhibit crusting which would reduce particulate (including salt) emissions. Notwithstanding, a photographic record of vegetation surrounding the mine path, initial slurried overburden emplacement and initial sand residue and water dams would be maintained to monitor for potential impacts of airborne salts. However, it is considered unlikely that airborne salts would impact on surrounding vegetation given observations from similar scenarios in natural ecosystems surrounding salt lakes within western NSW. For example, no impact of airborne salt/dust on surrounding vegetation is apparent in vegetation surrounding The Salt Lakes located approximately 8 km to the south of the Snapper Mine (Figure 4-1).

Failure of Clay Lining/Capping

The risk of failure of the clay lining/capping would be minimised by:

- survey control during construction; and
- permeability testing during construction and use.

Saline Water Used for Dust Suppression

Areas where saline water would be applied as a dust suppressant would be tested prior to rehabilitation to determine the suitability of the surface materials as a revegetation medium.

If necessary (i.e. where material is unsuitable), the affected surface materials would be disposed with slurried overburden and/or sand residues.

Land Contamination – Other

Measures used to prevent or reduce the potential for contamination of land from diesel and lubricants would include the following:

- External carriers and Snapper Mine road trains would maintain a communications system (e.g. two-way radio) in truck cabs to allow for prompt notification in the event of an accident.
- Diesel and other consumable storage areas would, where applicable, be operated in compliance with the requirements of AS 1940.

Overburden removal and replacement using the saline slurried overburden system (Section 2.4.3) would limit the use of conventionally fuelled vehicles at the mine site.

Traffic management measures to reduce the likelihood of vehicle accidents on the mineral concentrate transport route are discussed in Section 4.8.

Bushfire Hazard

An ERP would be formulated to detail responsibilities in the event of emergencies in and around the Snapper Mine area. Snapper Mine fire response would be co-ordinated with the local bushfire brigade.

In addition to environmental responsibilities, there exists significant economic incentive to prevent fire damage to the considerable investment in mining infrastructure and equipment. Where applicable, controlled burning to reduce fuel loads within Snapper Mine lands would be undertaken in consultation with the DNR and relevant landholders.

4.3 VISUAL CHARACTER

4.3.1 Existing Environment

The Snapper Mine is located within an area of low hills, sand ridges, depressed open plains and playa plains. The area is characterised by Black Oak-Rosewood-Wilga Woodland, Bluebush Shrubland, Austrostipa Grassland, Chenopod Mallee Woodland/Shrubland and Irregular Dune Mallee Shrubland with comparatively small areas of Black Box Woodland and Turpentine Shrubland (Appendix E).

There are no significant artificial light sources in the Snapper Mine area apart from the Ginkgo Mine which is located some 10 km to the north-east.

4.3.2 Potential Impacts

Landscape Alteration

Landscape impacts change the general fabric and pattern of the existing landscape and its component parts. Such impacts can result from landform modification, vegetation removal and modification to natural drainage patterns.

Potential landscape impacts associated with the Snapper Mine would be either temporary (i.e. short-term) or permanent. Potential temporary impacts would be a function of the projected life of the operation and the nature of the landscape modifications resulting from mine support facilities such as the workshop/administration facilities and temporary mine landforms such as mineral concentrate and soil stockpiles. Permanent landscape impacts would result from the development of mine landforms such as the initial overburden emplacements and final depressions (Figure 2-4).

Soil stockpiles and some minor water management structures would be decommissioned at various stages during and after the mine life and rehabilitated to approximate the original topography. The initial overburden emplacement and initial sand residue dam (up to 20 m high) would operate for the first year of operation and would then be rehabilitated.

Roads within the MLA area would be retained or rehabilitated following cessation of mining, depending on the results of consultation with regulatory authorities and local landholders. The roads would be largely located on natural grade and would not represent significant landform alterations.

Visual Impacts

Snapper Mine roads, soil stockpiles and water management structures would not represent significant visual impacts as the relative elevation of the proposed landforms would be moderate and the intervening topography and/or natural vegetation would limit potential views. The final depression and water disposal dam would not be visible from public vantage points, due to their low elevation.

The dredge mining operation would not generally be visible from any public viewpoints as the majority of activities would be undertaken below the natural ground level. However, secondary mining would be utilised in various locations along the mine path and would potentially be visible for short periods where such mining is undertaken close to public vantage points.

The Snapper Mine has three permanent landscape components that could present limited visual impacts to surrounding viewpoints, *viz*:

- the initial overburden emplacements;
- the initial sand residue dam; and
- the initial water dam.

Public viewpoints providing opportunity to view these components would be available along Nob Road and the HAR. However, the low rolling topography, intervening vegetation and rapid revegetation of these landforms would limit potential impacts. In addition, the likely number of viewers would be limited due to the sparse settlement in the region and the low use of local public roads.

The "Manilla" homestead would be the closest residence to the Snapper Mine and is located some 3.5 km away (Figure 1-2) within a slight topographical depression. Due to intervening topography and vegetation, views of the MLA area from "Manilla" homestead are not available. Similarly the "Trelega" homestead is located some 7 km to the south of the MLA area boundary (Figure 1-3). No views of the MLA area are available from the "Trelega" homestead.

The ETL extension between the Ginkgo Mine and the Snapper Mine (Figure 1-2) would be located approximately 4 km from the "Manilla" homestead. No significant views of the ETL extension would be available from "Manilla" or "Trelega", or the public sections of the HAR and Nob Road. Close views would be available from the existing HAR accessing the Ginkgo Mine.

Night lighting at the Snapper Mine would be of sufficient intensity to provide a safe working environment for operators in the active mining area and supporting facilities. This lighting would alter the night-time light levels in the vicinity of the mine. In addition, increased night-time vehicle traffic on Snapper Mine roads and the HAR could potentially affect residences located within the reach of vehicle lights.

The residents at "Manilla", "Trelega", "Waukeroo" and "Roo Roo" homesteads (Figure 1-3) would experience a glow in the night sky during Snapper Mine operation, particularly during overcast conditions.

Potential Cumulative Impacts

The Snapper Mine would be located approximately 10 km from the Ginkgo Mine and this limits the potential for cumulative visual impacts. Notwithstanding, at night-time, the glow above the two operations is likely to be visible from homesteads in the region and, in particular, the "Manilla" homestead would be expected to experience an increased glow in the night sky particularly during overcast conditions. In addition, the landforms and lights of the Ginkgo and Snapper Mines could both be visible to vehicles travelling on the HAR.

4.3.3 Mitigation Measures and Management

Visual Screening

The limited elevated mine landforms and the small number of residences in the vicinity of the mine site would assist in limiting the potential visual impacts of the Snapper Mine development. Given the distance to the nearest homestead ("Manilla") from the MLA area boundary (3.5 km), the temporary nature of the Snapper Mine infrastructure and the moderate elevation of the initial mine landforms, no specific visual impact mitigation measures are proposed. However, in the event that significant visual impacts are identified, suitable visual screening (e.g. vegetation would be established).

Night Lighting

While Snapper Mine lighting would be directional and light shields would be used to limit light spill where practicable, some light spill would be anticipated along sections of local roads, including the HAR. In the event that significant lighting impacts are identified at a particular location, suitable visual screening (e.g. vegetation would be established).

4.4 HYDROGEOLOGY

A Hydrogeological Assessment of the local and regional groundwater systems in the vicinity of the Snapper Mine was undertaken by Golder Associates Pty Ltd (Golder Associates) (2007) and is presented in Appendix A. The assessment included consideration of the regional hydrogeology, a review of previous studies, including the previous Ginkgo Mine investigations and additional hydrogeological field investigations at the Snapper Mine. The Hydrogeological Assessment study area extends from the Menindee Lakes in the north to the Murray River in the south, east of the Darling River and west of the Great Darling Anabranch (Appendix A).

The conceptual and numerical groundwater models used for the Snapper Mine assessment were calibrated using the results of the Ginkgo and Snapper Mine hydrogeological field investigations and other relevant regional hydrogeological studies.

4.4.1 Existing Environment

Field Investigations

BEMAX have investigated the Snapper mineral deposit over several years and drilled approximately 1,200 holes as part of the exploration programme. Information logged for the drilling programme of relevance to the Hydrogeological Assessment included records of lithology, grain size, texture, cementation and moisture levels.

Long and short-term pumping tests have been conducted at the Ginkgo and Snapper mineral deposits. Results from the tests including transmissivity, hydraulic conductivity, specific yield and groundwater level values are summarised in Table 4-3.

The data summarised in Table 4-3 was utilised in the Snapper Mine hydrogeological model. Additional detail on the field investigations is provided in Appendix A.

Hydrogeological Regime

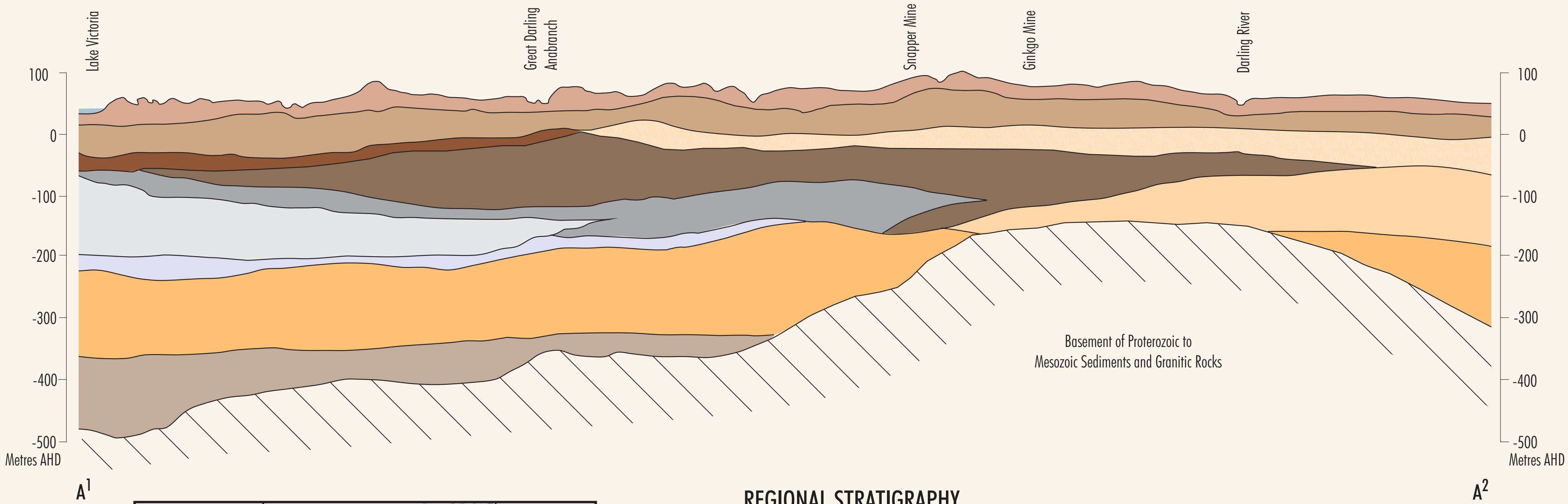
The Snapper Mine lies within a large aquifer system that extends west of the Great Darling Anabranch, east of the Darling River and south to the Murray River. The main aquifer of interest to the Snapper Mine is the Loxton-Parilla aquifer which overlies the sandy sediments of the Upper Renmark Group (Figure 4-4). The aquifer comprises the Loxton-Parilla Sands, which consists of mainly yellow-brown, weakly-cemented, fine to coarse sands. The unit is considered to have been deposited in various shelf to seashore environments (shallow marine, beach and estuarine deposits intersected by younger river systems) (Appendix A).

At the Snapper and Ginkgo Mine sites, the Loxton-Parilla Sands directly overlie the sandy sediments of the upper Renmark Group (Olney Formation) (Figure 4-4). Results of three pumping tests carried out at the Ginkgo Mine site indicate that the two formations respond as one aquifer (Golder Associates, 2001). The Loxton-Parilla aquifer at the Ginkgo and Snapper Mine sites varies little in groundwater quality or groundwater levels for tens of kilometres.

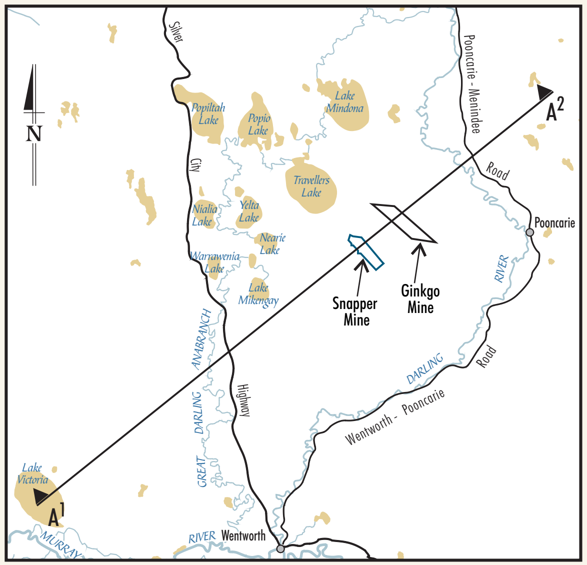
Table 4-3
Pumping Test Results from the Ginkgo and Snapper Mineral Deposits

Mineral Deposit	Date	Layer Tested	Pump Well	Duration (days)	Trans-missivity (m^2/day)	Hydraulic Conductivity (metres per second [m/s])	Specific Yield	Groundwater Level (RL m AHD)
Ginkgo	2001	Dune Sands, Beach Sands and Surf Zone	W01 W03 W04	7 7 7	700 800 950	$1.3x10^{-4}$ $1.4x10^{-4}$ $1.6x10^{-4}$	0.076 0.066 0.088	35.0 35.0 35.3
Ginkgo	2005	Sand	P1-P6	1	350	$1.0x10^{-4}$	0.030	34.1 – 35.4
Snapper	2002	Offshore Sand	SW01	6	10	$4.2x10^{-6}$	0.060	34.4
Snapper	2006	Dune Sands, Beach Sands and Surf Zone	PW1 PW2	4 4	860 730	$1.8x10^{-4}$ $2.8x10^{-4}$	0.035 0.043	34.2 34.2

Source: After Appendix A



REGIONAL STRATIGRAPHY



LEGEND

- Quaternary Sediments
- Loxton-Parilla Sands
- Bookpurnong Beds
- Upper Renmark Group
- Middle Remark Group
- Geera Clay
- Winnambool Formation
- Murray Group Limestone
- Ettrick Formation
- Lower Renmark Group
- Warina Sand

Not to Scale

Source: Golder Associates, 2001

SNAPPER MINERAL SANDS PROJECT

FIGURE 4-4

Regional Stratigraphy

ResourceStrategies

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The regional groundwater flow in all aquifers is very slow from the north margin of the basin and from the east toward the south-west. The Neckarboo Ridge east of the Darling River acts as a groundwater divide. The groundwater levels observed in regional groundwater monitoring bores indicate an upward hydraulic gradient from the deeper Renmark Group and Murray Group aquifers to the Loxton-Parilla aquifer (Appendix A). Recharge to the deep aquifers occurs at the basin margins, especially in the Broken Hill area.

The saline groundwater in the Loxton-Parilla aquifer receives little recharge from the Darling River, Menindee Lakes and intermittently from the Great Darling Anabranch, and moves very slowly. Losses from this aquifer occur via discharge to the Murray River and an area to the west of the Silver City Highway and evaporative discharge from the shallow water table at The Salt Lakes (Appendix A).

Groundwater Quality

In general, little groundwater between the Darling River and the Great Darling Anabranch is withdrawn and used for agricultural purposes due to either its poor quality and/or limited availability in comparison to fresh water piped from the Darling River and the Great Darling Anabranch systems (Golder Associates, 2001).

Table 4-4 presents a comparison of water quality data for various bores between the Darling River and the Great Darling Anabranch with relevant guideline values from the Australian and New Zealand Environment and Conservation Council (ANZECC) (2001) *Guidelines for Fresh and Marine Water Quality* (the ANZECC guideline).

The Loxton-Parilla aquifer is saline as indicated by the TDS concentrations in Table 4-4, which range from 21,105 mg/L to 53,064 mg/L and are comparable to the salinity of seawater. The salinity of the Loxton-Parilla aquifer renders the groundwater in the aquifer unsuitable for human/stock consumption or agricultural use.

In the immediate Snapper Mine area, groundwater for agricultural purposes is extracted from isolated freshwater lenses which occur in localised topographic depressions overlying the denser and more saline water of the Loxton-Parilla aquifer (Appendix A). As indicated in Table 4-4, the water from both Chalky Well and Greenvale Well is suitable for livestock watering and irrigation use according to the recommended ANZECC guideline level for TDS concentrations, although the chloride concentration in Chalky Well and sodium concentration in both bores are above the recommended ANZECC guideline level for sensitive crops (Appendix A).

Table 4-4
Groundwater Quality at Various Bores and Applicable ANZECC (2001) Guideline*

Sample	EC	TDS	Chloride	Sulphate	K	Na	Ca	Mg	Fe	Pb	Mn	P
	µS/cm[a]	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MO2, M19, M21, M26, M27, GW36669, GW36670	31,500–66,100	21,105–44,287	-	-	-	-	-	-	-	-	-	-
Chalky Well	3,100	2,077	190	180	4.9	290	630	64	9	0.02	0.09	0.2
Greenvale Well	1,600	1,072	160	200	43	160	180	34	0.04	<0.001	0.3	1.3
GW36820-2 (The Salt Lakes)	79,200	53,064	27,000	9,600	98	20,000	770	1,800	0.4	0.004	0.4	0.04
ANZECC Irrigation and General Water Use Guideline	-	-	<175[b]	-	-	<159[b]	-	-	-	-	-	-
ANZECC Stock Watering Guideline	-	0 – 2,000-5,000[c]	-	<1,000	-	-	<1,000	-	-	0.1	-	-

* Groundwater Quality Results as at November 2005.
[a] microSieverts per cm (µS/cm).
[b] Value based on foliar injury in sensitive crops (almonds, apricot, citrus, plum, grapes).
[c] Depends on the livestock. Higher concentrations (up to 10,000 mg/L, sheep) could be tolerated.
EC = electrical conductivity; K = potassium; Na = sodium; Ca = calcium; Mg = magnesium; Fe = iron; Pb = lead; Mn = manganese; P = phosphorus.

Recent TDS monitoring within regional bores has been conducted for the Ginkgo Mine and has shown no significant increases in local salinity levels since water extraction at the Ginkgo Mine began (BEMAX, 2005a).

Regional Groundwater Extraction

Figure 4-5 illustrates known groundwater bores in the region. The Ginkgo Mine is the only significant user of groundwater from the Loxton-Parilla aquifer in the vicinity of the Snapper Mine. As described above, the Loxton-Parilla aquifer is not used for domestic or pastoral activities due to its high salinity. Other groundwater use in the region includes extraction for local stock watering from isolated fresh groundwater sources such as isolated lenses (described above) and the alluvial aquifer associated with the Darling River.

For the *Ginkgo Mineral Sands Project Hydrogeological Assessment*, Golder Associates (2001) investigated groundwater use in the area. This investigation indicated that away from the Darling River and Great Darling Anabranch, bores that produce or have produced water suitable for stock are generally shallow and are located in topographically enclosed basins.

Recent regional groundwater level monitoring indicates little, if any, impact on the water level in regional bores since water extraction at the Ginkgo Mine began (BEMAX, 2005a).

Regional Hydrological Features

Regional and local hydrological features of relevance to the Snapper Mine Hydrogeological Assessment (Appendix A) are described below:

- **Darling River** - The Darling River is surrounded by a fresh to brackish groundwater lens (alluvial lens) (CSIRO, 2004). The Darling River provides some local fresh water recharge to groundwater systems, however, the level of connection and rate of flux between the alluvial system and the underlying deeper groundwater system is considered to be low (Appendix A).
- **Menindee Lakes** – The Menindee Lakes are natural lakes with man-made weirs to raise their level for water storage. The lakes provide local fresh water recharge to the Loxton-Parilla aquifer (Appendix A).
- **Great Darling Anabranch** - The Great Darling Anabranch normally consists of a series of pools and occasionally floods. Similar to the Darling River, the Great Darling Anabranch is surrounded by a fresh to brackish groundwater lens (alluvial lens) (CSIRO, 2004). It is expected that periods of high flow in the Great Darling Anabranch would result in some limited contribution to the underlying deeper groundwater systems, however, due to the intermittent nature of these events and the lack of significant connection between surface and deeper systems, this contribution is likely to be lower than that from the Darling River (Appendix A).
- **Great Darling Anabranch Lakes** - The lakes adjacent to the Great Darling Anabranch are gentle deflation basins that are normally dry but do receive water when the Great Darling Anabranch is in periods of high flow (Earthtech, 2004) or from localised rain. Occasional wet surface conditions in the lakes would provide small intermittent recharge to the deeper underlying saline groundwater (Appendix A).
- **The Salt Lakes** - Locally, loss from the Loxton-Parilla aquifer occurs via evaporation at The Salt Lakes, 8 km south of the Snapper MLA area (Figure 4-5). There is no permanent surface water in The Salt Lakes and this indicates that the lakes are not groundwater window lakes and evaporative losses are dominant (Appendix A).The surface salt crusting in low-lying parts of The Salt Lakes indicates upward movement of saline groundwater by capillary action driven by evaporation.
- **Localised Freshwater Lenses** - In addition to the above, isolated freshwater lenses also occur in localised topographic depressions in the region. This generally occurs in topographically enclosed basins where rainfall runoff is concentrated and recharges shallow groundwater. Low salinity recharge in these areas tends to form a localised freshwater lens over the denser more saline groundwater (Appendix A). An example of this is located at Chalky Well to the north-east of Ginkgo Mine (Figure 4-5).

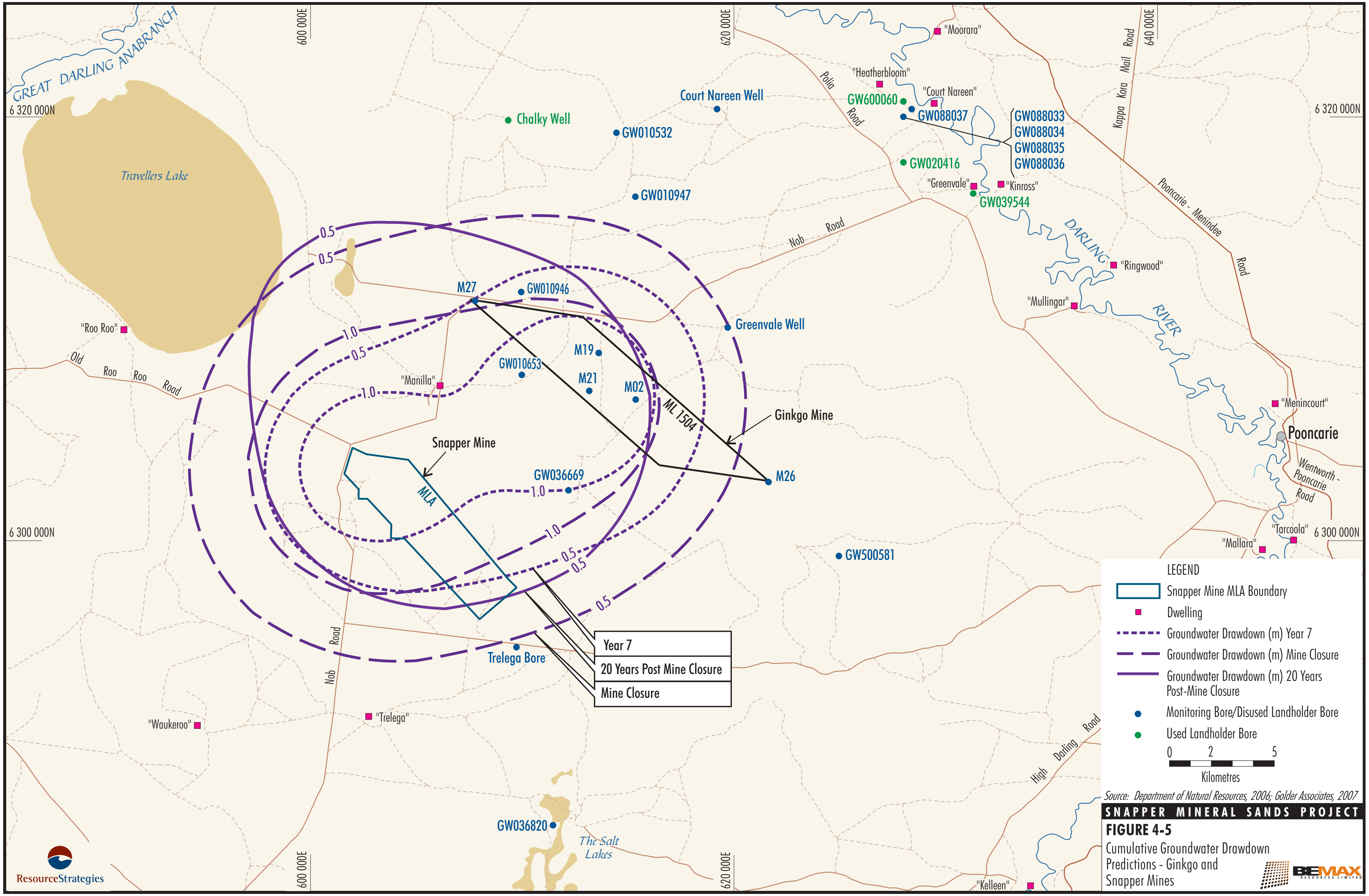

FIGURE 4-5
Cumulative Groundwater Drawdown Predictions - Ginkgo and Snapper Mines

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4.4.2 Potential Impacts

Groundwater Drawdown Predictions

Groundwater requirements of the Snapper Mine are described in Section 2.

