EXISTING OPERATION 2

2.1 INTRODUCTION

This chapter provides an overview of the existing mining and metallurgical operation at Olympic Dam, South Australia, including the associated infrastructure, current environmental management practices and waste management procedures.

Following the discovery of the mineral deposit in 1975, underground mining at Olympic Dam started in 1988 at a production rate of 45,000 tonnes per annum (tpa) of copper, plus associated products, which are uranium oxide, gold and silver. Following optimisation projects in 1992 and 1995, production rates increased to 66,000 tpa and 85,000 tpa of copper respectively. In 1997, and following a second EIS (Kinhill 1997), a major expansion received conditional approval to produce up to 350,000 tpa of copper, plus associated products. Current production and nameplate capacities are detailed in Table 2.1.

An overview of the location of the operation and existing infrastructure is shown in Figure 2.1. Figure 2.2 shows the major components of the existing operation within the Special Mining Lease (SML). The basic process of mining and minerals processing, including a summary of the key inputs and outputs, is shown in Figure 2.3.

A study to assess the optimisation of the existing operation to approximately 12 Mtpa of ore mined is occurring, the scope of which is discussed in Section 2.10. The optimisation, which would occur within the scope of existing laws and approvals, would consist of a minor expansion of the existing underground workings and de-bottlenecking of the metallurgical plant. For the purpose of the Draft EIS impact assessment, the full implementation of this optimisation has been assumed.

2.2 GEOLOGY, MINERAL RESOURCE AND ORE RESERVES

The geology of the Olympic Dam ore body is complex. It has been the subject of many studies and interpretations during the life of the mining operation.

The ore body was described in the two previous EIS documents (Kinhill-Stearns Roger 1982 and Kinhill 1997) and is further detailed in Reynolds (2000). The ore body itself was formed around 1.6 billion years ago, within the Olympic Dam Breccia Complex (ODBC), which is located within the Roxby Downs Granite (Flint 1993), as shown in Figure 2.4.

The ODBC is believed to have formed through a combination of hydrothermal, volcanic, sedimentary and tectonic processes. There are a wide variety of breccia types in the ODBC including granite breccias, volcanic breccias, haematitic granite breccias and haematite-quartz breccias.

Table 2.1 Existing production and nameplate capacity

Product	2007–08 production	Nameplate capacity
Ore mined (tpa)	9,674,000	9,000,000
Refined copper (tpa)	170,000	235,000
Uranium oxide (tpa)	4,144	4,500
Gold bullion (fine oz/a)	80,517	100,000
Silver bullion (fine oz/a)	780,000	800,000

Figure 2.1 Major components of the existing operation

Figure 2.2 Major components of the existing operation at Olympic Dam

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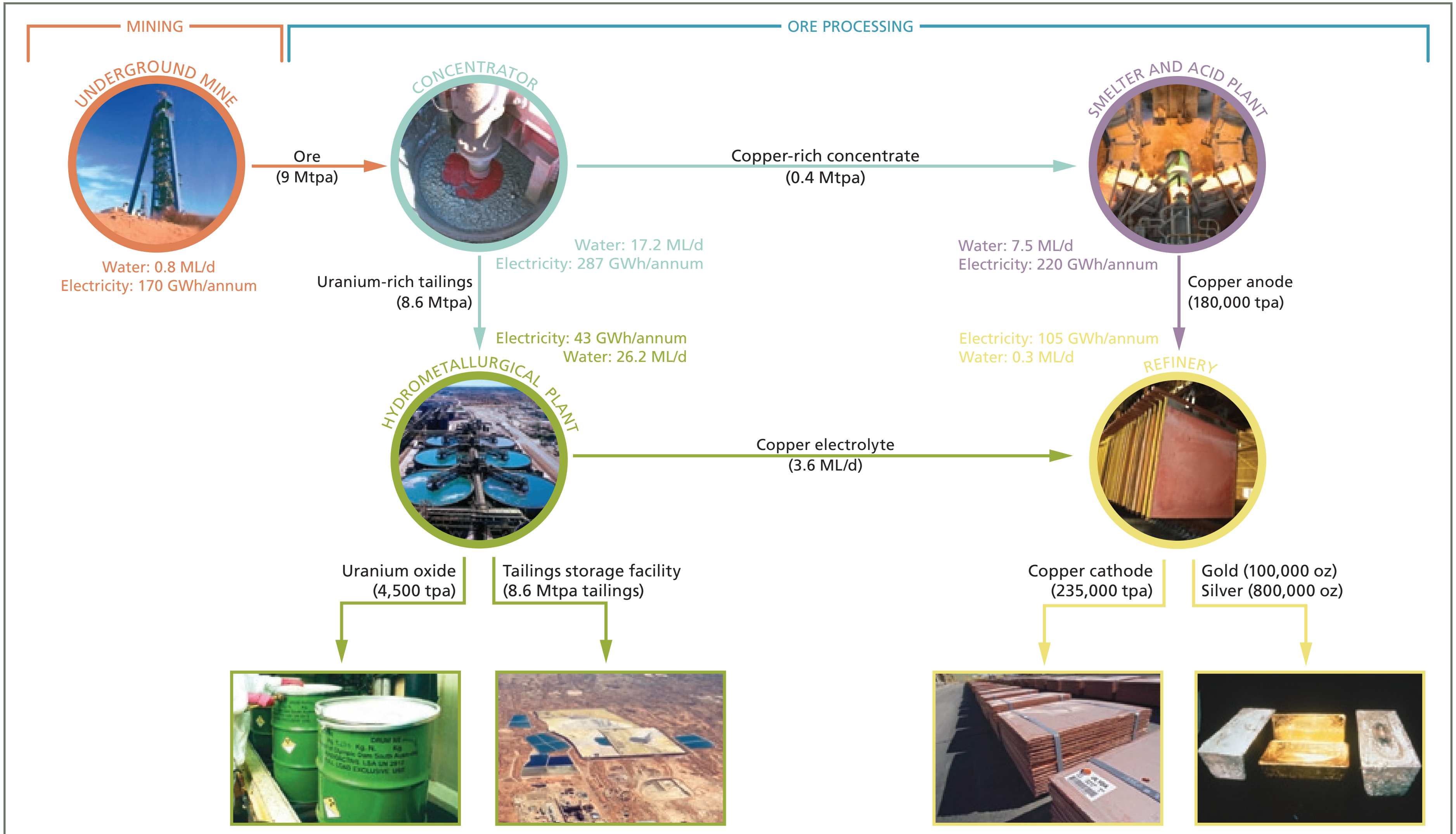

Note: Water and electricity demand amounts are for the existing operation and exclude off-site infrastructure and some on-site demands including administration facilities and processing infrastructure.

Figure 2.3 Process overview and main inputs and outputs for the existing operation