In order to assess the potential impacts of Snapper Mine water use, a regional groundwater model was used to assess groundwater availability and to predict the extent of groundwater drawdown in the Loxton-Parilla aquifer in the vicinity of natural surface water systems (Appendix A). The model included assessment and consideration of the potential cumulative effects of the Snapper and Ginkgo Mines. The net groundwater extraction rather than the total borefield demand was used in the regional model because of the close proximity of the points of extraction (i.e. the borefields) and points of return (i.e. the dredge pond and water disposal dam) (Appendix A).

The regional groundwater model indicates that the level of drawdown of the Loxton-Parilla aquifer would increase over the mine life, with groundwater level recovery commencing at the end of the mine life when pumping from the borefields ceases (Appendix A). While the groundwater drawdown cone would begin to reduce in depth after the cessation of mining, the overall extent of the shallow drawdown area would continue to extend outwards until an equilibrium is reached between inflows and the head gradient induced by extraction (Appendix A).

The cumulative predicted groundwater drawdown induced by the Snapper and Ginkgo Mines as defined by the 0.5 m drawdown contour is shown on Figure 4-5 for the Snapper Mine in Year 7, the end of the Snapper Mine life and 20 years after the end of mining at the Snapper Mine.

Due to the limited recharge rate to the Loxton-Parilla aquifer, there would be a slow recovery of groundwater levels over the area between the Darling River and the Great Darling Anabranch following the cessation of mining (Appendix A).

Other Groundwater Users

Where existing bores for stock watering access brackish or freshwater lens aquifers which overly the Loxton-Parilla aquifer, these bores could potentially experience a reduction in water levels as a result of the lowering of the underlying saline aquifer (Appendix A).

Figure 4-5 illustrates the locations of known bores in the vicinity of the Snapper Mine. The regional groundwater model indicates a groundwater drawdown of less than 0.5 m at landholder bores, such as Greenvale Well, Chalky Well and Court Nareen Well (Appendix A). The maximum drawdown at a bore can be expected to closely mirror the drawdown predicted for the saline Loxton-Parilla aquifer. In the event that freshwater lenses are lowered, no significant impact on groundwater quality is anticipated (Appendix A).

Regional Hydrological Features

The Darling River and Great Darling Anabranch

There is some limited connectivity between the major surface water features of the Darling River, Menindee Lakes and the Great Darling Anabranch and the Loxton-Parilla aquifer, however, the flux between these alluvial and shallow groundwater features and the deeper saline aquifer is low (Appendix A).

No significant drawdown of the saline aquifer beneath these features is predicted (Figure 4-5). Any mine drawdown of the Loxton-Parilla aquifer beneath these features that does occur (i.e. potentially in the order of centimetres) would be within the range of natural variations and would not result in any significant changes to the loss of surface water from the Great Darling Anabranch or Darling River to the saline aquifer (Appendix A).

The Salt Lakes

At The Salt Lakes, localised groundwater loss from the saline Loxton-Parilla aquifer occurs as a result of evaporation through capillary action, with a salt crust forming on the surface of low lying areas. While there is likely to be some minor reduction in the rate of groundwater loss via evaporation, The Salt Lakes would remain a net groundwater loss area and no measurable impact or alteration of the surface features at The Salt Lakes (e.g. a surface salt crust when not inundated by surface runoff) would be expected (Appendix A).

Other Surface Groundwater Expression Features

There would be no increase in the flux of saline groundwater discharging to any surface water bodies as a result of the Snapper Mine (Appendix A).

The reduction in the water table in the vicinity of the Snapper Mine would potentially have the effect of reducing the flux of saline groundwater to areas of aquifer discharge (e.g. the Murray River and areas west of the Silver City Highway). However, due to the significant distances between the centre of the cone of depression (i.e. relatively shallow hydraulic gradient), any change in flux is estimated to be negligible when compared to that of natural variation (Appendix A).

Groundwater Quality

The Snapper Mine is not predicted to have any significant impact on groundwater quality (Appendix A). The operation would use groundwater to physically convey ore, overburden, concentrate and sand residues through the mining and separation process and would not use any significant chemical reagents. Groundwater which would be returned to the water table would retain the same characteristics as the existing groundwater although a minor volume of the water returned would have a higher concentration of dissolved salts.

Lateral Saline Seepage from Dams and Slurried Materials

Saline seepage from mine storages and from slurried overburden could potentially move laterally into adjoining near surface materials and adversely affect both soils and vegetation. This potential would be limited by the high permeability of the sands that form the majority of the materials involved, however, if areas of low permeability occur beneath entrained saline water, there would be some potential for lateral seepage to occur.

Potential Cumulative Impacts

In order to assess the potential impacts of the Snapper Mine water use, a regional numerical groundwater model was used to assess groundwater availability and to predict the extent of groundwater drawdown in the Loxton-Parilla aquifer in the vicinity of natural surface water systems. The model included assessment and consideration of the potential cumulative effects of the Ginkgo Mine.

4.4.3 Mitigation Measures and Management

Groundwater Users

A revision of the Ginkgo Mine BIMP (BEMAX, 2006a) is proposed and is relevant to both the Snapper and Ginkgo Mines. The revised BIMP would provide:

- a method for using groundwater monitoring data to identify variance to modelled groundwater impacts and thereby trigger investigations or remedial action;
- bore monitoring trigger levels for relevant landholder bores (e.g. Chalky Well);
- investigation methodology to examine any exceedance of relevant triggers; and
- suitable remedial measures (e.g. lowering of the pump set or providing an alternative water supply) that would be undertaken in the event of a significant adverse affect on a landholder bore attributable to the potential cumulative effects of the Snapper and Ginkgo Mines.

Lateral Seepage Management

For the Ginkgo Mine, seepage analyses were carried out to identify seepage management practices that should be incorporated in the design of dam structures so that lateral seepage of saline water did not impact on the environment outside of the initial water dam or initial sand residue dam. The criteria for seepage management adopted for the Ginkgo Mine analyses were that surface breakout seepage and the lateral extent of seepage in the sand horizon did not extend past the downstream toe of the dam embankments (Appendix A).

As a result of the seepage analyses, a number of seepage management measures were adopted into the design of dams and other mining features at the Ginkgo Mine. These features include:

- initial sand residue dam comprised a clay-lined zoned embankment, a cut-off key trench, a toe drain and a compacted clay floor liner;
- foundation preparation under embankments generally consists of reworking the *in situ* soils by moisture conditioning and compaction; and
- spoon drains are constructed around the perimeter of the dams to intercept runoff from the downstream batter slope and drain to sumps for storage and evaporation of the runoff water.

The Snapper Mine initial water dam, initial slurried overburden emplacement and initial sand residue dam would be constructed with this configuration. The above features are shown on Figures 2-5 and 2-6.

In addition, disposal of fines material from the water treatment dams within the backfilled Snapper Mine path would be undertaken in such a manner as to avoid development of a continuous fines layer across the mine path, to minimise the potential for lateral seepage to occur.

Groundwater Monitoring

Groundwater depth and salinity would continue to be monitored monthly at 14 local and regional bores as described in the Ginkgo Mine BIMP. The location of these groundwater monitoring bores is shown on Figure 4-6. Two additional monitoring bores would be installed at the northern and eastern margins of the Snapper Mine MLA area. These bores would be monitored monthly for groundwater depth and quality (including salinity) to identify drawdown of the water table or changes in groundwater quality if they occur as a result of the Snapper Mine.

Monitoring of the ground surface around dams for seepage, salt deposition and effects on vegetation would be included as part of the site environmental monitoring programme.

4.5 SURFACE WATER

4.5.1 Existing Environment

Regional Hydrology

The following discussion is sourced from the Ginkgo EIS (BEMAX, 2001a) as the Snapper Mine would be within the same hydrological setting.

The Snapper Mine area is located within the lower Darling River system, which extends from the Menindee Lakes to the junction of the Darling River and the Murray River at Wentworth. Also included in the lower Darling River system are numerous ephemeral wetland systems that are linked to the Darling River and the Great Darling Anabranch.

The lower Darling River is a component of the larger Barwon-Darling River system, which drains a total area of some 650,000 km^2 and includes large tributary rivers in Queensland and NSW (e.g. Macintyre, Gwydir, Namoi, Castlereagh, Macquarie and Mooni Rivers). The water quality of the Darling River is variable according to the flow volume and to the proportion of flow contributed from each tributary region. It is, however, generally suitable for agricultural use.

The Darling River is typical of most inland Australian rivers in that it is subject to naturally large variations in flow due to the nature of episodic rainfall that occurs within the Barwon-Darling catchment. These natural flow variations have been reduced somewhat in the lower Darling by a series of weirs, regulators and levee banks located at the Menindee Lakes, which are collectively known as the Menindee Lakes storage scheme.

The Menindee Lakes storage scheme was developed in the 1960s to store and conserve flows in the Darling River by converting a series of ephemeral and permanent lakes into water retention structures covering some 45,000 hectares (ha). The scheme supplies water to Broken Hill and South Australia as well as providing regulated water releases to towns and significant areas of irrigation on the lower Darling River system.

South of the Menindee Lakes, the Great Darling Anabranch provides an alternative channel for the Darling River during high flow and flood events (Figure 4-1). The Great Darling Anabranch has a series of ephemeral lakes associated with the stream that fill during flood events. A number of these ephemeral lakes are opportunistically cropped when climatic conditions are suitable.

Snapper Mine Area

As a result of the limited and well dispersed annual rainfall (Section 4.1.1), the sandy soils, limited topographical relief and high evaporation rates, there are no well defined natural drainage channels within the Snapper Mine area. Overland flow does occur during prolonged rainfall events and surface waters accumulate in topographic depressions and then evaporate or seep into the groundwater table over time. No surface water quality data is available for the Snapper Mine area.

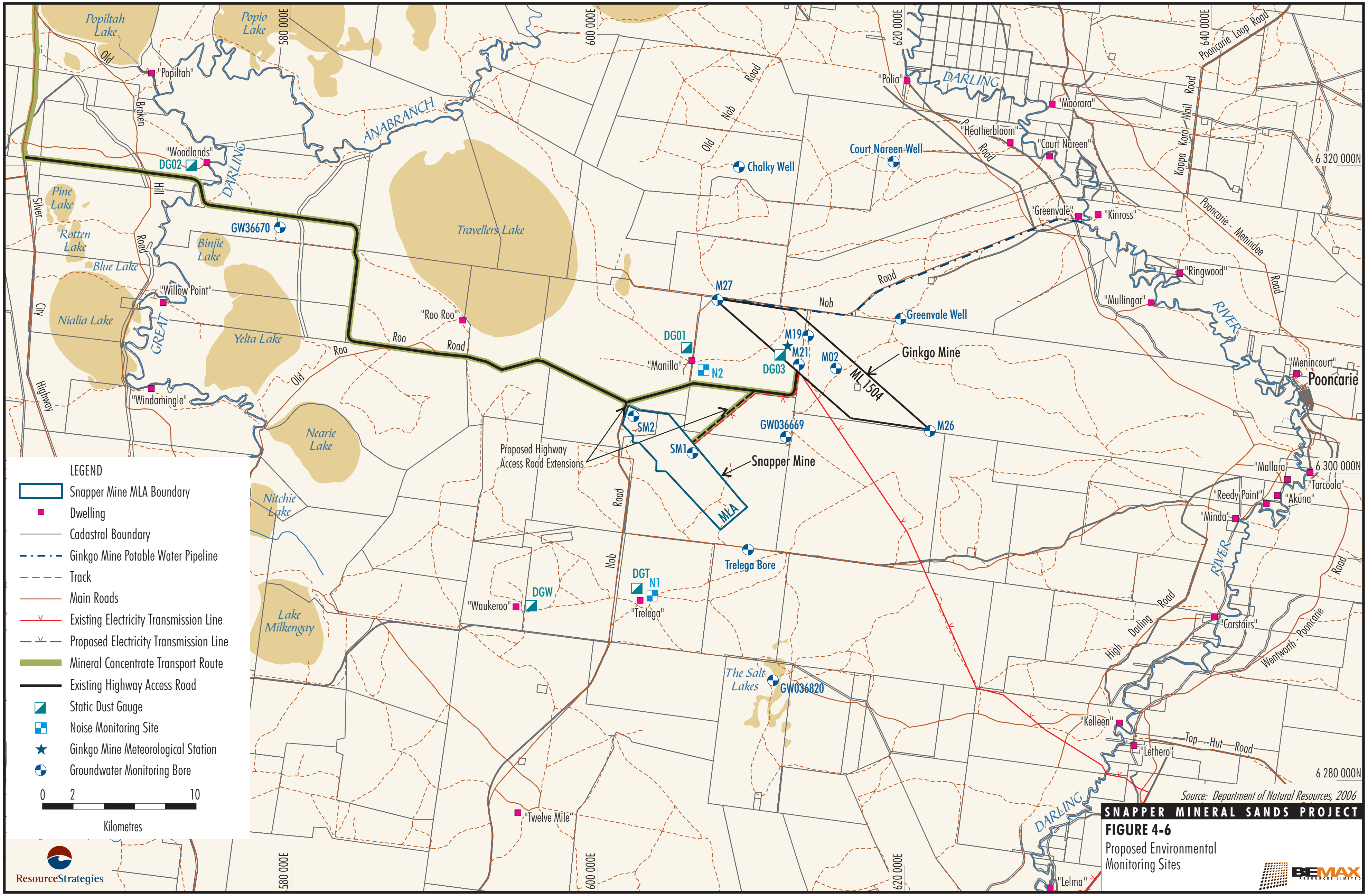

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FIGURE 4-6
Proposed Environmental Monitoring Sites

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4.5.2 Potential Impacts

Snapper Mine Area

The potential impacts of the Snapper Mine on surface water systems are limited due to the distance of the mining activity from any significant surface water systems (Figure 4-1). As described in Section 3.7.1, the DNR has advised that surface water modelling for the Snapper Mine is not required if surface water features are unlikely to be impacted.

The Darling River and Great Darling Anabranch are significant regional surface water features which, at their closest points are located some 30 km south-east and 23 km north-west of the MLA area respectively. The potential cumulative impacts of Snapper Mine groundwater extraction on regional surface water features is discussed in Section 4.4.2.

As described in Section 4.5.1, there are no well defined natural drainage channels within the MLA area and surrounds. However, there would be some potential for diesel or oil spills from mobile equipment and sediment or salt runoff from infrastructure areas to localised short-term water features during heavy rain.

As described in Section 2.6.1, the results of the Acid Rock Drainage Assessment (Appendix H) indicate that the overburden and ore would be non-acid forming. Therefore, no potential acid rock drainage impacts are predicted.

The potential impacts of the application of saline water as a dust suppressant within the MLA area are discussed in Section 4.2.2.

Road Transport

There would be potential for a truck or light vehicle accident on the HAR or Silver City Highway to result in pollution of surface water features (e.g. a spill of fuel to the Great Darling Anabranch).

As described in Section 2.4.9, MSP process waste would be backloaded to the Snapper Mine for disposal. As described in Section 2.6.2, the backloaded MSP process waste would consist of radioactive material (monazite) blended with the other MSP process waste materials.

Assuming similar physical and chemical properties to backloaded Ginkgo Mine MSP process waste, the backloaded MSP process waste would be classified as hazardous under the POEO Act and the *Environmental Guidelines: Assessment, Classification & Management of Liquid and Non-liquid Wastes* (DEC, 2004b), and radioactive under the RC Act (Appendix I). A detailed characterisation of the backloaded MSP process waste materials is provided in Appendix I.

In the event of a road accident or containment failure involving backloaded MSP process waste, there would be limited radiological consequences (due to the limited dispersion capabilities and specific activity of the backloaded waste). Monazite is insoluble in water and, therefore, there should be no dissolution of radionuclides in surface water runoff. In addition, the heavy nature of monazite (specific gravity between 4.6 and 5.4) would reduce its susceptibility to suspension in water, and would therefore limit the potential for its dispersal and the likely extent of surface water contamination (Appendix I).

Disposal of Backloaded MSP Process Waste

The potential hazards and risks associated with the handling and disposal of backloaded MSP process waste at the Snapper Mine has been assessed in a Process Waste Materials Assessment Risk Workshop (Appendix I).

As above, the insolubility and high specific gravity of monazite would limit the potential for suspension in water, and therefore would limit the potential for its dispersal and surface water contamination.

Potential Cumulative Impacts

The areas in and around the Ginkgo and Snapper Mines characteristically have almost no traces of channel flow, and in cases where channels occur, they are shallow, narrow and discontinuous. There are no defined surface drainage features (e.g. drainage channels) that link the Ginkgo and Snapper Mine areas. Potential cumulative impacts on regional surface water features as a result of groundwater drawdown are discussed in Section 4.4.2.

4.5.3 Mitigation Measures and Management

To manage any potential impacts on surface water resources, the Snapper Mine water management system would contain and control waters generated from Snapper Mine development and operation areas, while diverting other runoff water around such areas. The water management system would include permanent features that would continue to operate post-mining and temporary structures that would only be required until the completion of rehabilitation works.

Minimising Disturbance Areas

Areas disturbed by mining would be kept to a minimum. The site would be segregated into undisturbed runoff areas and operation runoff areas through the use of bunding.

Containment and Recycling

During mining, the dredge and primary gravity concentration unit would generally be located below the existing ground level. Water collected in this area would flow to the dredge pond, potentially reducing the amount of water required to be extracted from the borefield.

Operation areas would be separated from upslope surface water flow through the use of diversion bunds and runoff in operation areas would be intercepted and channelled to sumps. Waters stored in these sumps would be managed by priority re-use for dust control watering.

Drainage from disturbance areas around the overburden stripping and overburden replacement operation would be directed to evaporation/sediment sumps for containment. Waters collected in evaporation/sediment sumps would be utilised for dust suppression at the mine site or allowed to evaporate.

Snapper Mine roads and hardstand areas that are to be watered with saline water for dust suppression purposes would be bunded and all runoff contained within evaporation/sediment sumps for re-use. Salts collected in these sumps would be periodically removed and deposited with sand residues behind the dredge pond.

Progressive Stabilisation and Revegetation of Disturbed Areas

Areas disturbed by Snapper Mine activities would be progressively rehabilitated (Section 5). Rehabilitation would involve reprofiling, where necessary, to provide long-term slope stability.

It is anticipated that once rehabilitation is well established, surface runoff would be of comparable quality to undisturbed areas.

Active treatment systems in the form of temporary sediment retention storages, silt fences and passive measures such as vegetation buffers would be employed as interim erosion and sediment control measures during the rehabilitation process as required.

Erosion and Sediment Control

A SWMP would be developed in consultation with the relevant authorities prior to construction of the Snapper Mine. The SWMP would detail all measures to be employed to minimise potential impacts relating to the erosion and sedimentation of the soils and overburden materials to be handled during construction and operation of the Snapper Mine. The SWMP would describe:

- details of temporary and permanent sediment and erosion control systems which would be used during both mine construction and operation;
- details of salinity management;
- measures which would be employed to minimise soil erosion and the discharge of sediment and other pollutants to lands and/or waters during construction activities. The SWMP would be prepared in accordance with the requirements for such plans outlined in *Managing Urban Stormwater: Soils and Construction* (Department of Housing, 1998) or its latest version;
- measures which would be developed and implemented to mitigate the impacts of stormwater runoff from the site following the completion of construction activities;
- measures to construct banks, channels and similar works to divert stormwater away from disturbed and contaminated land surfaces;
- a programme for monitoring and reporting on the stability and effectiveness of the sediment and erosion control systems; and
- details of the management of soil stockpiles, erosion protection, soil stripping techniques and scheduling.

Surface water diversion bunds and drains would be sized to convey runoff generated by a 1 in 20 year, 72 hour critical duration storm event. Runoff from disturbed areas would be channelled to evaporation/sediment sumps where practicable.

Erosion and sediment control structures would be inspected monthly and following significant rainfall events (i.e. greater than 20 mm in 24 hours). Remedial measures would be applied if stability or erosion control faults are identified.

Figure 2-13 provides an illustration of the typical key components of the operational water management system at the mine site during Year 1. Figure 2-12 provides a general water management schematic diagram.

Management of Backloaded MSP Process Waste

Management and mitigation measures that relate to the handling and disposal of backloaded MSP process waste are described in Section 4.2.3.

4.6 ABORIGINAL CULTURAL HERITAGE

A Cultural Heritage Assessment was prepared for the Snapper Mine by Landskape (2007) which assessed Aboriginal cultural heritage and is presented in Appendix B. The assessment was prepared in accordance with the general requirements of the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, 2005a) and is consistent with the *NSW Heritage Manual* (NSW Heritage Office, 1996) and *Assessing Heritage Significance* (NSW Heritage Office, 2001).

4.6.1 Existing Environment

Background

Some of the earliest evidence of human occupation of Australia originates from south-western NSW (Bowler *et al*., 1970, 2003; Thorne *et al*., 1999; Cupper and Duncan, 2006; Olley *et al*., 2006). Stone artefacts found at Lake Mungo approximately 80 km to the east of the Snapper Mine (Lower Darling Region of the Murray Basin) have been dated between 46,000 and 50,000 years old (Bowler *et al*., 2003). Human occupation in the Lake Menindee area dates back to 45,000 years ago (Cupper and Duncan, 2006), with evidence of burial remains of a male and female at Lake Mungo of 42,000 years old (Olley *et al*., 2006, cf. Thorne *et al*., 1999).

Aboriginal people of the Barkindji language group occupied the Lower Darling region at the time of first contact with Europeans (Sturt, 1982 [1833]; 1984 [1844-6]; Mitchell, 1839; Krefft, 1865; Eyre, 1985 [1842]).

At this time the Barkindji were hunter-fisher-gatherers and appear to have led a semi-sedentary lifestyle. Early accounts from the 1850s by the German naturalist Gerard Krefft (1865) suggest that the Barkindji lived along the Lower Darling and Murray Rivers during the warmest months of the year, with people moving away from the rivers into the dunefields to collect food after winter rains (Appendix B).

Within a decade of the first contact with Europeans, many of the Barkindji were living adjacent to pastoral homesteads, often working as shepherds or engaged in other labouring activities (Lans *et al.*, 1988; Withers 1989). By 1893, the last of the Barkindji to live a traditional existence in the area had also been brought into non-traditional settlements (Hardy, 1976; Withers, 1989).

A grant of 640 acres of land was set aside on “Mallara” and “Tarcoola” stations for an Aboriginal mission reserve in 1911 (Hardy, 1976; Lans *et al*., 1988). The mission closed in 1933 and most of the families moved to Menindee.

Previously Recorded Aboriginal Cultural Heritage Sites

The types of Aboriginal cultural heritage sites previously recorded in the Lower Darling region consist of stone artefact scatters, hearths, freshwater shell middens, earth mounds, stone quarries, modified trees, stone arrangements, ceremonial grounds and natural sacred sites and burials (Appendix B).

Witter (2001) and Cupper (2003) previously surveyed the Ginkgo Mine and ancillary infrastructure routes. Witter (2001) identified 36 sites within the Ginkgo Mine MLA area of which the majority were isolated finds of stone artefacts or heat retainers from hearths. The remaining sites featured artefact scatters, some containing hearths and a stone quarry and stone artefact scatter site complex. In addition, Cupper (2003) located 13 sites within the dunefields and sandplains traversed by the HAR and ETL to the Ginkgo Mine. Ten of these sites were isolated finds of stone artefacts, with two hearth sites and one stone artefact scatter.

The DEC Aboriginal Heritage Information Management System (AHIMS) site database indicates six registered Aboriginal archaeological sites (isolated silcrete stone artefacts) within approximately 10 km of the Snapper Mine area. The closest of these sites is an isolated stone artefact (DEC site number 39-3-0043) recorded by Witter (2001) approximately 1 km north of the Snapper Mine ETL extension (Appendix B).

Consultation with the Aboriginal Community

The completion of the Cultural Heritage Assessment (Appendix B) included significant input from, and consultation with, the Aboriginal community. This included:

- preliminary inspection of the Snapper Mine disturbance area with Barkindji Elders (March 2006);
- discussion of the nature of the development and proposed Cultural Heritage Assessment methodology;
- Aboriginal participation in the field surveys of the Snapper Mine disturbance area (October 2006);
- discussion of the findings of the survey and assessment with Aboriginal representatives and provision of a draft assessment report to interested parties;
- consideration of comments and advice received from Aboriginal representatives in the finalisation of the Cultural Heritage Assessment; and
- feedback regarding the finalised report from the participating Aboriginal community (Appendix B).

Aboriginal Cultural Heritage Sites in the Snapper Mine Area

The Snapper Mine archaeological field survey was undertaken from 16 to 27 October 2006. Two sampling methods (i.e. area surveys and linear transects) were used. Twenty-two Aboriginal archaeological sites (SN01-22) were identified (Figure 4-7). Table 4-5 provides a summary of the physical characteristics of the sites and the location of the sites within the Snapper Mine area.

Of the sites presented in Table 4-5, sites SN20 and SN22 were considered to be of moderate-to-high significance, the remainder are considered to be of low or low-to-moderate significance (Appendix B).

4.6.2 Potential Impacts

The potential impacts of the Snapper Mine on Aboriginal cultural heritage would include direct impacts such as disturbance of sites via the removal of the soil and substrate and indirect impacts (e.g. inappropriate visitation) at some sites that are outside of the immediate Snapper Mine disturbance area.

Table 4-5
Identified Aboriginal Archaeological Sites

Site Name	Physical Characteristics	Location (Figure 4-7)
SN01, SN11	Quarried silicified and ferruginized sandstone cobbles with associated silcrete artefacts.	Sandplains at the southern end of the Snapper Mine MLA area.
SN02	Scatter of silcrete, chert and quartz artefacts with two associated *in situ* hearths of baked clay heat retainers.	Adjacent to a small ephemeral depression at the northern end of the Snapper Mine MLA area.
SN03, SN05	Isolated finds of a silcrete scraper and fragment of a quartzite pestle/hammerstone.	Northern end of the Snapper Mine MLA area.
SN04, SN06	Scattered baked clay heat retainers from eroded hearths.	
SN07	Scatter of silcrete and quartz artefacts with associated scattered calcrete hearthstones.	
SN08, SN10, SN12, SN13, SN14, SN15, SN17, SN18, SN19, SN21	Scatters of silcrete artefacts.	Southern end of the Snapper Mine MLA area.
SN09, SN16	Isolated finds of silcrete artefacts.	
SN20, SN22	Quarried silcrete outcrops with associated scatters of silcrete artefacts.	

Source: After Appendix B

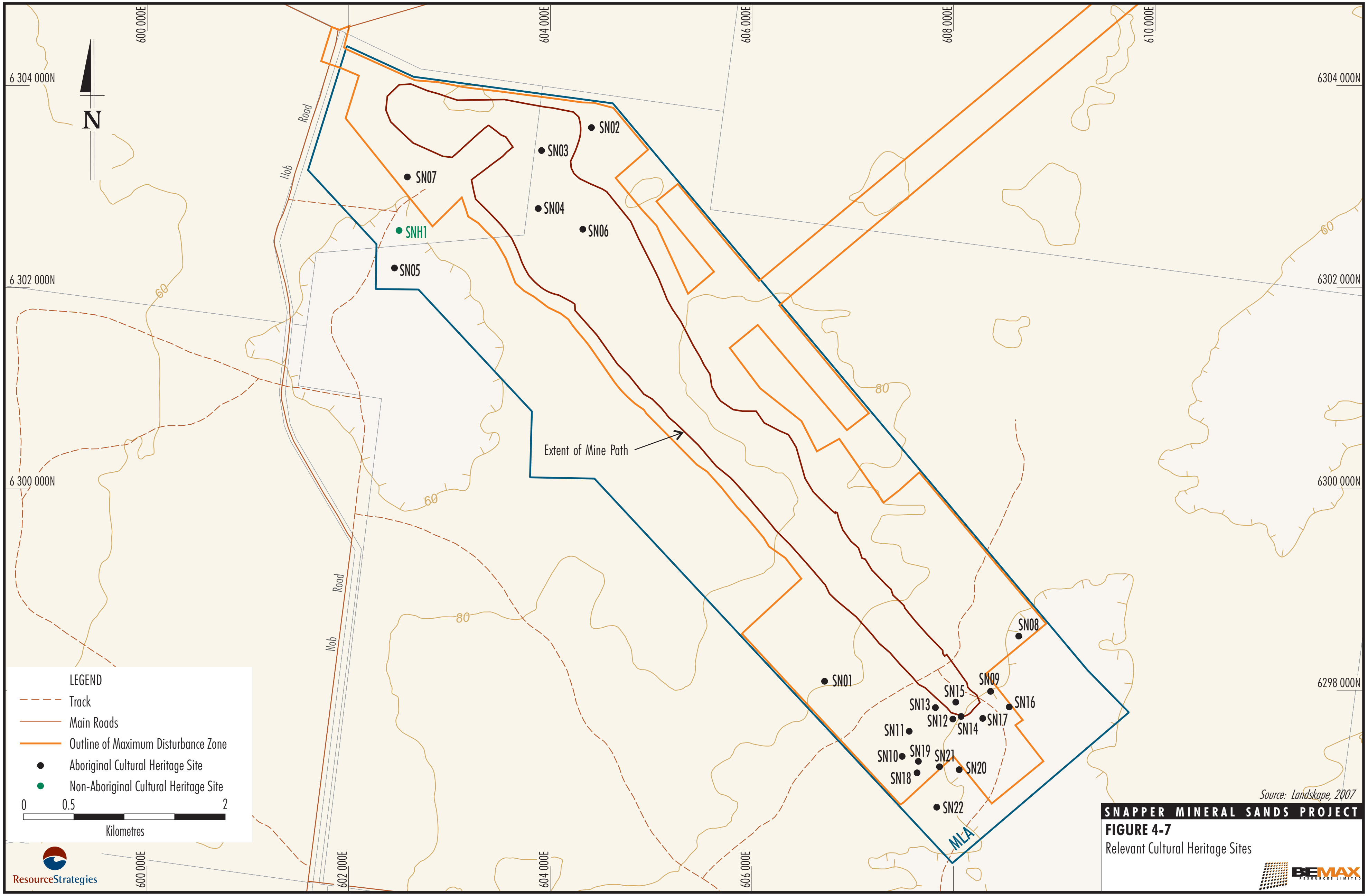

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FIGURE 4-7

Relevant Cultural Heritage Sites

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Direct Impacts

Nineteen cultural heritage sites located within the Snapper Mine disturbance area would be subject to direct disturbance during the life of the Snapper Mine. These comprise ten cultural heritage sites of low-to-moderate significance (e.g. stone artefact scatters) and nine cultural heritage sites of low significance (e.g. isolated finds).

Mine operation would also disturb the current land surface and the archaeological material associated with the affected landforms (including archaeological material that may occur in the soil profile that has not been identified during the site survey) and alter the substrate and landscape context.

Indirect Impacts

Three Aboriginal cultural heritage sites have been identified outside the Snapper Mine disturbance area. Two cultural heritage sites are of moderate to high significance (stone quarries with associated stone artefact scatters – Sites SN20 and SN22) and one is of low significance (stone artefact – SN05).

The sites could be indirectly impacted by the Snapper Mine in the absence of relevant mitigation measures. Potential indirect impacts to archaeological sites could include the following:

- deposition of dust generated by mining;
- accidental disturbance by peripheral activities; and
- inappropriate visitation.

Potential Cumulative Impacts

The development of the Snapper Mine, along with the Ginkgo Mine, would result in potential cumulative impacts on Aboriginal heritage in the region. However, the survey and assessment of these development areas have also led to a greater understanding and documentation of Aboriginal heritage in the area between the Darling River and Great Darling Anabranch.

The implementation of Aboriginal heritage management measures as described below and in the *Barkandji Heritage Management Plan* (BEMAX, 2004b) would minimise potential cumulative impacts where practicable.

4.6.3 Mitigation Measures and Management

The following Snapper Mine mitigation and management measures to minimise the potential impacts on Aboriginal heritage are based on the results of the Cultural Heritage Assessment and consultation with representatives of the local Aboriginal community:

- Cultural heritage management strategies for the Snapper Mine would be integrated into an ACHMP (similar to the *Barkandji Heritage Management Plan* [BEMAX, 2004b] already implemented for the Ginkgo Mine). The ACHMP would be prepared in consultation with the local Aboriginal community and the DEC.
- Training would be provided to all on-site personnel regarding the ACHMP strategies and constraints relevant to their employment tasks.
- If human skeletal remains are encountered during the course of the development, all work in the immediate area would cease and the police and/or DEC would be contacted (depending on the suspected age of the remains).
- Where cultural heritage materials are within the Snapper Mine disturbance area, BEMAX would engage a suitably qualified archaeologist and representatives of the local Aboriginal community to record and collect a representative sample of scientifically and culturally significant items from the sites. These items would be curated and stored in the 'Keeping Place' at BEMAX's Ginkgo Mine, and replaced within rehabilitated areas in consultation with the local Aboriginal community and the DEC.
- Consultation with the relevant local Aboriginal community members in matters pertaining to development of the Snapper Mine would continue. The recording, collection, curation and replacement of recovered materials would occur with the invited participation of local Aboriginal community representatives. Consideration would also be given to providing employment opportunities to local Aboriginal community members and their organisations.
- BEMAX would engage an archaeologist to investigate the lithic technologies and reduction strategies adopted at Aboriginal cultural heritage sites within the Snapper Mine disturbance area and analyse and describe their local and regional contexts.

- Hearths from SN02 would be excavated by a suitably qualified archaeologist and representatives of the local Aboriginal community and dated by radiocarbon and/or luminescence techniques to determine their age.
- Temporary barriers would be erected around sites SN20 and SN22 and maintained during the life of the Snapper Mine and its rehabilitation.
- If works are to be undertaken in the vicinity of site SN05 (Figure 4-7), a temporary barrier would be erected around the site to avoid accidental damage.

Mitigation measures relevant to dust control (Section 4.12.3) would minimise indirect impacts to archaeological sites from dust deposition.

4.7 NON-ABORIGINAL CULTURAL HERITAGE

A Cultural Heritage Assessment was prepared for the Snapper Mine by Landskape (2007) which assessed non-Aboriginal cultural heritage and is presented in Appendix B. The Cultural Heritage Assessment is generally consistent with the *NSW Heritage Manual* (NSW Heritage Office, 1996) and *Assessing Heritage Significance* (NSW Heritage Office, 2001).

4.7.1 Existing Environment

Snapper Mine Setting

The explorer Captain Charles Sturt was the first European to visit south-western NSW, passing the junction of the Lower Darling River with the Murray River during his 1829-1831 expedition of the Murrumbidgee and Murray Rivers (Sturt, 1982 [1833]). Within seven years of Sturt's expedition, the route along the Murray was used to drive cattle overland from the colony of NSW to Adelaide. The junction of the Murray and Darling Rivers became an important stopover location for these overland cattle drives and became known as Hawdon's Ford.

By the 1860s much of the Lower Darling and Murray River frontage had been occupied by pastoral squatters (Tulloch, 1984; Lans *et al*., 1988; Withers, 1989).

A policy of closer settlement was pursued in the Lower Darling region with the passing of the *Western Lands Act* in 1901. Some sections of the old pastoral holding of Avoca were resumed and subdivided into smaller Western Lands perpetual lease holdings in 1903 and 1904 (NSW Department of Lands, 1912). The Snapper Mine MLA area is located on two pastoral leases ("Trelega" and "Carstairs" stations). These were originally part of the large Avoca pastoral holding, which was centred further south on the Darling River.

Previously Recorded Non-Aboriginal Cultural Heritage Sites

The types of non-Aboriginal cultural heritage sites that occur in the Lower Darling region include pastoral sites, transport sites, water regulation and irrigation sites (Appendix B).

The NSW State Heritage Inventory contains items listed by the Heritage Council under the *Heritage Act, 1977*. The Wentworth LEP also lists heritage sites within the Wentworth Shire.

The "Windamingle" homestead is the closest registered (NSW Heritage database) site to the Snapper Mine and is located approximately 33 km south-west of the Cultural Heritage Assessment study area (NSW Heritage Office, 2006) (Appendix B).

The "Carstairs" homestead is listed as a heritage item (WSC, 1993, 2006) in the Wentworth Shire Heritage Study (WSC Heritage Item Number 103) (Hassell Planning Consultants, 1989; WSC, 1993) and is located approximately 30 km east of the development (Appendix B).

Further detail on previous studies is outlined in Appendix B.

Snapper Mine Non-Aboriginal Cultural Heritage Sites

One non-Aboriginal cultural heritage site ("Kertne Nob" outstation and stockyard ruin - SNH1) was identified in the Snapper Mine MLA area (Appendix B) (Figure 4-7). The site is approximately 100 x 100 m in area and once contained timber stockyards and a nearby area where station workers camped. Physical remains of these activities include a timber frame of a canvas tent and scattered domestic refuse including glass bottles, broken bottle glass, burnt animal bone, food cans and vacuum oil drums (Appendix B). All that remains of the stockyards are the timber bases of the posts and wrought iron braces and heavy gauge wire originally used to fix the rails.

Site SNH1 is of low to moderate local/regional significance and there are better preserved and more original examples of rural outstations in the region (Appendix B).

4.7.2 Potential Impacts

SNH1 is not located within the Snapper Mine disturbance area (Figure 4-7) and would not be subject to direct impacts, but would potentially be subject to indirect impacts from dust, accidental damage and inappropriate visitation.

No potential cumulative impacts with the Ginkgo Mine have been identified.

4.7.3 Mitigation Measures and Management

To avoid accidental disturbance of site SNH1, a temporary protective barrier would be erected around the site if works are to be undertaken in its vicinity.

Mitigation measures relevant to dust control (Section 4.12.3) would minimise indirect impacts to non-Aboriginal sites from dust deposition.

4.8 TRANSPORT

A Road Transport Assessment that considers potential traffic impacts during both the construction and operation phases of the Snapper Mine has been undertaken by Traffix (2007) (Appendix C).

4.8.1 Existing Environment

Road Hierarchy

Main Roads

The main arterial road of the mineral concentrate transport route is State Highway No. 22 (Silver City Highway), which provides a sealed north-south route connecting Mildura to the south with Broken Hill in the north (Figure 4-1). State Road (SR) 68 provides a north-south arterial route to the east of the Snapper Mine, connecting the township of Wentworth with Pooncarie and Menindee in the north (Figure 4-1). SR 68 is sealed between Wentworth and Pooncarie and is unsealed north of Pooncarie.

Local Roads

Local unsealed roads in the vicinity of the Snapper Mine include Old Roo Roo Road and Nob Road, which provide unsealed east-west routes connecting the Silver City Highway with SR 68 (Figure 1-2).

The existing 64 km HAR from the Ginkgo Mine to the Silver City Highway comprises an unsealed road some 8 m wide (including sections of Old Roo Roo Road and Nob Road) (Figure 1-2).

Access to the MSP is obtained from the Silver City Highway via Kanandah Road and Pinnacles Road (Figure 4-8).

Private Road

The section of the HAR to the east of Nob Road (Figure 1-2) is a private road maintained by BEMAX.

Ginkgo Mine Haulage

The Ginkgo Mine presently uses a fleet of 55 t payload double road trains to transport materials to and from the MSP via the mineral concentrate transport route (Section 2). This activity is undertaken in accordance with the Ginkgo Mine and MSP TCC (BEMAX, 2006b) and the Ginkgo Mine and MSP THMP (BEMAX, 2006c).

The Ginkgo Mine and MSP TCC (BEMAX, 2006a) outlines a range of traffic and transport management measures and traffic courtesy principles that are required from the transport contractors.

BEMAX has undertaken a series of road upgrades on the HAR and relevant intersections on the mineral concentrate transport route to Broken Hill to suitable specifications for the use of triple road trains. A road maintenance programme for the length of the HAR is also in place.

Background Traffic Volumes

As a component of the Road Transport Assessment, available traffic flow data was reviewed and Snapper Mine specific traffic counts were conducted. In order to establish base case weekday traffic flows against which Snapper Mine traffic generation can be assessed, the measured traffic flows have been adjusted upwards to conservatively include peak operational Ginkgo Mine traffic (Appendix C).

The relevant traffic counter locations are shown on Figures 4-1 and 4-8 and the base case daily traffic volumes (including estimated peak Ginkgo Mine flows) are summarised in Table 4-6.

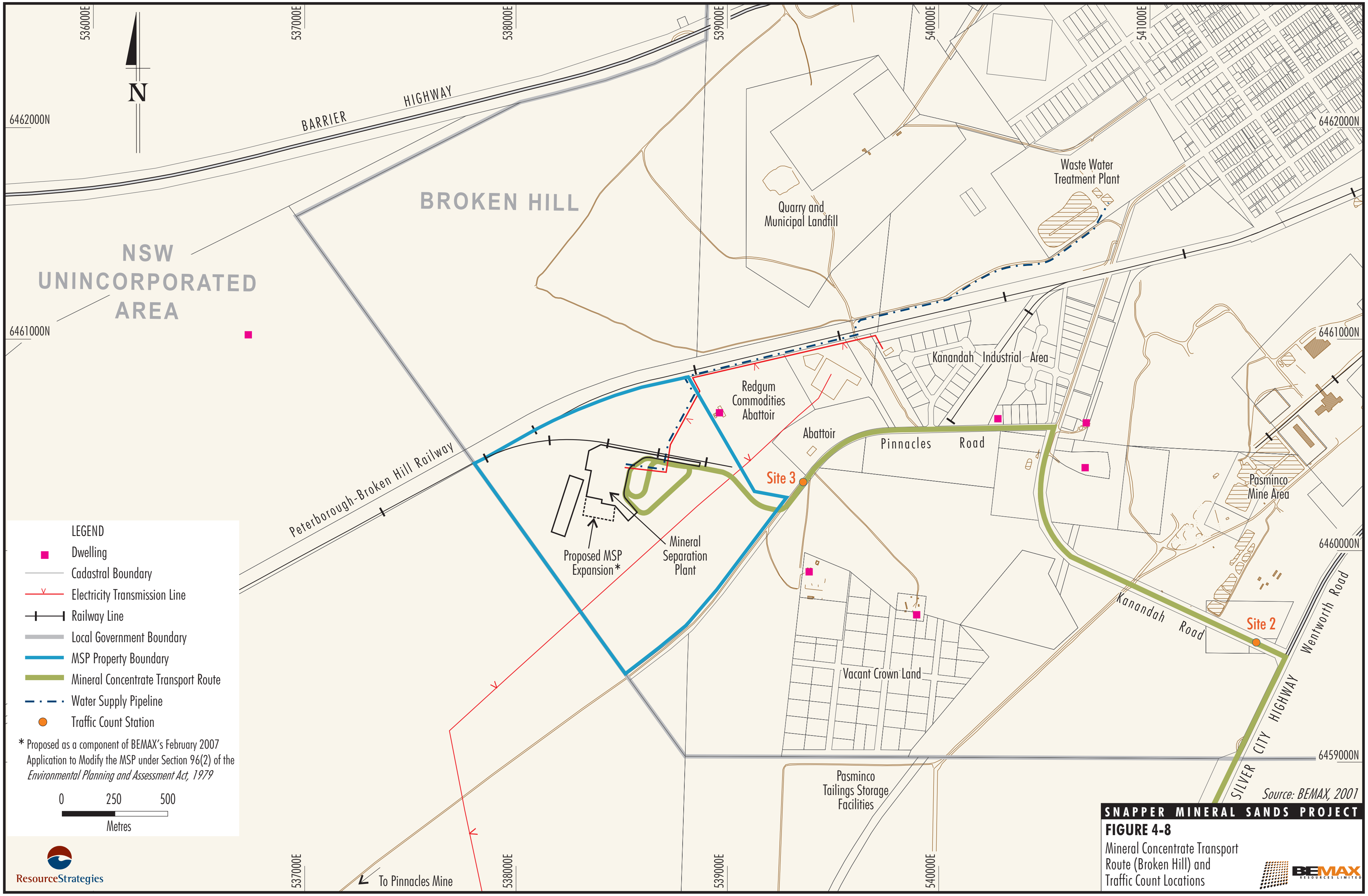

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FIGURE 4-8

Mineral Concentrate Transport Route (Broken Hill) and Traffic Count Locations

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Table 4-6
Estimated Base Case Average Weekday Traffic Flows – Including Ginkgo Mine at Full Production

Station Number[1]	Road	Location	Estimated Traffic (combined two-way)	
			Daily Flows	% Heavy Vehicles
RTA 98.002	Silver City Highway	13 km south of Eyre Street (Broken Hill)	543[2]	35
Survey Site 1	HAR	East of Silver City Highway	162[3]	45
Survey Site 2	Kanandah Road	West of Silver City Highway	628	25
Survey Site 3	Pinnacles Road	East of MSP Access Road	406[3]	30

Source: Appendix C

Notes

1 Figures 4-1 and 4-8.

2 Estimated weekday flow - based on 2002 Annual Average Daily Traffic (AADT), plus 10% plus peak Ginkgo Mine traffic.

3 Includes 2006 measured Annual Average Weekly Traffic (AAWT) traffic flows, plus peak Ginkgo Mine traffic

The ease of travel (Level of Service) provided by the Silver City Highway, the HAR, Kanandah Road and Pinnacles Road at these traffic levels is considered to be Level of Service A (i.e. drivers are virtually unaffected by the presence of other vehicles in the traffic stream) (Appendix C).

Road Safety

Traffix reviewed available traffic accident data for the period May 2001 to June 2006 for the length of Kanandah Road between Pinnacles Road and the Silver City Highway, and for the Silver City Highway between Kanandah Road and Wentworth.

No accidents were recorded for the length of Kanandah Road between Pinnacles Rd and the Silver City Highway in the data period. Analysis of the data on the Silver City Highway identified that there were a total of 37 reported personal injury accidents in the period, five of which were fatalities.

Traffix identified no particular accident patterns or causation factors and concluded that there is no cluster site that represents a blackspot that would warrant further investigation (Appendix C).

4.8.2 Assessment of Potential Impacts

Road Extensions

Two additional sections of HAR would be constructed to service the Snapper Mine site (Figure 1-2). To the north-west of the MLA area, approximately 1 km of road would be constructed.

To provide access to and from the Ginkgo Mine site, approximately 6 km of road would be constructed to the east of the MLA area. Both of these sections of road would be constructed to the same specifications as the existing HAR.

Other roads required for the Snapper Mine would include internal access roads at the mine site and maintenance tracks along the new section of ETL.

Traffic Generation

Predicted Snapper Mine daily traffic generation during the construction and operation phases would include light traffic associated with workforce and visitor movements as well as heavy vehicle deliveries and haulage of mineral concentrates to, and backloaded process waste from, the MSP (Table 4-7).

Table 4-7
Predicted Snapper Mine Daily Traffic Generation

Phase	Light	Heavy	Total
Construction	223	2	225
Operation	131	42	173

Source: After Appendix C

Predicted distribution of the additional Snapper Mine traffic on the local and regional road network is provided in Table 4-8.

Table 4-8
Potential Impacts of Snapper Mine on Baseline Traffic Flows

Road	Station Number	Location	Baseline Traffic Volume[1]	Plus Snapper Mine Construction	Plus Snapper Mine Operation
Silver City Highway	RTA 98.002	13 km south of Eyre Street (Broken Hill)	543	657	651
HAR	Survey Site 1	East of Silver City Highway	162	387	335
Kanandah Road	Survey Site 2	West of Silver City Highway	628	742	736
Pinnacles Road	Survey Site 3	East of MSP Access Road	406	406	478

Source: After Appendix C

1 Refer to Table 4-6

The traffic volumes shown in Table 4-8 are moderate and the predicted additional Snapper Mine traffic would have little effect on the existing levels of service of the road network, with all roads remaining at Level of Service A (Appendix C).

Peak Hour Intersection Performance

A consideration of the potential impacts of additional Snapper Mine traffic at peak hour periods has been included in Appendix C. Traffix concluded that the Snapper Mine at shift changeover times on Mondays and Fridays would contribute a maximum of 166 vehicles per hour and 72 vehicles per hour during construction and operation respectively (e.g. at the intersection of the HAR and Silver City Highway).

The existing intersection geometry is suitable for these flows and the changes associated with Snapper Mine peak hour traffic would be small and occur at times (i.e. before 7.00 am and after 7.00 pm) when background traffic volumes on the public road system would be minimal (Appendix C).

Potential Cumulative Traffic Impacts with Ginkgo Mine at Full Production

The current traffic volume that was measured on the HAR (71 vehicle movements per day) (Appendix C) is below the potential maximum daily traffic generation predicted for the Ginkgo Mine EIS. In order to make sure that the Road Transport Assessment considered potential cumulative impacts of the Ginkgo Mine at full production, the baseline traffic volumes were adjusted upwards (Table 4-6). The inclusion of additional vehicles to account for Ginkgo Mine at full production did not alter the levels of service at relevant intersections, due to the overall low traffic volumes involved.

Consideration of Future Background Traffic Growth

Background traffic growth in urban and coastal areas can be a significant consideration when developing long-term projects that involve road transport of products and materials. The Snapper Mine is not predicted to have an adverse impact on traffic flows or change the design requirements of existing intersections, even if background traffic flows were to grow by more than 20% over the life of the Snapper Mine (Appendix C).

Car Parking

Sufficient car parking for the Snapper Mine construction and operation workforce would be provided on-site in accordance with the requirements of the WSC.

Road Safety

The Snapper Mine development would increase usage of the Silver City Highway and other relevant roads, however, with the implementation of the traffic management measures outlined in Section 4.8.3 no significant additional road safety issues are anticipated (Appendix C).

Use of Vehicles Larger Than Double Road Trains

As described in Section 2.3.2, BEMAX is considering the use of vehicles longer than double road trains (e.g. AB-triple vehicles) for the haulage of materials between the Ginkgo and Snapper Mines and the MSP. BEMAX have an in principle agreement with the RTA to use AB-triple road trains, subject to some further assessment (Section 4.8.3) and subsequent RTA approval.

4.8.3 Mitigation Measures and Management

As described in Section 2.3.2, additional sections of HAR would be constructed to provide access to the Snapper Mine. The HAR extensions are shown on Figure 1-3. The final HAR alignment would be determined in consultation with the relevant landholders. Other traffic management measures which would be undertaken include:

- The Ginkgo Mine and MSP TCC (BEMAX, 2006b) would be updated to include transport activities relevant to the Snapper Mine and would be implemented.
- The Ginkgo Mine and MSP THMP (BEMAX, 2006c) would be updated to include transport activities relevant to the Snapper Mine and would be implemented.
- Extensions of the HAR to provide access to the Snapper Mine would be designed and constructed as per the specifications for the existing Ginkgo Mine HAR. Any roadworks that are required on the public road network would be designed in accordance with the RTA *Road Design Guide* (RTA, 2003a) and in consultation with the WSC, BHCC and RTA where relevant.
- Traffic management plans would be completed to address any roadworks on public roads (e.g. intersection of the new sections of HAR with the existing HAR) in consultation with the WSC and the RTA and in accordance with the RTA *Traffic Control at Worksites Manual* (RTA, 2003b).
- The existing Ginkgo Mine road pavement condition monitoring programme along the mineral concentrate route would be updated to include transport activities relevant to the Snapper Mine (e.g. inclusion of the extended section of the HAR).
- In consultation with the RTA, prior to the use of longer haulage vehicles than the currently operating double road trains, BEMAX would undertake an assessment of equivalent standard axle loading of the increased haulage rate associated with the additional Snapper Mine haulage and conduct an assessment of the tracking fidelity of such vehicles.
- BEMAX would encourage car pooling and other traffic minimisation measures (e.g. use of shuttle buses from the Ginkgo Mine accommodation camp) where practicable.

4.9 FLORA

A Flora Assessment was prepared for the Snapper Mine by FloraSearch and Resource Strategies and is presented in Appendix E. The Flora Assessment was prepared generally in accordance with the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and with consideration of the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (DEC, 2004a).

4.9.1 Existing Environment

Snapper Mine Setting

The Snapper Mine is located near the centre of the Far South Western Plains Botanical Division of NSW (Anderson, 1968; Harden, 1990-2002). It is also located within the Murray-Darling Depression (MDD) Region as defined by the *Interim Biogeographic Regionalisation for Australia* (Thackway and Cresswell, 1995; DEH, 2006a). The MDD Region lies entirely within the Western Division of NSW (Sahukar *et al*., 2003) and is based on the Murray Basin geological formation which encompasses significant parts of inland south-eastern South Australia and north-western Victoria. The Murray, Murrumbidgee, Lachlan, Darling, Barron and Yanda River catchments are included in the MDD Region. Landuse in the nearby area is predominantly livestock grazing of native pastures by sheep and cattle on Perpetual Western Land Leases.

Previous Vegetation Studies

The vegetation of areas within the MDD Region in NSW has been the subject of many studies in recent years and the vegetation present has been relatively well defined (Bower and Porteners, 2001; Morcom and Westbrooke, 1990; Fox, 1991; Westbrooke and Miller, 1995; Porteners *et al.,* 1997; Westbrooke *et al.,* 1997; Westbrooke *et al.,* 1998). Fox (1991) published detailed accounts and mapping of the vegetation communities on the Anabranch 1:250,000 mapsheet. Most recently the DNR (2005), through the Lower Murray Darling Catchment Management Authority (CMA), has produced a vegetation map covering the wider CMA area.

Benson *et al.* (2006) have reviewed previous published and unpublished work to compile a comprehensive list and descriptions of the plant communities of the NSW Western Plains as part of the NSW Vegetation Classification and Assessment Project. The Flora Assessment has been prepared with consideration of this contemporary work (e.g. nomenclature).

Field Surveys

Flora surveys were conducted for the Snapper Mine by FloraSearch in autumn and spring 2006 (Appendix E). The surveys were used to identify, describe and map vegetation communities present in the Snapper Mine area and surrounds and to compile comprehensive lists of flora species in each vegetation community.

Targeted searches for threatened flora species and ecological communities considered possible occurrences within the Snapper Mine area were conducted. All habitat types were surveyed to maximise the chances of finding populations of any threatened species that may occur.

Vegetation Communities in the Snapper Mine Area

Seven plant communities were identified in the Snapper Mine area (Figures 4-9 and 4-10). The vegetation communities identified are listed below:

- Black Box Woodland dominated by Black Box (*Eucalyptus largiflorens*).
- Black Oak-Rosewood-Wilga Woodland dominated by Black Oak (*Casuarina pauper)*, Rosewood *(Alectryon oleifolius* subsp. *canescens)* and Wilga *(Geijera parviflora).*
- Chenopod Mallee Woodland/Shrubland dominated by White Mallee (*Eucalyptus dumosa*), Pointed Mallee (*E. socialis*), Yorrell (*E. gracilis*) and *Maireana* spp.
- Irregular Dune Mallee Shrubland dominated by White Mallee (*Eucalyptus dumosa*), Pointed Mallee *(E. socialis*), Yorrell (*E. gracilis*) and Spinifex (*Triodia scariosa* subsp. *scariosa*).
- Turpentine Shrubland dominated by Turpentine (*Eremophila sturtii*).
- Bluebush Shrubland dominated by Black Bluebush (*Maireana pyramidata*) and/or Pearl Bluebush (*M. sedifolia*).
- Austrostipa Grassland dominated by Speargrass *(Acacia nitida).*

The condition of the vegetation in the Snapper Mine area is degraded mainly due to past pastoral land management practices (e.g. grazing, thinning and burning) and as a result, the vegetation is likely to be sub-optimal with respect to its flora and fauna components (Appendices D and E). Of the seven vegetation communities listed above, two (i.e. Bluebush Shrubland and Austrostipa Grassland) are considered to be secondary vegetation communities resulting from removal of the original tree cover by pastoral landholders to promote grass and herb growth for stock grazing (*ibid*.).

The vegetation communities form a mosaic such that the degree of connectivity within each vegetation community varies (Figure 4-9). The Black Oak – Rosewood - Wilga Woodland (*Casuarina pauper/Alectryon oleifolius* subsp. *canescens/Geijera parviflora*) vegetation community is the most dominant vegetation type within the study area.

Flora Species Composition

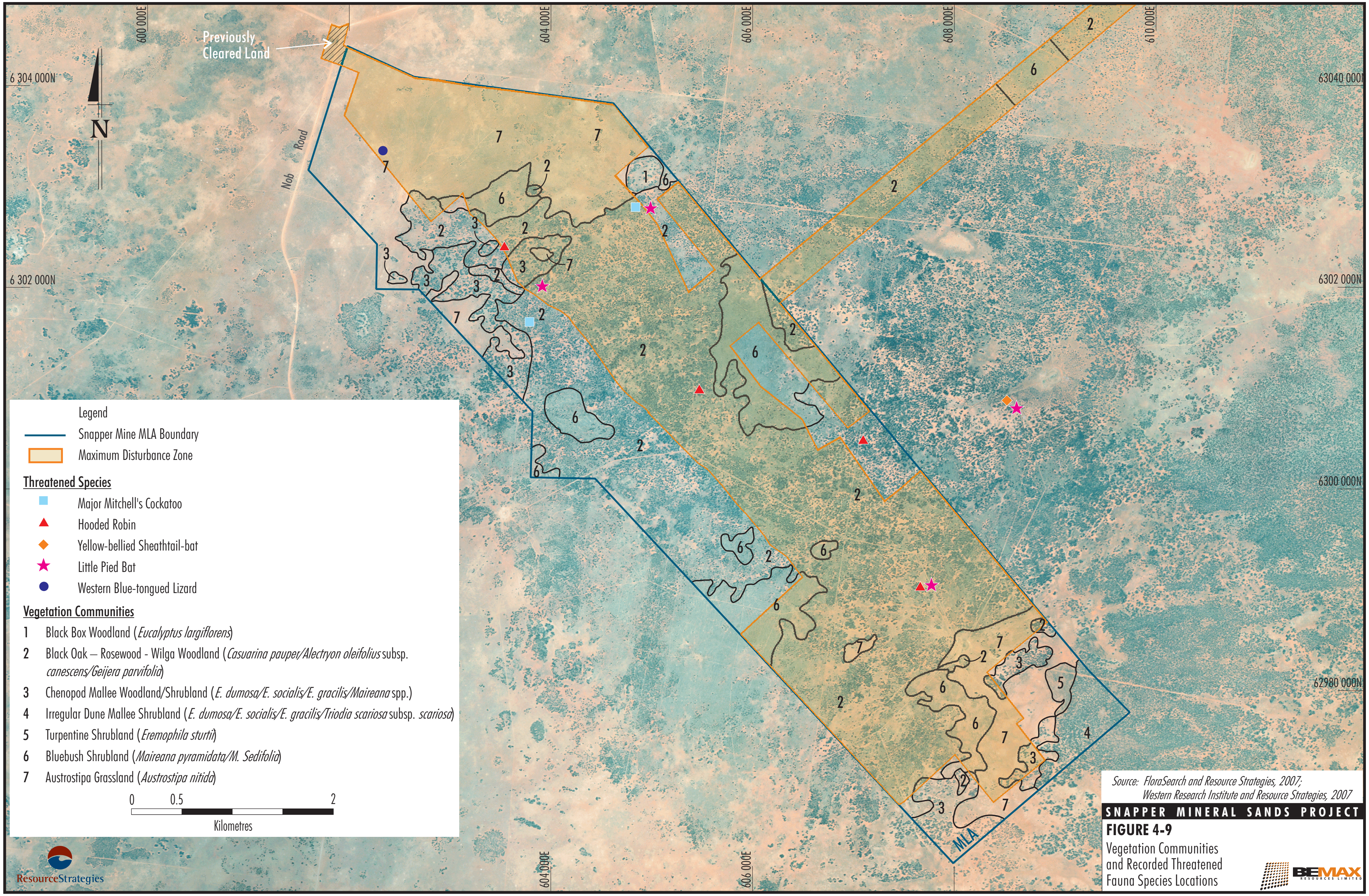
A total of 145 vascular plant species were identified within the Snapper Mine area, of which 111 are native (Appendix E). The most prominent families of native plants in descending order were the Chenopodiaceae (Saltbushes), Asteraceae (Daisies), Myrtaceae (Eucalypts), Zygophyllaceae (Twinleaves), Brassicaceae (Brassicas) and the Poaceae (Grasses). The dominant families of introduced plant species were the Asteraceae (Daisies), Poaceae (Grasses), Brassicaceae and the Caryophyllaceae. A list of the plant species recorded in the Snapper Mine area is provided in Appendix E.

Threatened Flora Species

A database search indicated that threatened flora species are known or considered likely to occur within the wider region. However, no species listed as threatened under the TSC Act or the federal EPBC Act were identified during the surveys for the Snapper or Ginkgo Mines.

Endangered Ecological Communities

Four ecological communities listed as endangered are known to occur in the MDD Region, three under the TSC Act and one under the EPBC Act (Appendix E). However, no threatened ecological communities listed under the TSC Act or the EPBC Act were identified during the surveys.



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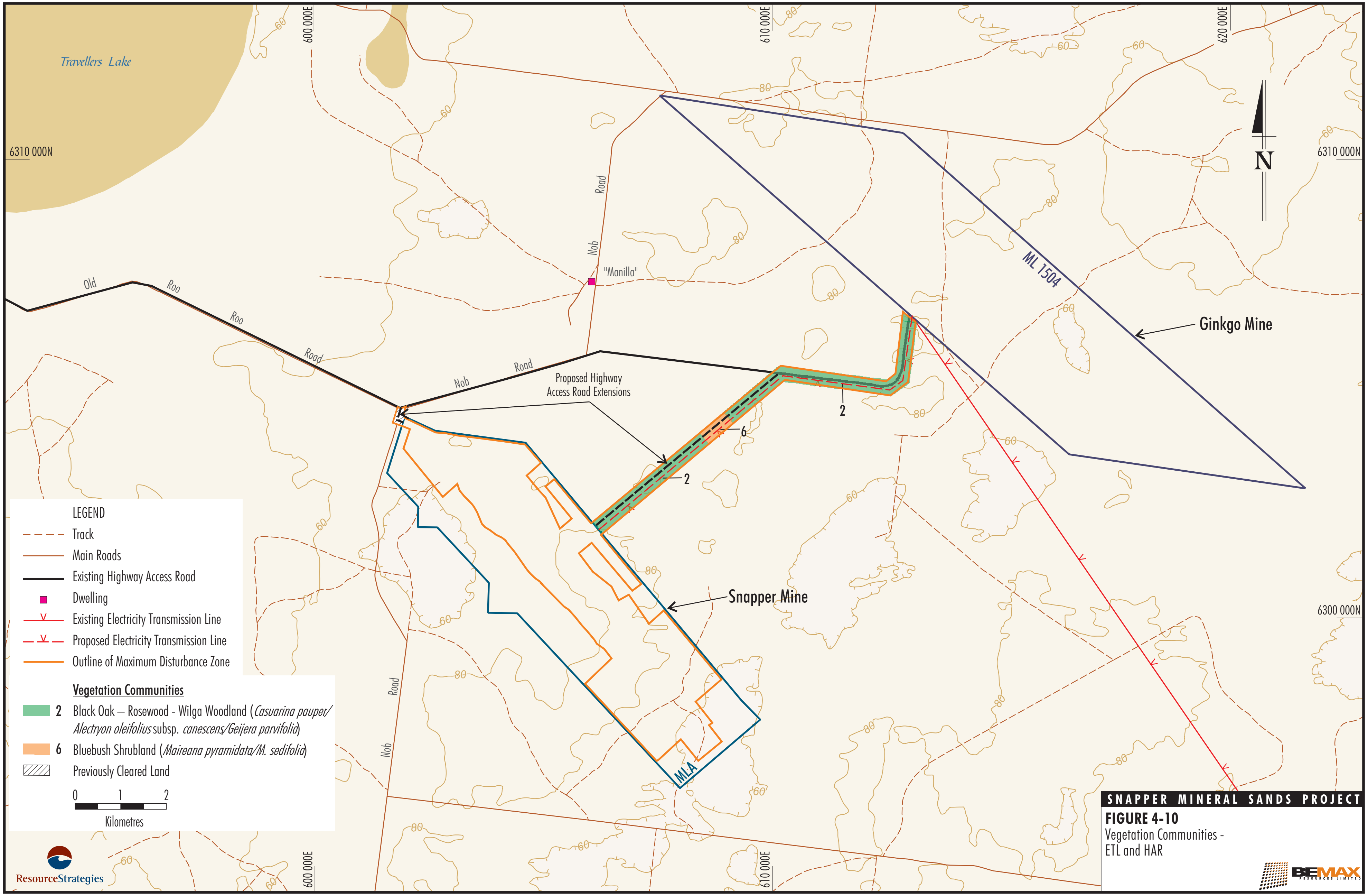

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Introduced Flora Species and Noxious Weeds

Thirty-four species of introduced plants were recorded on the Snapper Mine area comprising about 23% of the total species observed. This relatively high level of introduced species indicates a high level of disturbance to the natural communities on the Snapper Mine area. One species, Horehound (*Marrubium vulgare*), is listed as noxious for Wentworth Shire (DPI, 2006).

4.9.2 Potential Impacts

The following sub-sections identify the potential impacts of the Snapper Mine on flora. Proposed measures to avoid and mitigate potential impacts on flora are provided in Section 4.9.3.

Vegetation Clearance

It is conservatively estimated that approximately 1,630 ha of vegetation would be cleared or modified for the Snapper Mine (including the HAR and ETL extensions) (Figures 4-9 and 4-10) comprising approximately:

- 1,075 ha of Black Oak – Rosewood - Wilga Woodland (*Casuarina pauper/Alectryon oleifolius* subsp. *canescens/Geijera parviflora*);
- 325 ha of Austrostipa Grassland (*Austrostipa nitida*);
- 200 ha of Bluebush Shrubland (*Maireana pyramidata/M. sedifolia*); and
- 30 ha of Chenopod Mallee Woodland/Shrubland (*Eucalyptus dumosa/E. socialis/E. gracilis/Maireana* spp.).

Clearing native vegetation is a key threatening process listed under the TSC Act and the EPBC Act. The DEC website (DEC, 2006a) identifies impacts relevant to flora which may occur as a result of clearing native vegetation, including:

- destruction of flora habitat;
- fragmentation of flora populations; and
- creating disturbed habitat which may permit the establishment and spread of weed plant species which may displace native species.

Habitat disturbance can also increase refuge and scavenging areas for introduced animal species which may forage on plant species.

Introduced Flora Species

Native vegetation disturbance can act as a catalyst for weed incursion and if management initiatives are not implemented, proliferation of weeds can occur.

Introduced Animal Species

Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) and competition and habitat degradation by the feral Goat (*Capra hircus*) are key threatening processes listed under the TSC Act. Rabbits and Goats were both recorded during Snapper Mine surveys undertaken by Western Research Institute (Appendix D). Due to the potential for habitat disturbance, increased refuge and scavenging (i.e. discarded food scraps and other rubbish), populations of introduced species could increase or become concentrated in the vicinity of the Snapper Mine without appropriate measures.

Vegetation and Groundwater

Some vegetation is recognised as groundwater dependant vegetation as it is dependant on (Eamus *et al.*, 2006; DLWC, 2002):

- the surface expression of groundwater; or
- the sub-surface presence of groundwater, typically with no surface expression of the groundwater.

Riparian vegetation along rivers of central Australia and the vegetation which grows in saline discharge lakes of the Murray Basin are two local examples of vegetation considered to be dependant on groundwater (Eamus *et al.*, 2006).

No vegetation within the study area or close surrounds is considered groundwater dependant vegetation (Appendix E).

Groundwater modelling undertaken by Golder Associates (Appendix A) for the Snapper Mine indicates groundwater drawdown at the Darling River and The Salt Lakes if it occurred, would be in the order of centimetres and would therefore be immeasurable within seasonal variation. Potential effects on vegetation in these areas have, therefore, not been assessed.

There is potential for vegetation used in rehabilitation/revegetation of the mine path and vegetation proximal to the mine path to be impacted by groundwater salt concentration. Entrained water within the slurried overburden would have the potential to migrate upwards in the soil profile via capillary rise. The Rehabilitation Materials Assessment by BEMAX (Appendix H) considers higher salinity levels would be likely to occur within the lower parts of the replaced non-slurried material immediately above slurried material during the initial period following replacement. The majority of the replaced soil profile, however, would be unaffected by capillary rise (Appendix H).

Vegetation and Airborne Salts

There would be potential for airborne salts to occur at the Snapper Mine once slurried materials are deposited and dried. Airborne salts can affect sensitive vegetation by inhibiting photosynthesis and resulting in leaf toxicity. However, it would be considered unlikely that airborne salts would impact on surrounding vegetation as discussed in Section 4.2.3.

Vegetation and Dust

Studies have shown that excessive dust generation can impact on the health and viability of surrounding vegetation. Dust can affect vegetation by inhibiting physiological processes such as photosynthesis, respiration and transpiration, and allow penetration of phytotoxic gaseous pollutants (Farmer, 1993; Eller, 1977). Sand mining would have the potential to result in the generation and dispersion of atmospheric dust. The effect of dust caused by the Snapper Mine on the health and viability of surrounding vegetation would be likely to be localised. Further, any potential dust-related effects on vegetation in any one location would be likely to be short in duration given the progressive nature of the mining operation.

Threatened Flora Species

Although no flora species listed as threatened under the TSC Act or the EBPC Act were identified during the flora surveys (FloraSearch and Resource Strategies, 2007), ten flora species were assessed generally in accordance with the draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). The assessment considered the potential cumulative impacts of the Snapper and Ginkgo Mines.

The Flora Assessment concluded the following (FloraSearch and Resource Strategies, 2007):

- The flora values of the region would be likely to be maintained, and possibly improved, considering the Snapper Mine's proposed measures to avoid, mitigate and/or offset potential impacts.
- The Snapper Mine would be unlikely to reduce the long-term viability of any local population of flora species.
- The Snapper Mine would be unlikely to lead to the extinction of any flora species or population or place any at risk of extinction.
- The Snapper Mine would be unlikely to adversely affect critical habitat as no critical habitats are known to occur within the vicinity of the Snapper Mine area.
- The Snapper Mine would be unlikely to adversely affect areas of high conservation value.
- Habitat that would be removed from the Snapper Mine would not be likely to adversely impact the long-term viability of any flora species, population or ecological community.
- Adverse impacts from the Snapper Mine on flora are likely to continue to diminish throughout the life of the mine. At the time of mining lease relinquishment, the DPI-MR would ensure that relevant relinquishment requirements (e.g. demonstration of a stable final landform which is generally consistent with the surrounding landscape) have been fulfilled. It should be noted that appropriate impact mitigation measures would be implemented from the commencement of the Snapper Mine.
- Given the above, from a regional perspective, adverse impacts from the Snapper Mine on flora are unlikely to be permanent or irreversible.

Potential Cumulative Impacts

Potential cumulative impacts on flora from the combined operation of the Snapper and Ginkgo Mines would predominantly relate to impacts associated with habitat disturbance and alteration (described above). The assessment of potential cumulative impacts on flora has taken into consideration the results of flora surveys within the vicinity of the Snapper and Ginkgo Mine areas, the characteristics of the existing vegetation, existing landuses and the extent and type of vegetation disturbance associated with the Snapper and Ginkgo Mines.

The Ginkgo Mine would involve disturbance to similar vegetation as at the Snapper Mine area. The Ginkgo Mine has various management and mitigation measures for flora, including a vegetation offset strategy.

The extent of potential cumulative impacts would be minimised by management and mitigation measures required and/or implemented at the Ginkgo Mine and the Snapper Mine.

4.9.3 Mitigation Measures and Management

Flora and fauna values in the area would be maintained such that there would be no net loss in the medium to long-term. The following components of the Snapper Mine would achieve this:

- impact avoidance and mitigation measures (e.g. minimising disturbance to native vegetation, control of weeds and pests and monitoring);
- progressive rehabilitation and revegetation; and
- the Snapper Mine vegetation offset.

Flora related components of these are described below.

Flora and Fauna Management Plan (FFMP)

Flora and Fauna impact avoidance and mitigation measures would be detailed in a FFMP which would be prepared prior to Snapper Mine construction. The FFMP would include measures which would be undertaken during construction and operation, including a Vegetation Clearance Protocol (VCP), Threatened Species Management Protocol (TSMP), grazing management, control of introduced flora species, control of introduced animal species, vegetation monitoring and bushfire management.

VCP

A VCP would be implemented to minimise the removal/modification of flora species and their habitats. Key components of the VCP which apply to flora would include the delineation of areas to be cleared of remnant vegetation.

Habitat features (e.g. hollows) identified for use in rehabilitation would be salvaged and stockpiled for use in rehabilitation, where practicable.

Vegetation clearance along the ETL would be minimised where practicable using techniques such as selective clearing (i.e. minimising vegetation clearance to higher midstorey and upperstorey vegetation).

TSMP

A TSMP would be prepared and implemented to facilitate the management and minimisation of potential impacts on threatened species. Key components of the TSMP which would apply to flora include site observations/surveys, threatened species management strategies and reporting.

Grazing Management

Appropriate fencing would be used to prevent the uncontrolled entry of livestock within the progressive work and rehabilitation areas for the life of the mine.

Control of Introduced Flora Species

Control measures would be implemented to minimise the occurrence of weeds. These would potentially include the mechanical removal of identified weeds and/or the application of approved herbicides in authorised areas. Herbicides that contain glyphosate as the active ingredient and/or surfactants (detergent additive used as a dispersant/wetting agent) would not be utilised due to potential adverse impacts on amphibians.

Vegetation Monitoring

A photographic monitoring programme would be developed to assess the performance of the rehabilitation areas (Section 5.6) and monitor the health of the vegetation surrounding the mine path and initial overburden emplacement with regard to potential impacts from airborne salts or lateral seepage (Section 4.2.3).

Dust Suppression

Dust suppression would be undertaken on the Snapper Mine roads within the MLA area (Section 4.8.3).

Bushfire Risk Management

The potential for a change in the frequency of fires due to the Snapper Mine would be reduced through implementation of the ERP (Section 4.2.3).

Vehicular Traffic Management

To reduce the potential for vehicular related vegetation disturbance, the number of roads constructed for the Snapper Mine would be minimised and employees and contractors would be instructed to only use the Snapper Mine roads.

Rehabilitation/Revegetation of the Disturbance Areas

While approximately 1,630 ha of native vegetation would be removed over the life of the Snapper Mine, the Snapper Mine disturbance areas would be progressively rehabilitated and revegetated as mining proceeds and infrastructure is decommissioned (Section 5).

The revegetation programme provides for the selective planting of species characteristic of the vegetation communities cleared. Rehabilitation and revegetation would be progressive and would aim to re-establish vegetation across the disturbance areas in order to reduce the impact on connectivity.

Comprehensive Snapper Mine Offset Strategy

Overview

Consultation with respect to establishing a Snapper Mine vegetation offset strategy was undertaken with the DoP, DEC and DNR during the preparation of this EA (Section 3.7). During this consultation it was agreed that a process for offsetting the vegetation clearance associated with the Snapper Mine would be provided. As described below, this offset strategy provides for either a process for establishing an offset landholding and/or participation in the Biodiversity Banking (BioBanking) Scheme under the TSC Act, or an alternative arrangement that is acceptable to the Director-General of DoP.

This offset strategy would result in the conservation of an equivalent area of vegetation to that disturbed by the Snapper Mine (i.e. 1,630 ha) (or an alternative area to the satisfaction of the Director-General of DoP).

While the establishment and management of an offset landholding is currently being considered as the proposed method of establishing a Snapper Mine vegetation offset, an alternative approach may also be available via the BioBanking Scheme. BEMAX would consult with the DEC and DoP in regard to the application of BioBanking as a possible alternative offset arrangement, if the provisions under the BioBanking Scheme are available within 12 months of Snapper Mine project approval.

Offset Landholding

BEMAX has acquired and is in the process of acquiring landholdings in the region, all or part of which could potentially be available for consideration as a suitable offset area.

It is noteworthy, that, unlike clearing for agricultural developments (e.g. establishment of new areas of wheat farming), mineral sands mining is a short to medium term landuse. While the *Native Vegetation Act, 2003* generally applies to agricultural developments, sand mining under the *Mining Act, 1992* is exempt from its requirements. In accordance with the *Mining Act, 1992*, the mined land would be progressively rehabilitated and revegetated using species characteristic of the vegetation communities cleared. The rehabilitation plan for the Snapper Mine is outlined in Section 5.

If an offset landholding is to be established, BEMAX would prepare and submit a Snapper Mine Vegetation Offset Proposal to DoP within 12 months of Project Approval. In developing the Snapper Mine Vegetation Offset Proposal, consideration would be given to relevant components of *BioMetric* (i.e. a computer modelling programme which facilitates the preparation of property vegetation plans under the *Native Vegetation Act, 2003* [DEC, 2006b]) and the Ginkgo Mine Offset Strategy (BEMAX, 2006g) (prepared in May 2006 to satisfy the relevant condition of the Ginkgo Mine Development Consent).

The Snapper Mine Vegetation Offset Proposal would:

- Provide the results of a desktop evaluation to describe the conservation values of the vegetation offset area (e.g. known or potential threatened species occurrences).
- Provide results of a site evaluation which would include:
  - vegetation condition assessment;
  - an inventory of habitat resources and species recorded during the site evaluation;
  - vegetation mapping; and
  - habitat complexity assessment, including relevant components of *BioMetric.*
- Justify why the proposed vegetation offset area is suitable, considering the condition of the vegetation and regional location.
- Describe how the vegetation offset proposal would be implemented (e.g. re-zoning of land to nature conservation and establishment of fencing and signage).

- Describe how the performance of the vegetation offset would be monitored and managed over time (e.g. exclusion of stock, control of introduced species and other management and maintenance measures).
- Describe how conservation of the vegetation offset would be secured over the long-term (see below).

Long-Term Security and Management of the Vegetation Offset Area

Regardless of the offset approach adopted (i.e. an offset landholding, participation in BioBanking and/or an alternative arrangement to the satisfaction of the Director-General of DoP), the security of the Snapper Mine vegetation offset measures would be established within three years of Project Approval or a time period to the satisfaction of the Director-General of the DoP.

If an offset landholding is to be established, it would be through rezoning and/or re-conditioning of relevant lease conditions to reflect conservation purposes. The offset area is likely to be located on a Western Lands Lease, therefore the zoning and/or re-conditioning would be undertaken in consultation with the DNR in their capacity as administrators of such leases. Should the tenure of the proposed offset area be otherwise, the relevant land administrator would be consulted with respect to appropriate approvals and processes.

In addition, if an offset landholding is established, a management plan would be prepared to facilitate the management of the relevant lands. It is anticipated that this would include the exclusion of stock and other management measures to facilitate the regeneration of native vegetation and fauna habitat features.

4.10 FAUNA

A Fauna Assessment was prepared for the Snapper Mine by Western Research Institute and Resource Strategies (2007) and is presented in Appendix D. The Fauna Assessment was prepared generally in accordance with the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and with consideration of the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DEC, 2004a).

4.10.1 Existing Environment

Snapper Mine Setting

The Snapper Mine is located within the MDD Region (Section 4.9.1) and also the Eyrean zoogeographic region. Landuse in the area is predominantly livestock grazing (Section 4.9.1).

Previous Fauna Studies

A number of vertebrate fauna surveys have been carried out in recent years in the wider region and general locality of the Snapper Mine area. The most applicable of these surveys are those carried out by Mount King Ecological Surveys (2001) for the development of the Ginkgo Mine. These are considered most applicable as the Ginkgo Mine is located in close proximity to the Snapper Mine and contains similar landforms and fauna habitat. The surveys were conducted in spring 2000 during warm wet conditions and in May 2001 under cooler autumn conditions. These surveys were undertaken within the Ginkgo Mine ML area as well as along infrastructure corridors within approximately 50 km of the Ginkgo Mine. The results of the Ginkgo Mine fauna survey were considered in the Fauna Assessment for the Snapper Mine.

Field Surveys

Fauna surveys were conducted for the Snapper Mine by Western Research Institute in autumn 2006 (Appendix D). The survey was used to identify and describe fauna species and their habitats within the Snapper Mine area and to determine the presence or likelihood of threatened fauna species.

Targeted searches for threatened fauna species considered possible occurrences within the Snapper Mine area were conducted. All habitat types were surveyed to maximise the chances of finding populations of any threatened species that may occur.

Habitat Resources

Three major fauna habitat types were identified as follows (Appendix D):

- Mixed Woodland - characterised by sparse Black Oak (*Casuarina pauper*) woodland approximately 8-10 m in height with a mid-storey of Rosewood (*Alectryon oleifolius* subsp. *canescens*) and Wilga (*Geijera parvifolia*) approximately 4 to 5 m in height with a moderately dense shrub layer of Bluebush (*Maireana* spp.) up to 1 m in height. The Mixed Woodland habitat type is the most prevalent habitat in the study area, including the ETL and HAR extensions.
- Open Grassland/Shrubland with Scattered Trees - characterised by scattered Bluebush shrubland and grassland, large bare areas.
- Mallee Shrubland - characterised by open Mallee to approximately 6 m in height.

All three habitat types have a medium to a high level of degradation due to pastoral land management practices. Under current pastoral land management practices the conservation values are slowly further degrading (Appendix D).

Fauna Species Composition

A total of 95 fauna species were identified within the Snapper Mine area, of which 90 (95%) were native and five (5%) were introduced (Appendix D). The most diverse group of species recorded were birds (53 native species observed), followed by reptiles (22 native species observed) and mammals (15 native species observed). No amphibian species were recorded during the survey. A list of the fauna species recorded in the Snapper Mine area is provided in Appendix D.

Threatened Fauna Species

Five threatened fauna species were recorded during the fauna survey of the Snapper Mine, namely the Western Blue-tongued Lizard (*Tiliqua occipitalis*), Major Mitchell's Cockatoo (*Cacatua leadbeateri*), Hooded Robin (*Melanodryas cucullata cucullata*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Little Pied Bat (*Chalinolobus pictatus*) (Appendix D). All five are listed as vulnerable under the TSC Act.

Seventeen threatened fauna species were also recorded during Ginkgo Mine surveys by Mount King Ecological Surveys (2001). The species recorded were the Painted Burrowing Frog (*Neobactrachus pictus*), Jewelled Gecko (*Diplodactylus elderi*), Crowned Gecko (*Diplodactylus stenodactylus*), Wedgesnout Ctenotus (*Ctenotus brooksi*), Western Blue-tongued Lizard (*Tiliqua occipitalis*), Freckled Duck (*Stictonetta naevosa*), Blue-billed Duck (*Oxyura australis*), Grey Falcon (*Falco hypoleucos*), Square-tailed Kite (*Lophoictinia isura*), Major Mitchell's Cockatoo (*Cacatua leadbeateri*), Regent Parrot (eastern subsp.) (*Polytelis anthopeplus monarchoides*), Barking Owl (*Ninox connivens*), Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*), Grey Crowned Babbler (*Pomatostomus temporalis temporalis*), Little Pied Bat (*Chalinolobus picatus*), Inland Forest Bat (*Vespadelus baverstocki*) and Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

4.10.2 Potential Impacts

The following sub-sections identify the potential impacts of the Snapper Mine on fauna. The measures to avoid and mitigate potential impacts on fauna are provided in Section 4.10.3.

Habitat Removal/Modification

The Snapper Mine disturbance area would comprise approximately 1,630 ha of land. Major fauna habitat types which would be cleared or modified for the Snapper Mine include:

- approximately 1,075 ha of Mixed Woodland;
- approximately 525 ha of Open Grassland/Shrubland with Scattered Trees; and
- approximately 30 ha of Mallee Shrubland.

'Clearing of Native Vegetation', 'Bushrock Removal' and 'Removal of Dead Wood and Dead Trees' are key threatening processes listed under the TSC Act which would be potentially applicable to the Snapper Mine.

Creation of Barriers to Fauna Movement

The capacity of individual species to move into, within or out of the study area would vary significantly, depending on their capacity to move through the landscape. Fauna movement in the study area and surrounds would potentially be restricted by factors such as habitat clearance, fire, road construction, track width, fences and the moving mine path which would potentially create a barrier to dispersal and/or movement for some species. Such movements would potentially be critical to the maintenance of genetic health and viable population numbers by enabling interaction with different populations (meta-populations) in a locality or region (Bridgewater, 1987).

Species possess a variety of dispersal/movement mechanisms by which they are able to colonise new habitats, and/or move within and between vegetation-habitat mosaics. Birds, for example, are generally highly mobile and are able to cover relatively large areas of land. However, it is unlikely that all bird species would have equal capacity to move through, into or out of the study area. A small lizard species may be effectively isolated in a remnant surrounded by even narrow tracks, whereas this is unlikely to be an effective barrier for most arboreal mammals (Bennet, 1987).

Introduced Flora Species

Disturbance would potentially act as a catalyst for weed incursion and if management initiatives are not implemented, proliferation of weeds would potentially occur which would modify fauna habitat.

Introduced Animal Species

The Rabbit, Goat, Red Fox and Cat are introduced animal species which have been recorded within the study area and wider region. Each of these species has a corresponding key threatening process listed under the TSC Act, *viz.*:

- competition and grazing by the Rabbit;
- competition and habitat degradation by the Goat;
- predation by the Red Fox; and
- predation by the Cat.

There would be potential for further colonisation of the study area by introduced animal species due to potentially increased refuge sites/scavenging areas and potential for introduced animal species to be transported into the area via vehicles.

Fauna and Noise

Numerous studies have been undertaken on the affects of noise on wildlife (e.g. Algers *et al.*, 1978 in Richard Heggie Associates, 1997; Allaire, 1978; Ames, 1978 in Fletcher and Busnel, 1978; Busnel, 1978 in Fletcher and Busnel, 1978; Lynch and Speake, 1978 in Fletcher and Busnel, 1978; Shaw, 1978 in Fletcher and Busnel, 1978; Streeter *et al.*, 1979; Poole, 1982 in Richard Heggie Associates, 1997).

In essence, these studies indicate that many fauna species are well adapted to human activities and noise. Notwithstanding, the Snapper Mine would increase the existing level of noise, which has the potential to disrupt the routine activities of vertebrate fauna.

Fauna and Artificial Lighting

Artificial lighting for the Snapper Mine would potentially affect the behavioural patterns of some fauna species such as bird and bat species that are attracted to insects around lights. As a consequence of this, they would become prey for larger predators (e.g. owls) which would potentially lead to changes in population structure and community composition.

Vehicular Traffic Movements

Vehicular traffic movements associated with the construction and operation of the Snapper Mine would have the potential to increase the incidence of mortality of fauna via vehicle strike.

Bushfire Risk

'*High frequency fire resulting in the disruption of lifecycle processes in plants and animals, and loss of vegetation structure and composition*' is listed as a key threatening process under the TSC Act.

Infection of Frogs by Amphibian Chytrid

'*Infection of frogs by amphibian chytrid causing the disease Chytridiomycosis*' is listed as a key threatening process under the TSC Act.

Threatened Fauna Species

As stated in Section 4.10.1, five threatened fauna species were recorded during the Snapper Mine fauna survey, namely the Western Blue-tongued Lizard (*Tiliqua occipitalis*), Major Mitchell's Cockatoo (*Cacatua leadbeateri*), Hooded Robin (*Melanodryas cucullata cucullata*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Little Pied Bat (*Chalinolobus pictatus*) (Western Research Institute and Resource Strategies, 2007).

Twenty-four threatened fauna species were assessed generally in accordance with the draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). The assessment considered the potential cumulative impacts of the Snapper and Ginkgo mines.

The Fauna Assessment concluded the following (Appendix D):

- The fauna values of the region would be likely to be maintained, and possibly improved, considering the Snapper Mine's measures to avoid, mitigate and/or offset potential impacts.
- The Snapper Mine would be unlikely to reduce the long-term viability of any local population of fauna species.
- The Snapper Mine would be unlikely to lead to the extinction of any fauna species or population or place any at risk of extinction.
- The Snapper Mine would be unlikely to adversely affect critical habitat as no critical habitats are known to occur in the within the vicinity of the mine.
- The Snapper Mine would be unlikely to adversely affect areas of high conservation value.
- The habitat removal would be considered unlikely to adversely impact the long-term viability of any fauna species, population or ecological community.
- Adverse impacts from the Snapper Mine on vertebrate fauna are likely to continue to diminish throughout the life of the mine. At the time of mining lease relinquishment, the DPI-MR would ensure that relevant relinquishment requirements (e.g. demonstration of a stable final landform which is generally consistent with the surrounding landscape) have been fulfilled. It should be noted that appropriate impact mitigation measures would be implemented from the commencement of the Snapper Mine.
- Given the above, from a regional perspective, adverse impacts from the Snapper Mine on vertebrate fauna are unlikely to be permanent or irreversible.

Potential Cumulative Impacts on Fauna

Potential cumulative impacts on fauna from the combined operation of the Snapper and Ginkgo Mines would predominantly relate to habitat disturbance and fragmentation which would primarily be associated with the clearance of vegetation (described above). The assessment of potential cumulative impacts on fauna has taken into consideration the results of fauna surveys within the vicinity of the Snapper and Ginkgo Mine areas, existing landuses and the extent and type of habitat disturbance associated with the Snapper and Ginkgo Mines.

The Ginkgo Mine would involve disturbance to similar fauna habitat as identified at the Snapper Mine area. The Ginkgo Mine has various management and mitigation measures for fauna, including a vegetation offset strategy.

The extent of potential cumulative impacts would be minimised by management and mitigation measures required and/or implemented at the Ginkgo Mine and proposed for the Snapper Mine.

4.10.3 Mitigation Measures and Management

As stated in Section 4.9.3, flora and fauna values in the area would be maintained such that there would be no net loss in the medium to long-term. The following components of the Snapper Mine would achieve this:

- impact avoidance and mitigation measures (e.g. minimising disturbance to native vegetation, control of weeds and pests and monitoring);
- progressive rehabilitation and revegetation; and
- the Snapper Mine vegetation offset.

Fauna related components of these are described below.

FFMP

The FFMP is outlined in Section 4.9.3.

VCP

As described in Section 4.9.3, a VCP would be implemented to minimise the removal/modification of fauna species and their habitats. Key components of the VCP which would apply to fauna include the delineation of areas to be cleared of remnant vegetation, a pre-clearance survey, identification of fauna management strategies and specific procedures for vegetation clearance. Further, vegetation clearance would be timed to minimise disturbance to potential roosting/breeding activities of fauna, where practicable.

Vegetation clearance along the ETL would be minimised where practicable using techniques such as selective clearing (i.e. minimising vegetation clearance to higher midstorey and upperstorey vegetation).

TSMP

As stated in Section 4.9.3, a TSMP would be prepared and implemented to facilitate the management and minimisation of potential impacts on threatened species. Key components of the TSMP which would relate to fauna include site observations/surveys, threatened species management strategies and reporting. The TSMP would be implemented by a suitably qualified person(s).

Grazing Management

Grazing management is described in Section 4.9.3.

Control of Introduced Flora Species

Control of weeds is described in Section 4.9.3.

Control of Introduced Animal Species

A clean, rubbish-free environment would be kept to discourage scavenging and reduce the potential for further colonisation of the study area by non-endemic fauna (e.g. introduced rodents and foxes). The introduction of animals on to the site would be prohibited. Domestic pets would not be allowed at the mine site.

In addition, control measures would be conducted to minimise the occurrence of declared pests (e.g. Rabbits) and other introduced animal species (e.g. Red Fox). These may include cat trapping and fox baiting. Animal pest control would be undertaken by a licensed contractor.

Painted Burrowing Frog Monitoring

Although the Painted Burrowing Frog was not found at the Snapper Mine, it was identified at the Ginkgo Mine (Section 4.10.1). Monitoring for the frog would be conducted by a suitably qualified person(s) following heavy rain (>25 mm in 24 hours). Selection of monitoring locations would primarily be based on rainfall distribution and intensity.

Frog populations can be particularly sensitive to the introduction of infectious pathogens such as the chytrid fungus. To reduce the likelihood of spreading infection, the Painted Burrowing Frog monitoring would be conducted in accordance with the guidelines for the collection, handling and transport of amphibians.

Vehicular Traffic Management

The movement of vehicles associated with the Snapper Mine would have the potential to increase the incidence of fauna mortality via vehicular strike. To reduce this potential, the number of roads constructed for the Snapper Mine would be minimised, employees and contractors would be instructed to only use the Snapper Mine roads, speed limits would be imposed on vehicles using roads and tracks, and signposting would be installed to remind personnel of the danger of vehicles to wildlife. Vehicle speed would be restricted to 50 km/hour on all roads inside the MLA area and the section of road where the HAR crosses the Great Darling Anabranch.

Bushfire Risk Management

Bushfire risk management is described in Section 4.9.3.

Site Induction

An environmental education programme would be included in employee and contractor inductions.

Rehabilitation/Revegetation of the Disturbance Areas

The rehabilitation and revegetation of the disturbance areas is described in detail in Section 5.

Comprehensive Snapper Mine Offset Strategy

The Snapper Mine offset strategy is described in detail in Section 4.9.3.

4.11 NOISE

An assessment of the existing noise environment and potential noise emissions of the Snapper Mine has been undertaken by Holmes Air Sciences (2007a) in accordance with the requirements of the NSW *Industrial Noise Policy* (INP) (EPA, 2000) and the *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999) and is provided as Appendix F.

The assessment includes the following components:

- noise impact assessment for the construction of the Snapper Mine;
- noise impact assessment for the operation of the Snapper Mine; and
- road noise impact assessment.

The assessed noise levels described in the following text are expressed in A-weighted decibels (dBA). This system simulates the response of the human ear, which is more sensitive to high-frequency sounds and de-emphasises lower frequency sounds.

Table 4-9 provides information on common noise sources in dBA for comparative reference.

Hearing "nuisance" for most people begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}) which are the levels exceeded for a specified percentage (N) of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is considered to be the average maximum noise level.

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating level over the interval period.

4.11.1 Existing Environment

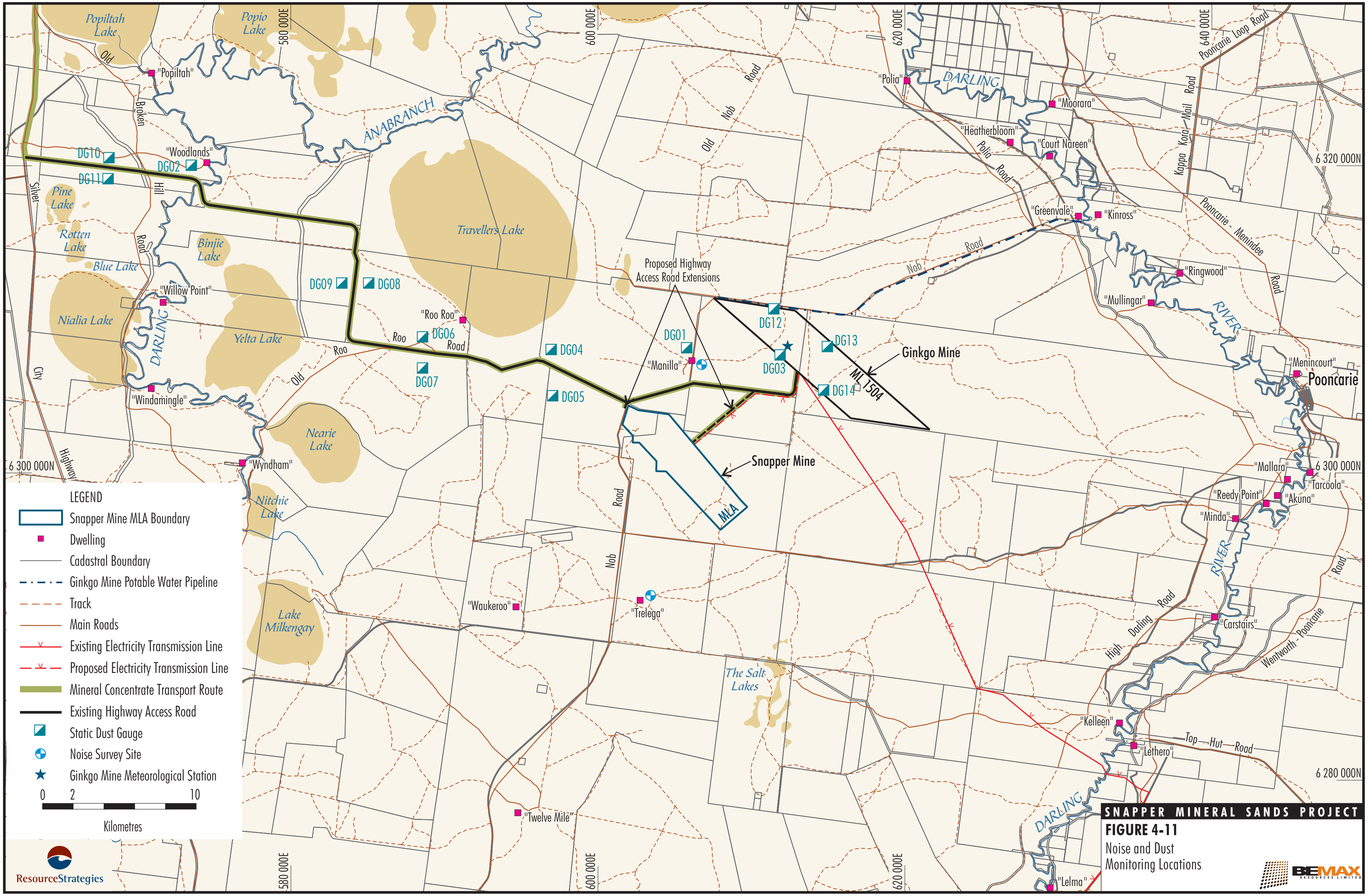
Background Noise Levels

Background noise surveys to characterise and quantify the acoustical environment in the area surrounding the Snapper Mine were conducted in August and September 2006. This involved the positioning of two unattended noise loggers at the two closest residences to the Snapper Mine, the "Manilla" and "Trelega" homesteads (Figure 4-11).

Table 4-9
Relative Scale of Various Noise Sources and Effect on People

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 – 130	Extremely noisy	Rock band.	Jet flyover at 1,000 m
100	Very noisy	Inside subway train.	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m.	Diesel truck at 15 m
90	Loud	Garbage disposal at 1 m, shouting at 1 m.	Urban daytime noise
70*	Loud	Vacuum cleaner at 3 m, normal speech 1 m.	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office.	-
50	Moderate to quiet	Dishwasher next room, wind in trees.	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), Library.	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background).	Quiet rural night-time
20	Almost silent	Broadcast and recording studio.	-
10-0	Silent	Threshold of hearing.	-

After United State Department of Interior (1994) and Richard Heggie Associates (1995).
* Reference level – 70 dBA.



LEGEND
Snapper Mine MLA Boundary
Dwelling
Cadastral Boundary
Ginkgo Mine Potable Water Pipeline
Track
Main Roads
Existing Electricity Transmission Line
Proposed Electricity Transmission Line
Mineral Concentrate Transport Route
Existing Highway Access Road
Static Dust Gauge
Noise Survey Site
Ginkgo Mine Meteorological Station
0 2 10
Kilometres
ResourceStrategies
SNAPPER MINERAL SANDS PROJECT
FIGURE 4-11
Noise and Dust Monitoring Locations
BEMAX
Proposed Highway Access Road Extensions
Ginkgo Mine
Snapper Mine
ML 1504
MLA
Pooncarie
DG01
DG02
DG03
DG04
DG05
DG06
DG07
DG08
DG09
DG10
DG11
DG12
DG13
DG14
"Popiltah"
"Woodlands"
"Willow Point"
"Windamingle"
"Wyndham"
"Roo Roo"
"Manilla"
"Waukeroo"
"Trelega"
"Twelve Mile"
"Polia"
"Moorara"
"Heatherbloom"
"Court Nareen"
"Greenvale"
"Kinross"
"Ringwood"
"Mullingar"
"Menincourt"
"Mallara"
"Tarcoola"
"Reedy Point"
"Akuna"
"Minda"
"Carstairs"
"Kelleen"
"Lethero"
"Lelma"
Popiltah Lake
Popio Lake
Pine Lake
Rotten Lake
Blue Lake
Binjie Lake
Nialia Lake
Yelta Lake
Travellers Lake
Nearie Lake
Nitchie Lake
Lake Milkengay
The Salt Lakes
ANABRANCH
DARLING
DARLING RIVER
RIVER
Old Broken Hill Road
Silver City Highway
Old Roo Road
Old Nob Road
Nob Road
Polia Road
Kappa Kara Mail Road
Pooncarie Loop Road
Pooncarie - Menindee Road
Wentworth - Pooncarie Road
High Darling Road
Top Hut Road
580 000E
600 000E
620 000E
640 000E
6 320 000N
6 300 000N
6 280 000N

In accordance with the requirements of the NSW INP, the rating background level (RBL) is a calculated median background level representing each assessment period (e.g. day/evening/night) over a monitoring period. The monitored RBL at the two residences was below 30 dBA for the day, evening and night periods (Appendix F). As the monitoring was undertaken during Year 1 of the Ginkgo Mine, the monitoring included the effects of the existing mine.

The INP specifies that where the measured RBL is less than 30 dBA, then for the purposes of the noise assessment, a RBL of 30 dBA should be adopted.

Road Transport Background Noise Levels

In accordance with the requirements of the ECRTN, assessment of the potential traffic noise impacts of mine traffic needs to be made against goals for *collector roads* and *rural roads in a rural area*. In summary the road transport noise goals for these road types are:

Collector Road

- $L_{Aeq(1hour)}$ 60 dBA for 7.00 am to 10.00 pm; and
- $L_{Aeq(1hour)}$ 55 dBA for 10.00 pm to 7.00 am.

Local Road

- $L_{Aeq(1hour)}$ 50 dBA for 7.00 am to 10.00 pm; and
- $L_{Aeq(1hour)}$ 45 dBA for 10.00 pm to 7.00 am.

Background road transport noise levels have been calculated for the Silver City Highway (a collector road) as a basis for assessment of the road transport noise impact assessment.

Existing RTA traffic counts for the Silver City Highway were factored up to account for maximum daily Ginkgo Mine traffic to a daily total of some 543 vehicles per day on the section of the Silver City Highway between the HAR and Broken Hill (Section 4.8.1).

Estimated background traffic noise levels at various distances from the highway for weekdays and weekends are detailed in Table 4-10.

Table 4-10
Calculated Existing Vehicle Traffic Noise
Silver City Highway – South of Broken Hill

Distance from Highway to Receiver (m)	$L_{Aeq(1hour)}$ (dBA) Weekday	$L_{Aeq(1hour)}$ (dBA) Weekend
10	62.6	59.2
50	52.6	49.3
100	49.7	46.4
1,000	39.7	36.7

Source: Appendix F

Comparison of the estimated existing traffic noise levels (Table 4-10) and the road traffic noise criteria for collector roads indicates that the existing traffic noise on the Silver City Highway exceeds the night-time criteria at distances of 10 m during weekday periods and during weekends. The calculated existing traffic noise also exceeds the daytime criteria during weekdays at a distance of 10 m.

Traffic flows on the HAR are very low (Section 4.8) and the closest residence is some 800 m from the road (Figure 1-2), so no existing exceedance of the criteria is anticipated.

4.11.2 Potential Impacts

Applicable Noise Criteria

The procedure for assessing the potential impacts of industrial noise sources in NSW is set out in the INP. The INP assessment procedure for industrial noise sources has two components:

- controlling intrusive noise impacts in the short-term for residences; and
- maintaining noise level amenity for particular landuses, for residences and other landuses.

The intrusive criterion is met if the $L_{Aeq(15\ minutes)}$ is less than or equal to the RBL plus 5 dBA. As discussed in Section 4.11.1, analysis of the background noise monitoring in accordance with the INP determined that the RBL for the two closest residences is 30 dBA. Thus the Snapper Mine specific intrusiveness criterion is 35 dBA for the assessment for day, evening and night periods.

The applicable project-specific intrusiveness criterion (i.e. 35 dBA) is the most stringent of the criteria described in Appendix F that need to be satisfied. The amenity criteria are therefore not discussed in this section.

Noise Modelling

An acoustic model was developed that simulates Snapper Mine components and noise source information (i.e. sound levels and locations). The primary sources of noise identified included:

- overburden fleet;
- secondary mining fleet;
- general loading and operational fleet;
- overburden slurrying systems; and
- dredge and primary gravity concentration unit.

The model also considers meteorological effects, surrounding terrain and distance from source to receiver.

Meteorological effects included in the modelling are those characterised as prevailing in accordance with INP assessment methodologies. The definition of prevailing conditions included statistical analysis of meteorological data (including consideration of wind speed and direction, as well as temperature lapses and inversions). Conservative assumptions with respect to a combination of wind effects and temperature inversions have been included in the modelling (Appendix F).

Noise Emission Scenarios

Predictive noise emission modelling has been undertaken for two representative periods in the Snapper Mine life, when the major activities would be in closest proximity to the closest residences. Snapper Mine operation activities would be undertaken 24 hours per day, seven days per week (Section 2.10.2).

During construction the "Trelega" homestead would be the closest residence to the Snapper Mine, located approximately 7 km to the south-west. A construction modelling scenario was developed to predict the noise levels likely to be experienced at the "Trelega" and "Manilla" homesteads during construction.

During Year 14 of operation, the "Manilla" homestead would be the closest residence to the Snapper Mine, which would be located approximately 3.5 km to the north. An operation modelling scenario was developed to predict the noise levels likely to be experienced at the "Trelega" and "Manilla" homesteads during operation.

Predicted Noise Emissions

Predicted Snapper Mine intrusive construction noise emissions during the day, evening and night periods would be below the project-specific criteria for both closest residences (Appendix F).

Predicted Snapper Mine operation intrusive noise emissions would be below the project-specific criteria for both closest residences (Appendix F).

The intrusive noise contours under adverse inversion conditions for the construction and operation scenarios are presented on Figures 4-12 and 4-13.

Road Transport Noise

Road transport noise has been assessed for heavy traffic only. The potential road transport noise impact associated with light vehicle movements to and from the Snapper Mine would be generally limited to tidal flows (of approximately one to two hours) when Snapper Mine workers would be commuting to and from the Ginkgo Mine accommodation camp (e.g. Mondays and Fridays) (Appendix F). Haulage traffic would therefore be considered to represent the worst-case scenario for potential road transport noise emissions (Appendix F).

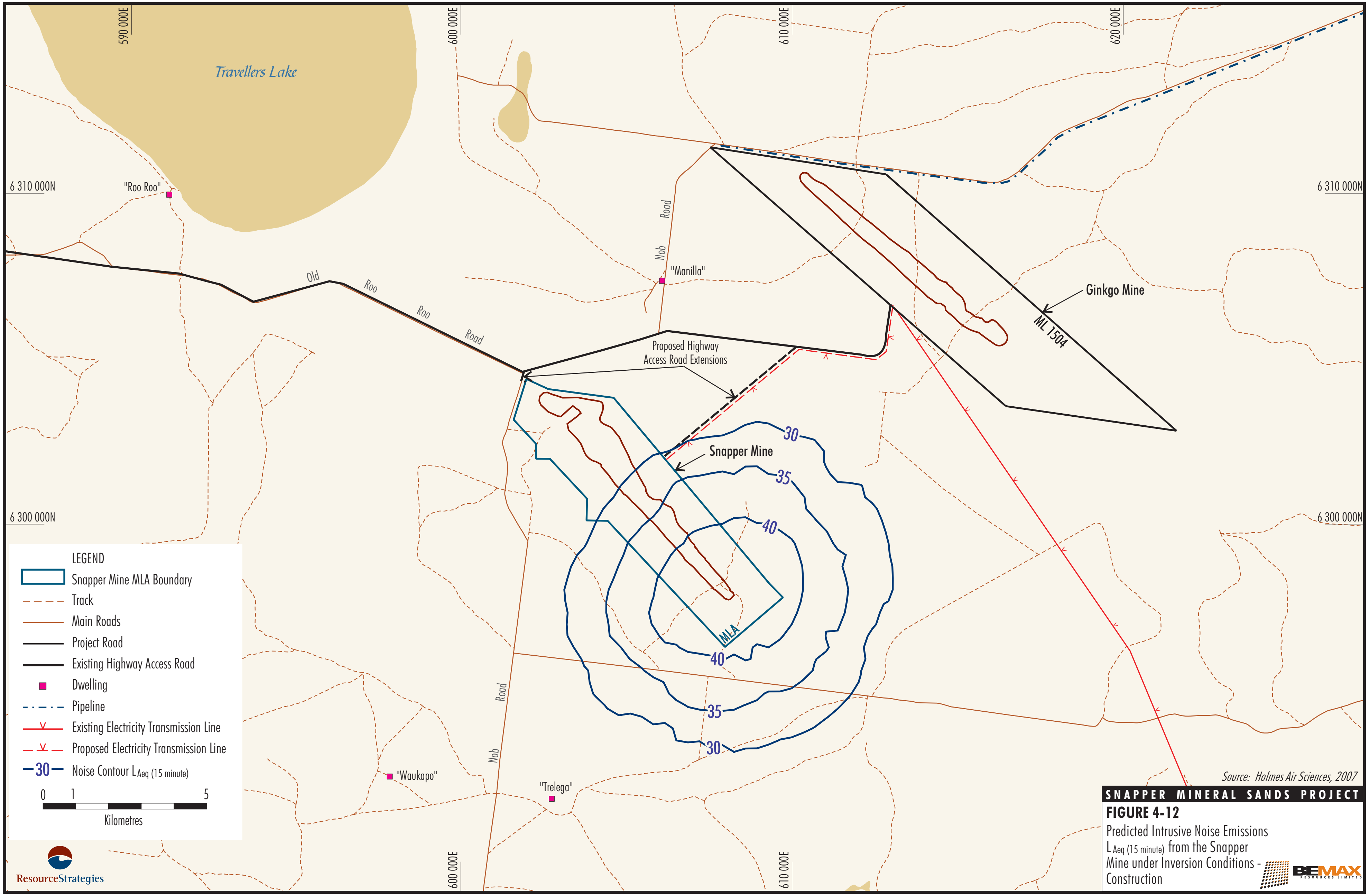
HAR

The mineral concentrate transport route would pass a number of residences on the HAR. The closest of these to the HAR is the "Woodlands" homestead, which would be approximately 800 m from the HAR. Due to the distance of the closest residence to the road, no exceedances of applicable criteria would be expected (Appendix F).

Silver City Highway

Along the Silver City Highway between the HAR and Broken Hill, existing traffic noise levels are assessed to exceed DEC goals for residences very close to the road (e.g. around 10 m from the road edge) (Appendix F).

A comparison of existing predicted transport noise levels on the Silver City Highway between the HAR and Broken Hill with the additional Snapper Mine haulage vehicles indicates that existing noise levels would not increase by more than approximately 0.8 dBA for residences within 1 km of the road and this increase would not be discernible (Appendix F).



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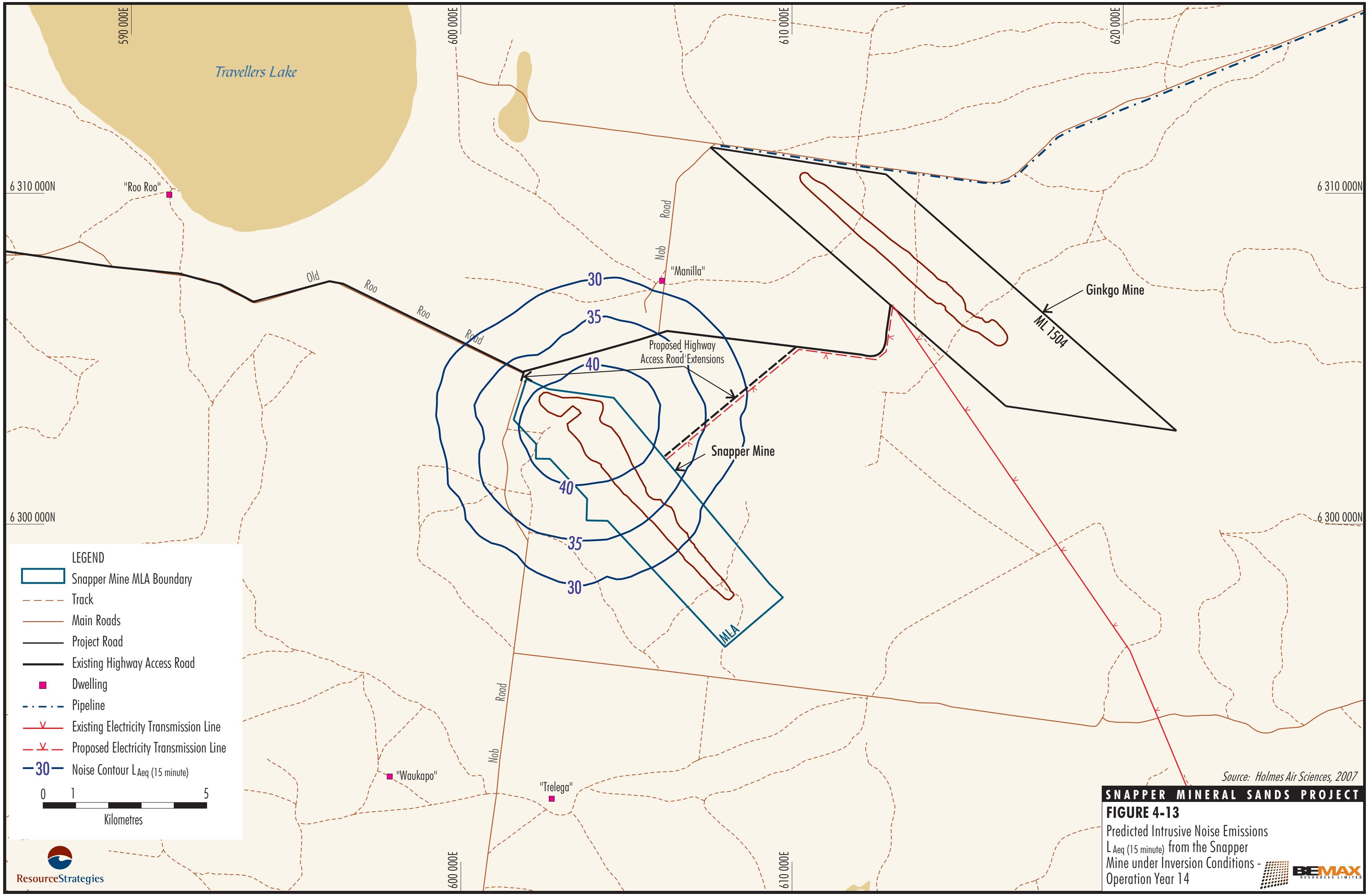

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FIGURE 4-13

Predicted Intrusive Noise Emissions $L_{Aeq\ (15\ minute)}$ from the Snapper Mine under Inversion Conditions - Operation Year 14

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Potential Cumulative Impacts

The closest residence to both mines would be "Manilla". Simultaneously, the closest location of mine noise sources from "Manilla" would be approximately 3.5 km and 5 km from the Snapper and Ginkgo Mines respectively.

Potential cumulative noise impacts during Snapper Mine operation would be limited by these distances.

4.11.3 Mitigation Measures and Management

Mine Noise Mitigation Measures

Notwithstanding the predicted compliance with applicable noise level criteria at the nearest residences, a range of measures would be employed to reduce noise emissions of the Snapper Mine.

A NMP would be prepared for the Snapper Mine which would describe the following:

- applicable noise criteria;
- potential sources of noise emissions;
- emission mitigation and management measures;
- the noise monitoring programme;
- emission management protocols;
- stakeholder consultation; and
- reporting requirements.

The following noise control measures would be applied at the Snapper Mine:

- development and implementation of an equipment maintenance schedule to maintain equipment noise emission levels and reduce the likelihood of tonal noise impacts; and
- administration of a noise awareness programme for employees on the effects of noise and quiet work practices.

Noise monitoring would comprise unattended and attended monitoring at the locations shown on Figure 4-6. The results of noise monitoring would be used to optimise noise controls, validate the noise modelling predictions and would be reported to relevant authorities via the AEMR (Section 6). Notwithstanding the predicted compliance with applicable noise criteria, the NMP would detail specific actions for responding to exceedances of criteria and complaints should they occur.

Road Transport Noise Mitigation Measures

Notwithstanding the predicted low road transport noise levels at homesteads on the HAR and the very slight increase in transport noise levels predicted for the Silver City Highway between the HAR and Broken Hill, the following transport noise mitigation strategies would be implemented and detailed in the NMP for road transport associated with the Snapper Mine:

- road train driver training undertaken for the Ginkgo Mine haulage fleet to minimise noise where practicable (e.g. to avoid exhaust braking at night in built up areas and in the vicinity of homesteads along the HAR) would be updated with the commencement of Snapper Mine haulage;
- if road transport noise concerns from a landholder cannot be resolved through consultation, monitoring to assess compliance with applicable road transport noise criteria would be undertaken; and
- if the compliance monitoring indicates the Snapper Mine road transport is resulting in exceedance of relevant criteria, in consultation with regulatory authorities and the affected resident, noise management measures (e.g. alterations to dwellings) would be considered.

In addition, the Ginkgo Mine and MSP TCC (BEMAX, 2006b) would be updated to include transport activities relevant to the Snapper Mine (Section 4.8).

4.12 AIR QUALITY

An Air Quality Assessment for construction and operation of the Snapper Mine has been undertaken by Holmes Air Sciences (2007b) and is presented in Appendix G. The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005b).

4.12.1 Existing Environment

As a component of the Air Quality Assessment, background air quality data was collected and reviewed. The locations of background monitoring sites (i.e. static dust gauges) are shown on Figure 4-11. The following section provides an overview of background air quality for relevant parameters.

Air Quality Criteria

Dust Deposition

The DEC amenity criteria for dust deposition seek to limit the maximum increase in the mean annual rate of dust deposition from a new development to 2 grams per square metre per month (g/m^2/month) and total dust deposition (i.e. including background air quality) to 4 g/m^2/month.

Concentrations of Suspended Particulate Matter

Exposure to suspended particulate matter can be associated with health and amenity impacts. The likely risk of these impacts depends on a range of factors including the size, chemical make-up and level of the particulate matter and the general health of the person (NSW Health & NSW Minerals Council, 2006).

Such particles (total suspended particulates [TSP]) are typically less than 50 micrometres (µm) in size and can be as small as 0.1 µm. Fine particles less than 10 µm are referred to as particulate matter less than 10 microns in size (PM_{10}). Suspended particulate matter criteria, standards and goals used in the assessment comprise:

- The National Environment Protection Measure (NEPM) 24-hour reporting standard for PM_{10} of 50 micrograms per cubic metre (µg/m^3) (with five exceedances allowed per year) and the DEC 24-hour PM_{10} assessment criterion of 50 µg/m^3.
- The DEC annual assessment criterion for PM_{10} of 30 µg/m^3 has been interpreted as a concentration that should be met within the region (concentrations due to the Snapper Mine and background).
- The National Health and Medical Research Council's (NHMRC) annual goal for TSP of 90 µg/m^3 (which has been interpreted as the assessment criterion for TSP concentrations due to the Snapper Mine and background air quality).

Details of the air quality criteria for concentrations of particulate matter are provided in Table 4-11.

Dust Deposition

Dust deposition data was obtained from gauges monitored by BEMAX at 14 locations as part of the existing Ginkgo Mine air quality monitoring programme (Figure 4-11). This programme commenced in December 2004 at three sites and has been progressively extended.

Dust deposition results for the 14 sites are presented in Table 4-12.

The average dust deposition rate over the 14 sites ranged from 1.0 to 2.4 g/m^2/month. This monitoring included the dust emissions associated with the Ginkgo Mine, which commenced in October 2004. The average monthly dust deposition rate for all sites was well below the DEC goal of 4 g/m^2/month (Appendix G).

Table 4-11
Air Quality Standards/Assessment Criteria for Particulate Matter Concentrations

Pollutant	Standard/Goal/Criterion	Agency
TSP	90 µg/m^3 (annual mean).	NHMRC
PM_{10}	50 µg/m^3 (24-hour average – maximum).	DEC assessment criterion
	30 µg/m^3 (annual mean).	DEC assessment criterion
	50 µg/m^3 (24-hour average, 5 exceedances permitted per year).	NEPM reporting standard

Source: Appendix G

Table 4-12
Average Dust Deposition Results (g/m^2/month)

Dust Gauge[1]	DG01	DG02	DG03	DG04	DG05	DG06	DG07	DG08	DG09	DG10	DG11	DG12	DG13	DG14
Average Dust Deposition*	1.5	1.0	1.1	1.7	1.1	1.9	1.7	1.8	1.1	1.5	1.2	1.5	2.4	1.5
No. of Measurements	18	18	6	18	11	8	8	8	8	4	4	2	2	2

After: Appendix G
1 Refer to Figure 4-11
* Insoluble Solids

Conservatively using the site with the highest average dust deposition record (Site DG13), it has been assumed that the annual average background dust deposition rate in the Snapper Mine area is 2.4 g/m^2/month (Appendix G).

This is highly conservative, as DG13 is located on the Ginkgo Mine ML area boundary and only has a record of two months. Sites with longer records (e.g. sites DG01, DG02 and DG04) that are not located on the ML area boundary all have significantly lower average dust deposition results (Table 4-12).

Suspended Particulates

PM_{10}

No PM_{10} monitoring data is available for the Snapper Mine area. However, the annual average background PM_{10} concentration can be inferred from the conservatively adopted background dust deposition rate of 2.4 g/m^2/month. An inferred annual average background PM_{10} concentration of 22 $\mu g/m^3$ has been adopted for the purposes of the Air Quality Assessment (Appendix G).

TSP

TSP levels can also be inferred from the dust monitoring data. The annual average inferred TSP background concentration based on the adopted background dust deposition (2.4 g/m^2/month) is 54 $\mu g/m^3$ (Appendix G).

4.12.2 Potential Impacts

The Air Quality Assessment considered the air quality emissions likely to be generated by the Snapper Mine and the predicted impact of these emissions in combination with existing background air quality in the vicinity of the Snapper Mine (Appendix G). Potential cumulative emissions with the Ginkgo Mine were also considered.

Emissions associated with operation of the Snapper Mine would be primarily derived from the mechanical disturbance of soils and overburden when using conventional mining equipment, the transport of mineral concentrates and particles from diesel exhausts in activities where diesel powered equipment are used, as well as wind blown emissions from open areas. The wet nature of dredge mining would limit potential dust emissions from this activity.

Modelling Scenarios

Potential impacts for dust deposition and suspended particulates were modelled for two scenarios, construction and operation (Year 14). These scenarios were selected as the periods when the activities associated with the Snapper Mine would be closest to the "Trelega" and "Manilla" homesteads respectively. A full description of the dispersion model and the emissions inventory (including the locations of fixed and mobile dust sources) and modelling outputs is provided in Appendix G.

Dust Deposition

In accordance with the DEC's dust deposition criteria, dust deposition impacts from the Snapper Mine in isolation and the Snapper Mine including background air quality were assessed. The conservatively assumed annual average background dust emission rate is 2.4 g/m^2/month (Section 4.12.1).

Construction

Figure 4-14 shows the predicted annual average dust deposition rates resulting from the construction of the Snapper Mine. Incremental increases in annual average dust deposition due to the Snapper Mine only are not predicted to exceed the applicable 2 g/m^2/month DEC amenity criterion at either the "Manilla" or "Trelega" homesteads (Appendix G).

Annual average dust deposition due to the Snapper Mine plus the assumed background was also not predicted to exceed the applicable 4 g/m^2/month DEC amenity criterion at either homestead (Appendix G).

Operation – Year 14

Figure 4-15 shows the predicted annual average dust deposition rates resulting from the operation of the Snapper Mine in Year 14. Incremental increases in annual average dust deposition due to the Snapper Mine only are not predicted to exceed the applicable 2 g/m^2/month DEC amenity criterion at either the "Manilla" or "Trelega" homesteads (Appendix G).

Annual average dust deposition due to the Snapper Mine plus the assumed background was also not predicted to exceed the applicable 4 g/m^2/month DEC amenity criterion at either homestead (Appendix G).

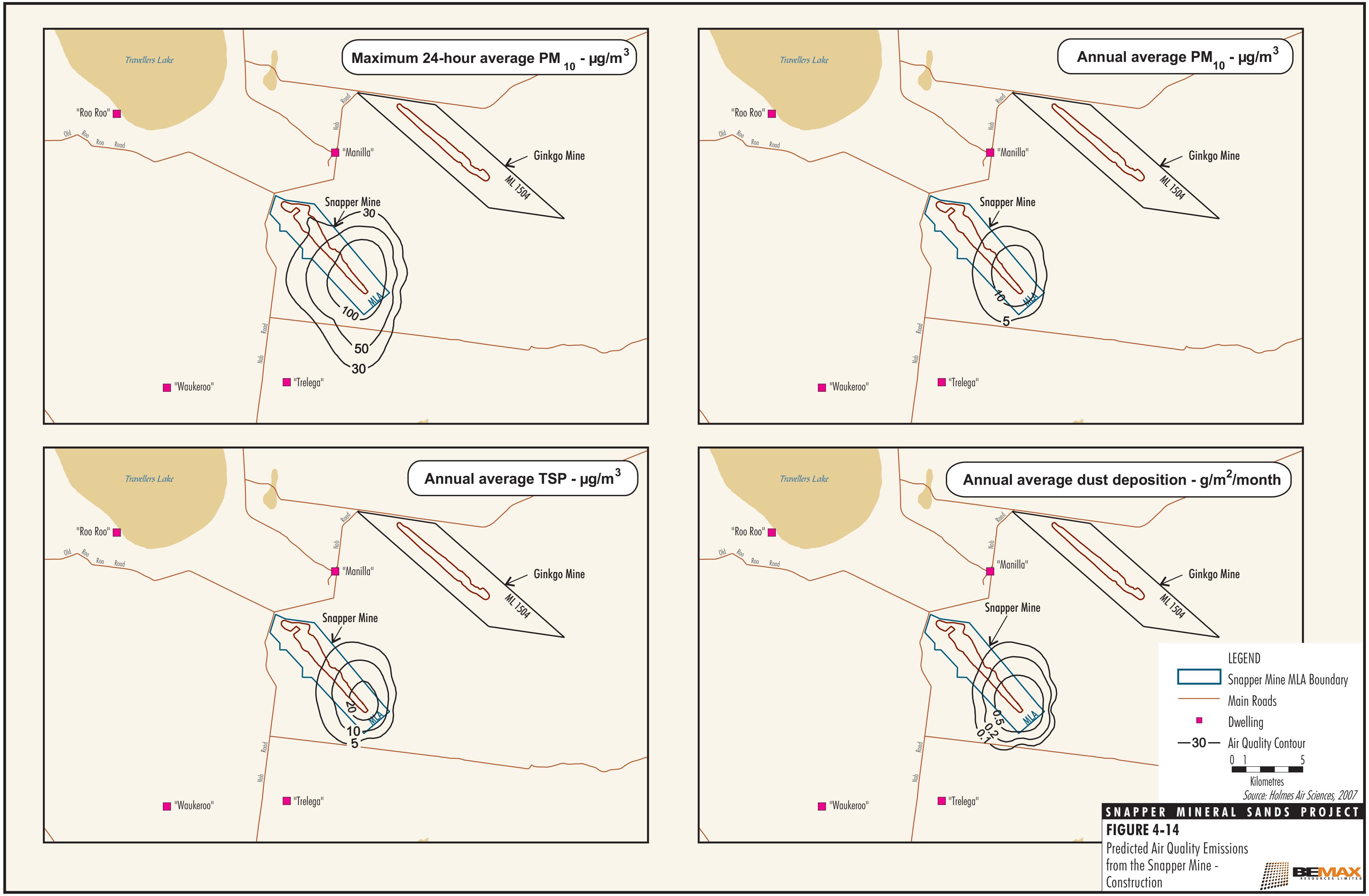

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FIGURE 4-14

Predicted Air Quality Emissions from the Snapper Mine - Construction

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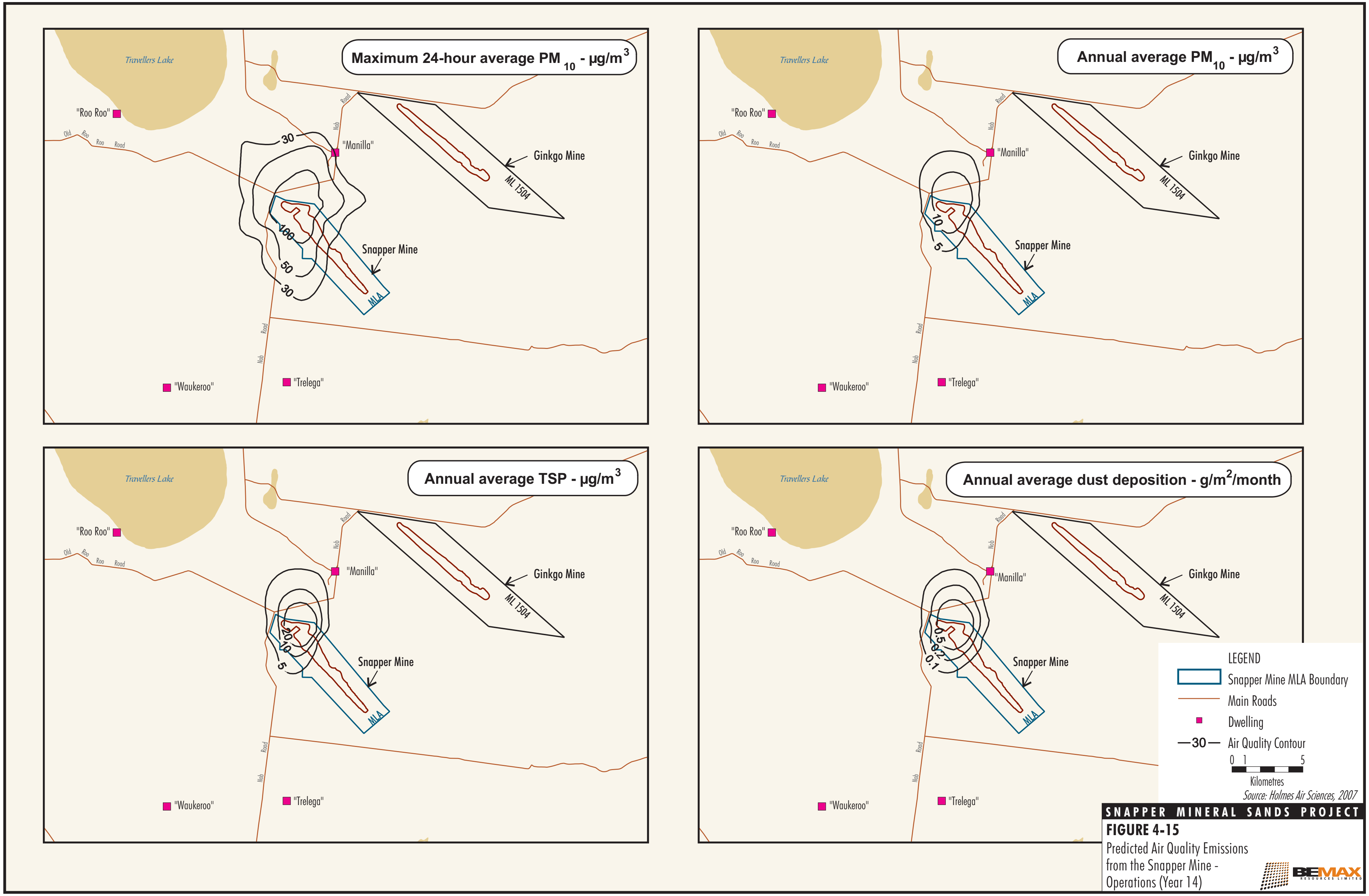

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FIGURE 4-15

Predicted Air Quality Emissions from the Snapper Mine - Operations (Year 14)

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Suspended Particulates

Concentrations of suspended particulate matter were calculated as 24-hour average and annual average PM_{10} concentrations and annual average TSP concentrations for comparison against the applicable criteria (Table 4-11). The maximum 24-hour average PM_{10} criteria was assessed for the Snapper Mine alone, whilst the annual average PM_{10} and TSP assessment criterion/standards relate to Snapper Mine emissions in addition to background concentration levels (Appendix G).

On the basis of dust monitoring data, the background annual average PM_{10} concentration for the Snapper Mine site is inferred to be 22 $\mu g/m^3$ and the inferred annual average TSP background level is 53 $\mu g/m^3$ (Section 4.12.1).

Annual Average PM_{10}

Construction

Predicted annual average PM_{10} (Snapper Mine plus background) concentrations (Figure 4-14) were not predicted to exceed the DEC assessment criterion at either the "Trelega" or "Manilla" homesteads during construction (Appendix G).

Operation – Year 14

Predicted annual average PM_{10} (Snapper Mine plus background) concentrations (Figure 4-15) were not predicted to exceed the DEC assessment criterion at either the "Trelega" or "Manilla" homesteads during operation (Appendix G).

Annual Average TSP

Construction

Annual average TSP (Snapper Mine plus background) concentrations (Figure 4-14) were not predicted to exceed the NHMRC goal at either the "Trelega" or "Manilla" homesteads during construction (Appendix G).

Operation – Year 14

Annual average TSP (Snapper Mine plus background) concentrations (Figure 4-15) were not predicted to exceed the NHMRC goal at either the "Trelega" or "Manilla" homesteads during operation (Appendix G).

Maximum 24-hour average PM_{10}

Construction

Figure 4-14 shows the predicted maximum 24-hour average PM_{10} concentrations resulting from the construction of the Snapper Mine. Maximum 24-hour average PM_{10} concentrations (Snapper Mine only) are not predicted to exceed the DEC assessment criterion of 50 $\mu g/m^3$ at either the "Trelega" or "Manilla" homesteads (Appendix G).

Operation – Year 14

Figure 4-15 shows the predicted maximum 24-hour average PM_{10} concentrations resulting from the operation of the Snapper Mine in Year 14. Maximum 24-hour average PM_{10} concentrations (Snapper Mine only) are not predicted to exceed the DEC assessment criterion of 50 $\mu g/m^3$ at either the "Trelega" or "Manilla" homesteads (Appendix G).

Potential for the Snapper Mine to Increase Exceedances of the Short-Term PM_{10} Criteria

Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC, 2005b) recommends that for areas where there are already exceedances of the 50 $\mu g/m^3$ criterion, there should be no additional exceedances of 24-hour average PM_{10} air quality criteria due to a new project. At times there would be exceedances of the 50 $\mu g/m^3$ criterion at all residential properties in the area, due to natural sources of particulate matter such as bushfires or dust storms (Appendix G).

Holmes Air Sciences have assessed the potential for the Snapper Mine to cause additional exceedances of the 24-hour average PM_{10} air quality criteria and concluded the potential would be very low (Appendix G).

Potential Cumulative Air Quality Impacts with Ginkgo Mine

In accordance with the Snapper Mine DGRs (Section 1.3), potential cumulative impacts due to the Snapper Mine and Ginkgo Mine were assessed (Appendix G). The only area where concentrations or deposition levels would be enhanced would be between the operations (to the north-east of the Snapper Mine and to the south-west of the Ginkgo Mine) and the enhancement would be negligible (Appendix G).

The cumulative assessment indicated there would be no change to the maximum 24-hour average PM_{10} concentration model prediction calculated for the Snapper Mine only (i.e. 34 $\mu g/m^3$) and only a small effect on annual average PM_{10}, TSP and dust deposition levels at the "Manilla" and "Trelega" homesteads. The potential cumulative effect of the two mining operations would not cause exceedances of annual average air quality criteria (Appendix G). Predicted cumulative air quality emissions are shown on Figure 4-16.

Greenhouse Gas Emissions

An assessment of Snapper Mine greenhouse gas emissions is provided in Appendix G. The outcomes of the assessment are summarised below.

The major source of greenhouse gas emissions from the Snapper Mine would be the combustion of diesel in mobile equipment on-site and indirectly by the use of electricity to power the dredge, primary gravity concentrator and associated equipment.

An assessment of the Snapper Mine greenhouse gas emissions was conducted using empirical emission factors provided by the Australian Greenhouse Office (AGO) (2006). The average annual emission estimate for the life of the Snapper Mine (including construction) would be approximately 0.098 Mt $CO_{2\text{-}e}$ pa (Appendix G).

The average annual greenhouse gas emission estimate can be compared with the following 2004 estimates provided by the latest National Greenhouse Gas Inventory report (DEH, 2006b) (Appendix G):

- estimate of Australia's 2004 net emissions, 564.7 Mt CO_2-e;
- estimate of Australia's 2004 net emissions for the energy sector, which is the major contributor to carbon-dioxide emissions, 387.2 Mt CO_2-e; and
- estimate of Australia's 2004 net emissions for the industrial sector, 29.8 Mt CO_2-e.

4.12.3 Mitigation Measures and Management

Dust and Suspended Particulate Emission Management

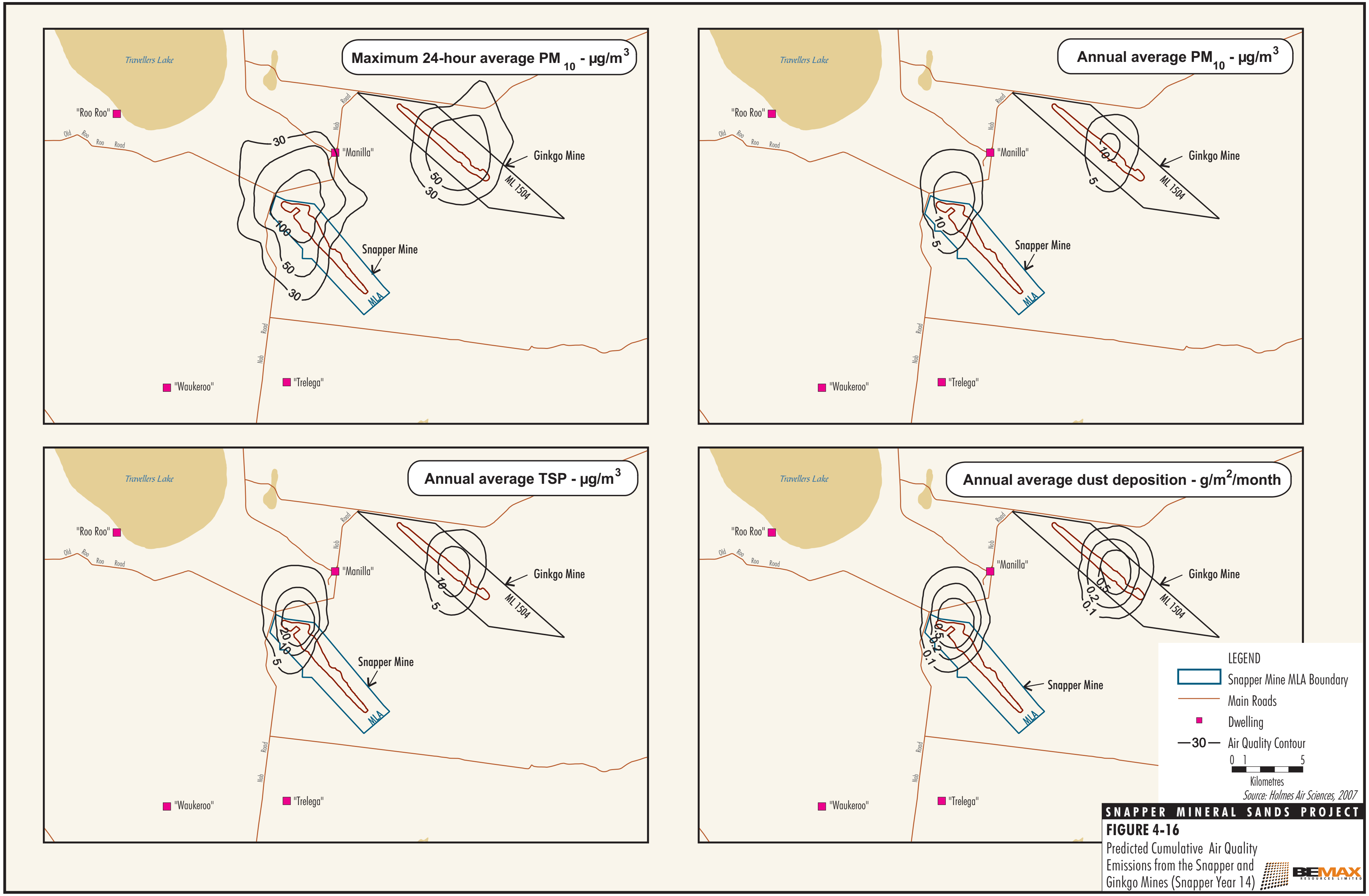
Notwithstanding the predicted compliance with applicable dust deposition and suspended particulate criteria (Section 4.12.2) an AQMP would be prepared which would describe measures to reduce emissions of atmospheric dust from the Snapper Mine. The measures would be based on current control techniques as applied at the Ginkgo Mine in accordance with the Ginkgo Mine AQMP (BEMAX, 2005b).

The AQMP would describe the following:

- applicable air quality criteria;
- potential sources of air quality emissions;
- emission control and management measures;
- the air quality monitoring programme;
- emission management protocols;
- stakeholder consultation; and
- reporting requirements.

The AQMP would describe air quality control measures for managing wind blown dust from exposed areas as well as dust generated by mining activities. The air quality control measures outlined below would be applied at the Snapper Mine:

- Land clearing would be minimised.
- Exposed mined areas would be rehabilitated as soon as practicable.
- Mineral stockpiles would be maintained at a contained moisture content of 6-8%.
- Haul roads and trafficked areas would be watered using water carts to minimise the generation of dust.
- Where the HAR passes the "Manilla" and "Woodlands" stations, the road would be treated with a dust suppression system if required.
- Development of minor roads would be limited and the locations of these would be clearly defined.
- Regularly used minor roads would be watered.
- Obsolete roads would be revegetated.
- Mineral concentrate haulage truck trailers would be covered.
- Long-term topsoil stockpiles would be revegetated with a cover crop.



SNAPPER MINERAL SANDS PROJECT

FIGURE 4-16

Predicted Cumulative Air Quality Emissions from the Snapper and Ginkgo Mines (Snapper Year 14)

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BMX-03-09 Sect 4_014E

Air quality monitoring would monitor dust deposition at the locations shown on Figure 4-6. The results of air quality monitoring would be used to optimise air quality controls, validate the air quality modelling predictions and would be reported to relevant authorities via the AEMR. Notwithstanding the predicted compliance with applicable air quality criteria, the AQMP would detail specific actions for responding to exceedances of criteria and complaints should they occur.

Two additional dust depositional gauges would be installed for the Snapper Mine prior to the commencement of construction. These gauges would be installed at the "Trelega" and "Waukeroo" homesteads (Figure 1-3). The dust deposition gauges would be analysed for ash content and insoluble solids in accordance with AS/New Zealand Standard (NZS) 3580.10.1-2003 *Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method*.

Greenhouse Gas Emissions

Minimising fuel and electricity usage would be an inherent objective of Snapper Mine planning and cost control systems. Additional measures to mitigate greenhouse gas emissions associated with the Snapper Mine would include:

- consideration of energy efficiency in plant and equipment selection/purchase;
- regular maintenance of plant and equipment to minimise fuel consumption and associated emissions; and
- the implementation of a vegetation off-set strategy (Section 4.9.3).

4.13 REGIONAL ECONOMY

A regional economic assessment was prepared for the Snapper Mine by Gillespie Economics as part of the Socio-Economic Assessment and is presented in Appendix J.

The regional economy chosen for the study was the Far West/Wentworth/Mildura region, comprising the statistical local areas (SLAs) of Broken Hill, Far West Unincorporated, Wentworth and Mildura Rural City (RC) Part A (Appendix J). This region was adopted because even though the selected region straddles the NSW and Victorian borders, this reflects the significance of the two nearest major population centres to the Snapper Mine, Broken Hill in NSW and Mildura in Victoria (Figure 4-1).

The assessment was conducted at the regional economy level, however, consideration was also given to the potential impacts at the NSW state level for planning purposes.

4.13.1 Existing Environment

The regional economic assessment is based on a 2000-2001 input-output analysis for the regional economy. The 2000-2001 input-output data is the latest that is available. Therefore, the table does not reflect the development of the Ginkgo Mine which commenced production in late 2005. As described above, the local region comprises the Far West/Wentworth/Mildura region.

Gross regional product (GRP) for the regional economy is estimated at $2,049M, comprising $829M in wages and salaries and $1,221M in other value added contributions.

The comparative distribution of various industry sectors to employment, the GRP and output earnings for the local region and for the state of NSW are presented in Table 4-13.

Table 4-13
Contributions to Employment, the GRP and Output by Industry Sector – Regional Economy and NSW (2001)

Sector	Total Employment (%)		Contribution to GRP (%)		Contribution to Output (%)	
	Region	NSW	Region	NSW	Region	NSW
Agriculture/Forestry and Fishing	14	4	10	2	10	2
Mining	2	1	6	2	8	2
Manufacturing	8	12	13	13	25	29
Utilities	2	1	5	2	5	2
Building	5	7	3	4	3	4
Services	70	76	52	67	49	61

Source: After Appendix J

Comparison with the NSW economy indicates that the agriculture, forestry and fishing sector, mining sector and utilities in the regional economy are of greater relative importance than they are to the NSW economy. While the manufacturing sector, building sector and services sectors are of less relative importance in the region than they are to the NSW economy (Appendix J).

The services sector is the most significant sector in terms of employment numbers and contribution to both GRP and output for the local region (Table 4-13).

4.13.2 Potential Impacts

Regional economic impact assessment is primarily concerned with the effect of an impacting agent on an economy in terms of specific indicators, such as employment, income, GRP and gross regional output. The assessment in Appendix J included consideration of the regional economic impacts of construction and the operation of the Snapper Mine on both the regional economy, and the State of NSW.

Snapper Mine Construction

Using input-output analysis, it was estimated that on average the construction of the Snapper Mine would contribute the following to the regional economy (Appendix J):

- $38M in annual direct and indirect regional output or business turnover;
- $19M in annual direct and indirect regional value-added;
- $11M in annual household income; and
- 250 direct and indirect jobs.

Approximately 40% of these impacts would be likely to occur in the NSW part of the local region (Appendix J).

The impacts would persist for about one year and the main sectors of the regional economy that would be stimulated by the Snapper Mine construction would be: the wholesale and retail trade sectors; accommodation, cafes and restaurants sector; structural metal products manufacturing sector; other property services sector; and the transport (predominantly road transport) and mechanical repairs sectors (Appendix J).

Snapper Mine Operation

The operation of the Snapper Mine is likely to contribute in the order of:

- $91M in annual direct and indirect regional output or business turnover;
- $42M in annual direct and indirect regional value-added;
- $8M in annual household income; and
- 140 direct and indirect jobs.

Approximately 50% of these impacts would be likely to be felt in the NSW part of the region (Appendix J).

These impacts would be likely to be felt for some 16 years across a range of sectors. The sectors most impacted by output, value-added and income flow-ons would be likely to be: the other construction sector; road transport sector; electricity sector; wholesale trade sector; retail trade sector; water supply sector; accommodation, cafes and restaurants; and other property services sector (Appendix J). Employment impacts would also be likely to be felt across a number of sectors including the mining sector, other construction sector, transport sector, wholesale and retail trade sectors and services sectors (Appendix J).

End of Snapper Mine Life

The construction and operation of the Snapper Mine would stimulate demand in the regional and NSW economies leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the Snapper mine would, however, lead to a reduction in economic activity.

The socio-economic significance of cessation of the Snapper mine would depend on the relative significance of the Snapper Mine to the regional economy and other regional economic factors at the time. Impacts associated with Snapper Mine cessation would be likely to be greater in a declining economy than in a growing diversified economy.

Potential Cumulative Impacts

In addition to the potential impacts on the regional economy that have been identified for the Snapper Mine, the operation of the Ginkgo Mine is also contributing significantly to the regional economy. Gillespie Economics (2001) estimated that the operation of the Ginkgo Mine would contribute some $48M in annual direct and indirect regional output or business turnover and some $19M in direct or indirect regional value-adding, including some $9M in household income. As described in Section 2.3.5, the workforce for the Ginkgo Mine comprises approximately 120 people.

4.14 POPULATION, EMPLOYMENT AND COMMUNITY INFRASTRUCTURE

Changes in the workforce and populations of regions and towns can have implications in relation to access to housing, health and education facilities. A community infrastructure assessment was included in the Socio-Economic Assessment (Appendix J) to consider these issues. The geographic scope of the community infrastructure assessment was determined by the main towns that have the potential to service the Snapper Mine and its employees.

The Snapper Mine is located in the Wentworth SLA, which contains the towns of Pooncarie, Wentworth and Dareton, which are approximately 40 km, 70 km and 70 km from the MLA area, respectively. While not in the Wentworth SLA, Broken Hill, some 170 km north of the mine site, would be expected to supply some of the Snapper Mine labour force, due to its long mining history. Mildura is a major regional centre located in Victoria, some 80 km from the mine site, and is also expected to be significant to the Snapper Mine for workforce and housing (Appendix J).

4.14.1 Existing Environment

A summary of the Socio-Economic Assessment in relation to background demographics, employment and community infrastructure is provided below.

Population and Employment Profile

Wentworth Shire

In the 2001 census, the Wentworth Shire population was approximately 7,000 people, having fallen approximately 6% since the 1991 census. Over this same period the percentage of the population over 65 years of age increased (Appendix J).

Over the ten years from 1991 to 2001, the unemployment rate for the region fell from 12% in 1991 down to 5% in 2001 (Appendix J). However, data from the March 2006 Small Area Labour Markets publication indicates that the unemployment rate for the shire is 10.9% (395 people) which is significantly higher than at the last Census (Appendix J).

Towns in Wentworth Shire of particular relevance to the Snapper Mine include Pooncarie, Dareton and Wentworth. Additional information on these towns is provided below.

<u>Pooncarie</u>

Pooncarie is the nearest town to the Snapper Mine (Figure 4-1). The 2001 census indicates that approximately 200 people live in the Pooncarie district. The population of the town itself is approximately 80 people (Appendix J).

<u>Dareton and Wentworth</u>

In 2001, the population of Wentworth was 1,435 (79 less than at the 1996 Census) and Dareton had a population of 620 (32 less than at the 1996 Census). Both Dareton and Wentworth have a smaller proportion of the labour force involved in agriculture (15%) than the Wentworth Shire as a whole (34%). This reflects the service centre role played by these towns (Appendix J). The retail trade and the accommodation, cafes and restaurants sectors employ the largest number of people in Dareton and Wentworth.

Broken Hill

Broken Hill is the largest regional centre in the western half of NSW (BHCC, 2007), however, the city's population has fallen by nearly one third since 1972 (Appendix J). Between the 1996 and 2001 census the Broken Hill SLA population declined from 23,879 to 20,363 and regional employment statistics suggest a continuing slow decline in population since 2001 (Appendix J).

Census data indicates that while historically, mining was the largest employer in Broken Hill, this sector has declined significantly from 19% of the workforce in 1991 to 7% of the workforce in 2001. In 2001 the retail trade sector and health and community services sector were the largest employers at 19% and 15% respectively (Appendix J).

The March 2006 quarter Small Area Labour Markets publication indicates that there were some 749 people unemployed in Broken Hill, equating to an unemployment rate of some 8.2% (Appendix J). This is higher than the NSW unemployment rate of 5.2%, however, it is lower than the unemployment rate (12.8%) recorded during the 2001 census (Appendix J).

Mildura

Mildura has been growing steadily and the broader region (Mildura RC Part A) has grown considerably from 40,644 to 44,194 in the period 1996 to 2001 (Appendix J).

In Mildura, retail is the largest sector, providing 18% of employment, while health and community services and manufacturing (primarily food and wine) are the next most significant sectors (11% and 10% respectively). At the regional level, the most significant industry is still retail (16% of employment) followed by agriculture (14%) and manufacturing (10%) (Appendix J).

At the 2001 census, Mildura had an unemployment rate of 11.5% (952 people) while the broader region had an unemployment rate of 7.0% (1,391 people). The March 2006 quarter Small Area Labour Markets publication indicates an unemployment rate of 8.2% for the Mildura RC Part A SLA (1,866 people) (Appendix J).

Housing

Wentworth Shire

There are around 3,000 dwellings in Wentworth Shire, and approximately 80% of these are separate houses. Some 250 dwellings in the shire were unoccupied at the time of the 2001 census (Appendix J).

Gillespie Economics contacted a number of local real estate agents who reported that there is a reasonable supply of rental properties currently available as well as houses for purchase (Appendix J). There is a variety of short-term accommodation available in the Shire including hotels/motels, holiday units, houseboats, bed and breakfasts and caravan parks. The Centre for International Economics (CIE) (2001) estimated that the Wentworth Shire has short-term accommodation capacity for around 960 people.

In Pooncarie there is little housing available for rent, however, the Pooncarie Hotel provides short-term accommodation. Around 80% of the dwellings in Wentworth and Dareton are separate houses. Units and flats along with caravans and cabins make up the remaining dwellings. Both houses and flats are available for lease in Dareton and Wentworth, with real estate agencies indicating that more rentals could be found if demand warranted it (Appendix J).

Broken Hill

At the time of the 2001 census there were 9,752 dwellings in Broken Hill, of which 1,307 were unoccupied. Some 17% (1,396) of the occupied dwellings were rented and 45% of renters paid less than $100 per week in rent (Appendix J). House prices are generally lower than in similar regional centres. The on-going population decline indicates that there is likely to be an oversupply of housing both in the rental and ownership markets. However, the available vacant housing may not match the location and quality of houses demanded by migrating populations (Appendix J).

There is also a large supply of short-term accommodation in Broken Hill. There are 13 hotels and motels providing 321 rooms and 920 beds (Appendix J). Broken Hill also has two caravan parks and a large number of holiday homes. Recently there has been the development of a stock of cottage accommodation to service growing tourism visitation to Broken Hill (Appendix J).

Mildura

At the time of the 2001 census there were 11,669 dwellings in the town of Mildura, of which 70% were classified as separate houses and 18% as townhouses, flats, units or apartments. There were also 852 unoccupied private dwellings (Appendix J).

The rental market is larger in Mildura than in most of the other towns/cities of relevance to the Snapper Mine. This is reflected in the lower home ownership rate compared with the other centres, with some 3,466 properties being rented (Appendix J).

There are approximately 150 accommodation and hospitality establishments within the Mildura City Municipality. These establishments have the capacity to accommodate around 7,500 people (CIE, 2001).

Education, Health and Community Services

Wentworth Shire

There are seven public primary schools and one private primary school in the Shire (Appendix J). Dareton has the only high school in the Shire. The Department of Education indicated that the public schools in the Wentworth Shire generally have spare capacity and that staffing can be adjusted based on student numbers (Appendix J).

The Greater West Area Health Service has a major service centre in Dareton servicing the Wentworth and Balranald Shires. Thirty full-time staff are employed in a range of positions including primary health care. These are supported by visiting specialists and access to Telehealth services. Services are delivered through the Dareton Community Health Centre and the Wentworth Hospital, plus a regular clinic at Buronga and Pooncarie (Appendix J).

Medical services are available at Dareton and Wentworth and the Flying Doctor has a regular scheduled visit to Pooncarie. Wentworth District Hospital has a 24-hour emergency service and also provides acute care, long-term care, palliative care, respite care and diversional therapy and Community Health services. A limited ambulance service is based at the Wentworth District Hospital but there are no trained paramedics available. This leaves the Shire very dependent on services based across the Victorian border, adding to response times in an emergency (Appendix J).

The Department of Community Service (DOCS) provides a range of services both directly to clients and through supporting community service organisations (e.g. children services, disability services and care protection services). It is supported in some areas of its work by Mallee Family Care that set up operations in Dareton during 2003 (Appendix J).

Wentworth and Dareton both have small shopping centres including post offices and supermarkets. Both towns have large service clubs incorporating dining and sporting facilities, including tennis, golf, and bowls. There is also a swimming pool in each town. There are a number of sporting and recreational bodies in the region.

Broken Hill

Broken Hill has historically had community infrastructure to sustain a population of approximately 30,000 people, so given its current population of just over 20,000 it is well-resourced in capital infrastructure (Appendix J).

There are four preschools, six public primary schools, two public high schools to year 12 and one private catholic school from kindergarten to year 10 (CIE, 2001). Broken Hill also has a TAFE college and the Robinson Adult Education Centre as well as a campus of Charles Sturt University that offers arts and welfare degrees plus support for students studying externally. The Department of Rural Health, University of Sydney has a campus offering remote nursing graduate certificates and masters, Aboriginal Health Worker training at Associate Diploma level and other professional programmes (Appendix J).

Broken Hill has the only 'base' hospital in the Far West Area and is the referral centre for surrounding communities, receiving patients via road or the Royal Flying Doctor Service. Medical staff are on duty 24 hours per day and 7 days per week in the Emergency Department with full-time surgical, medical, anaesthetic, paediatric and obstetric/gynaecological specialists available (CIE, 2001). The Integrated Care and Allied Health Care Team offer an on-site range of services to inpatients, outpatients and in the community.

Broken Hill has a large number of parks and reserves and has over 300 sporting and recreational groups. There is one swimming pool and a number of gymnasiums. Further afield, the Mutawintji, Kinchega and Sturt National Parks offer bushwalking and camping opportunities. The Menindee Lakes Scheme, one hour by road provides fishing, sailing, speed boat, skiing and camping facilities (Appendix J).

Mildura

In Mildura there are numerous primary (23) and secondary schools (10) both public and private (Appendix J). Mildura is a source of education facilities, high schools, TAFE and training agencies, for people who reside in the Wentworth Shire, particularly residents around Wentworth and Dareton. There is a local campus of La Trobe University at Mildura.

Mildura has a base hospital that also services the Wentworth Shire. The hospital has 114 beds and operates a 24-hour emergency facility. The region has a number of support and family welfare organisations such as the Salvation Army and Emmaus house (CIE, 2001).

Mildura has a large number of parks and recreation facilities, including two swimming pools and a diving pool. There are a range of sports clubs and recreational groups and an arts centre complex that includes a gallery and an amphitheatre (Appendix J).

4.14.2 Potential Impacts

As described in Section 2.10, the development of the Snapper Mine would employ up to 250 people during the construction period and would employ some 110 people when operating. In addition, the development would facilitate flow-on employment in the region. The primary potential impact of the Snapper Mine on community infrastructure would therefore relate to population growth and related effects on housing and community facilities.

The Snapper Mine would have the potential to generate employment outside of the region. Potential employment effects, population effects and community infrastructure demands that take place outside of the region are expected to be largely concentrated in major centres, and hence in relative terms any potential adverse impacts would be likely to be minor in nature. The following assessment therefore concentrates on potential impacts in the Far West/Wentworth/Mildura region.

Workforce

As described in Section 2.10, it is anticipated that 200 people would be employed on average over a 15 month period to undertake the Snapper Mine construction activities. During short-term peaks in construction activity, up to a maximum of 250 people would be employed. The operation of the Snapper Mine would employ some 110 people over a 16 year period.

Approximately 80% of the Snapper Mine workforce is expected to be sourced from the local region (i.e. Wentworth Shire, Broken Hill and Mildura).

Population Effects

During Snapper Mine construction, there would be a temporary increase in population in the region as an estimated 40 (average) to 50 (peak) people are expected to come from outside the region to fill 20% of the direct construction employment (Appendix J). It is anticipated that between 60 and 75 people would migrate into the region (Appendix J). Gillespie Economics has estimated that this would result in a requirement for accommodation for 18 to 23 people in Broken Hill, 6 to 8 people in Wentworth Shire and 36 to 45 people in Mildura (Appendix J).

While some 50 flow-on jobs are predicted to be created in the region during the construction period, given the temporary nature of the flow-on effects, Gillespie Economics considers that these jobs would be filled by the local population, without the need for migration (Appendix J).

During Snapper Mine operation, there would be an increase in population in the region as an estimated 22 people are expected to come from outside the region to fill 20% of the operational jobs. It is anticipated that some 57 people would migrate into the region (Appendix J). Some 33 flow-on jobs are predicted to be created in the region during operation and Gillespie Economics estimate that this would result in an additional 17 people migrating into the region (Appendix J).

Gillespie Economics has estimated that direct and flow-on employment associated with the Snapper Mine operation would result in a requirement for accommodation for 19 people in Broken Hill, 19 people in Wentworth Shire and 37 people in Mildura (Appendix J).

For both Broken Hill and the Wentworth Shire the additional population migration associated with the Snapper Mine would help to offset historic population decline. The additional population predicted for the Mildura region would be small in the context of Mildura annual population growth (Appendix J).

Housing

The accommodation camp at the Ginkgo Mine would be expanded to accommodate the increased requirement for on-site housing during construction and the majority of the non-local construction workforce would stay in the accommodation camp.

While rostered-off, workers would be likely to generate demand for short-term accommodation mainly in Mildura (up to 30 residences) but also in Broken Hill (up to 15 residences) and Wentworth Shire (up to five residences) (Appendix J).

Direct and flow-on employment related population growth resulting from the Snapper Mine operation would be likely to generate demand for accommodation mainly in Mildura (up to 14 residences) but also in Broken Hill (up to seven residences) and Wentworth Shire (up to seven residences).

The housing demand associated with the Snapper Mine construction and operation would be largely insignificant in the context of the total housing stock, rental stock and unoccupied dwellings (potential rental stock) and annual housing construction in the region (Appendix J). However, because of higher relative wages in the mining sector, the demand for rental accommodation and purchase of housing would be likely to be at the higher end of the real estate market where supply would be more limited.

Education, Health and Community Services

The Snapper Mine workforce is not expected to place any significant demands on tertiary education institutions in the region (Appendix J).

During the construction phase, incoming workers would be expected to be mostly single and unaccompanied. No significant effects upon schools in the region would be expected (Appendix J). During operation of the Snapper Mine, incoming workers would be associated with some children and increased demand for education facilities within the region. Gillespie economics has estimated that the demand for pre-school to high school places associated with the operation of the Snapper mine would be five places in Broken Hill, five places in Wentworth Shire and nine places in Mildura. This level of additional enrolments would be insignificant (Appendix J).

There would be potential for the Snapper Mine to increase the demand for public health facilities in the region via the anticipated increase in population during construction and operation. However, the anticipated population increase would be very small compared to the total population of the region and main population centres (Appendix J).

In Mildura, the anticipated population increase would add the general population growth of the region, adding to demand for community services and facilities. However, the expected temporary population growth associated with the Snapper Mine would be in the order of 5% to 6% of average annual population growth and the increased demand for community services and facilities in Mildura would therefore be likely to be minor (Appendix J).

Potential Cumulative Impacts

Gillespie Economics has considered potential cumulative impacts associated with the Snapper and Ginkgo Mines on housing, education and community infrastructure and found that population growth associated with these developments would potentially offset historical declines in population in the Wentworth Shire and Broken Hill.

4.14.3 Mitigation Measures

Although the potential population and community infrastructure effects of the Snapper Mine are limited, BEMAX would continue to consult with relevant local government agencies and government departments during the development of the Snapper Mine to monitor any housing or community infrastructure issues that may occur. If social or community infrastructure issues arise during the development of the Snapper Mine, these would be managed in consultation with the local government agencies and/or the relevant state government department.

The Ginkgo Mine CCP would be revised to include the Snapper Mine. The Ginkgo Mine CCP provides for on-going consultation with local residents.

4.15 HAZARD AND RISK

Four separate assessments have been conducted as part of the EA to address key issues and associated hazards and risks, including:

- **PHA** to evaluate the hazards associated with the Snapper Mine (Appendix K). The PHA was conducted in accordance with the general principles of risk evaluation and assessment provided in the NSW *Multi-Level Risk Assessment Guidelines* (DUAP, 1999).
- **General Overview** to identify key issues for the construction and operation of the Snapper Mine, taking into consideration issues raised during consultation (Appendix L).

- **Process Waste Materials Risk Assessment** to identify risks associated with the handling and disposal of waste (including backloaded MSP process waste) at the Snapper Mine (Appendix I).
- **Saline Slurried Overburden Risk Assessment** to identify and assess risks to the success of rehabilitation and revegetation of the Snapper Mine site associated with the use of saline slurry in the overburden emplacements (Appendix H).

4.15.1 Hazard Identification and Risk Assessment

PHA

Potentially hazardous materials present at the Snapper Mine would generally be limited to diesel and backloaded MSP process waste (Appendix K). Risks posed by the usage of these materials for the Snapper Mine would include transport, handling and consumption.

For the purposes of risk identification, the Snapper Mine was divided into a number of operation areas including:

- dredge mining and mineral concentration;
- sand residue and overburden management;
- water management;
- concentrate haulage and waste backloading;
- diesel storage facilities;
- mine stores;
- concentrate stockpile/road train loading;
- consumables transport;
- electricity transmission; and
- external events.

Potential incidents were then identified within each operation area and divided into generic classes including (Appendix K):

- fire;
- explosion;
- leaks/spills;
- failure; and
- vehicle accident.

Potential hazards identified in the PHA related to the following Snapper Mine elements/activities:

- the operation of the initial sand residue dam and initial slurried overburden emplacement;
- the transport and storage of diesel for use in operation (e.g. fires and leaks/spills); and
- the haulage of mineral concentrates to the MSP and the backloading of MSP process waste products by double road trains or other RTA-approved vehicles (e.g. AB-triple vehicles) (e.g. vehicle accidents and leaks/spills).

Following the identification of potential hazards associated with the Snapper Mine, a qualitative assessment of risks to the public, property and the environment associated with the development and operation of the Snapper Mine was undertaken (Appendix K). Risk treatment measures have been proposed, where required, to produce a low level risk in accordance with the risk acceptance criteria (Appendix K). These risk treatment measures are presented in Section 4.15.2.

General Overview

The methodology employed during the preparation of the General Overview was as follows:

- Identify the potential environmental impacts associated with the Snapper Mine.
- From the potential impacts identified, determine the key issues.
- Confirm that the key issues identified have been included in the scope of the Snapper Mine EA.
- Identify whether further assessment is required (i.e. beyond the current scope of the Snapper Mine EA).

The above methodology was implemented during a General Overview workshop in October 2006. The key environmental issues that were identified in the General Overview and the sections of this EA that address these issues are presented in Table 3-1.

All of the key issues (and associated hazards and risks) identified in the General Overview and listed in Table 3-1 were considered to be incorporated within the EA scope. Therefore, no further assessment beyond the scope of the EA is required.

The General Overview is provided in full as Appendix L.

Process Waste Materials Risk Assessment

Potential hazards identified in the Process Waste Materials Risk Assessment related to the following elements/activities:

- inadequate containment of the MSP process waste on-site resulting in land and or surface water contamination;
- disposal of backloaded MSP process waste below the groundwater table resulting in groundwater contamination;
- inaccurate classification of wastes (in accordance with *Environmental Guidelines: Assessment, Classification & Management of Liquid and Non-liquid Wastes* [DEC, 2004b]) resulting in inappropriate disposal;
- on-site roll-over of a vehicle transporting backloaded MSP process waste resulting in spillage of radioactive waste to land and surface waters;
- wind-blown backloaded MSP process waste;
- leaks or ruptures of the pipe carrying slurried backloaded MSP process waste; and
- waste tyres.

Proposed control measures to address the above potential hazards are discussed in Section 4.15.2.

Saline Slurried Overburden Risk Assessment

Potential hazards identified in the Saline Slurried Overburden Risk Assessment related to the following elements/activities:

- capillary rise increasing salinity levels within the PRZ of the non-slurried material;
- leakage or loss of saline water or lateral salt movement (seepage) within the slurried overburden along the mine path and in the emplacements to rehabilitated and/or revegetated areas;
- salts contained within the slurried material becoming airborne once the material has dried; and
- failure of clay lining in initial slurried overburden emplacements.

Proposed control measures to address the above potential hazards are discussed in Section 4.15.2.

4.15.2 Mitigation Measures and Management

A number of hazard preventative and mitigative measures would be described in management plans for the Snapper Mine, including the following:

- MOP;
- SWMP;
- LEMP;
- ERP;
- Revision of the Existing Ginkgo Mine and MSP TCC (BEMAX, 2006b); and
- Revision of the Existing Ginkgo Mine and MSP THMP (BEMAX, 2006c).

PHA – Risk Treatment Measures

As described in the PHA, the following risk treatment measures would be adopted for the Snapper Mine:

- **Maintenance –** On-going and timely maintenance of all mobile and fixed plant and equipment in accordance with the manufacturer's recommended maintenance schedule, and consistent with the maintenance schemes required by relevant standards. Only vehicles permitted to carry dangerous goods would be used for transport of hazardous materials.
- **Staff Training –** Operators and drivers would be trained and (where applicable) licensed for their job descriptions. Only those personnel licensed to undertake skilled and potentially hazardous work would be permitted to do so.
- **Structures –** Mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, BEMAX would obtain the necessary licences and permitting for engineering structures.
- **Diesel Storage –** The storage of diesel at the mine site would be designed, constructed and operated in accordance with the requirements of AS 1940 (Standards Australia International, 2004). This would include bunding of storages to contain 110% of the contents of the tank.

- **Backloaded MSP Process Waste Disposal** – The disposal of backloaded MSP process waste would be conducted in accordance with the Snapper Mine LEMP (based on the Ginkgo Mine LEMP [BEMAX, 2006f]). The Snapper Mine LEMP would be consistent with the Mining and Minerals Processing Code (ARPANSA, 2005) and would also generally meet the environmental goals listed in *Environmental Guidelines: Solid Waste Landfills* (EPA, 1996).

- **Site Emergency Response Team –** Selected BEMAX employees and/or contractors would be trained to respond to emergencies and spills within the Snapper Mine area. The emergency response team would be supported by a dedicated emergency response vehicle which would be equipped to provide fire control, spill clean-up and/or first aid capability as required.

Process Waste – Risk Treatment Measures

The following measures are proposed to address potential hazards associated with MSP process waste materials (Appendix I).

- Emergency response procedures including spill clean-up procedures to reduce the risk of land and or surface water contamination.

- Dedicated bunded storage area for waste hydrocarbons at the workshop to reduce the risk of land and or surface water contamination.

- Disposal of MSP process waste in accordance with DEC requirements to reduce the risk of groundwater contamination.

- Appropriate classification of backloaded MSP process waste by laboratory testing of radioactivity levels, waste tracking procedures and transporter training.

- Appropriate vehicle signage/placarding.

- Transport of waste in accordance with the Mining and Minerals Processing Code.

- Minimising the size of waste stockpiles within a bunded area fitted with sprinklers.

- Daily inspection of the pipeline containing the slurried backloaded MSP process waste to identify leaks or ruptures.

- Off-site disposal of tyres.

Saline Slurried Overburden – Proposed Control Measures

Measures proposed to address potential hazards associated with saline slurried overburden are described below (Appendix H):

- Implementation of a strategy to cover slurried overburden material to minimise the potential for an increase in salinity levels within the PRZ of the non-slurried material via capillary rise.

- Lateral salt movement from the initial slurried overburden emplacement would be minimised by clay lining the emplacement, preparing and constructing the foundation as well as providing a cut-off key trench, a toe drain and spoon drains.

- Permeability testing of clay lining during construction to minimise the potential for failure of clay lining in initial slurried overburden emplacements.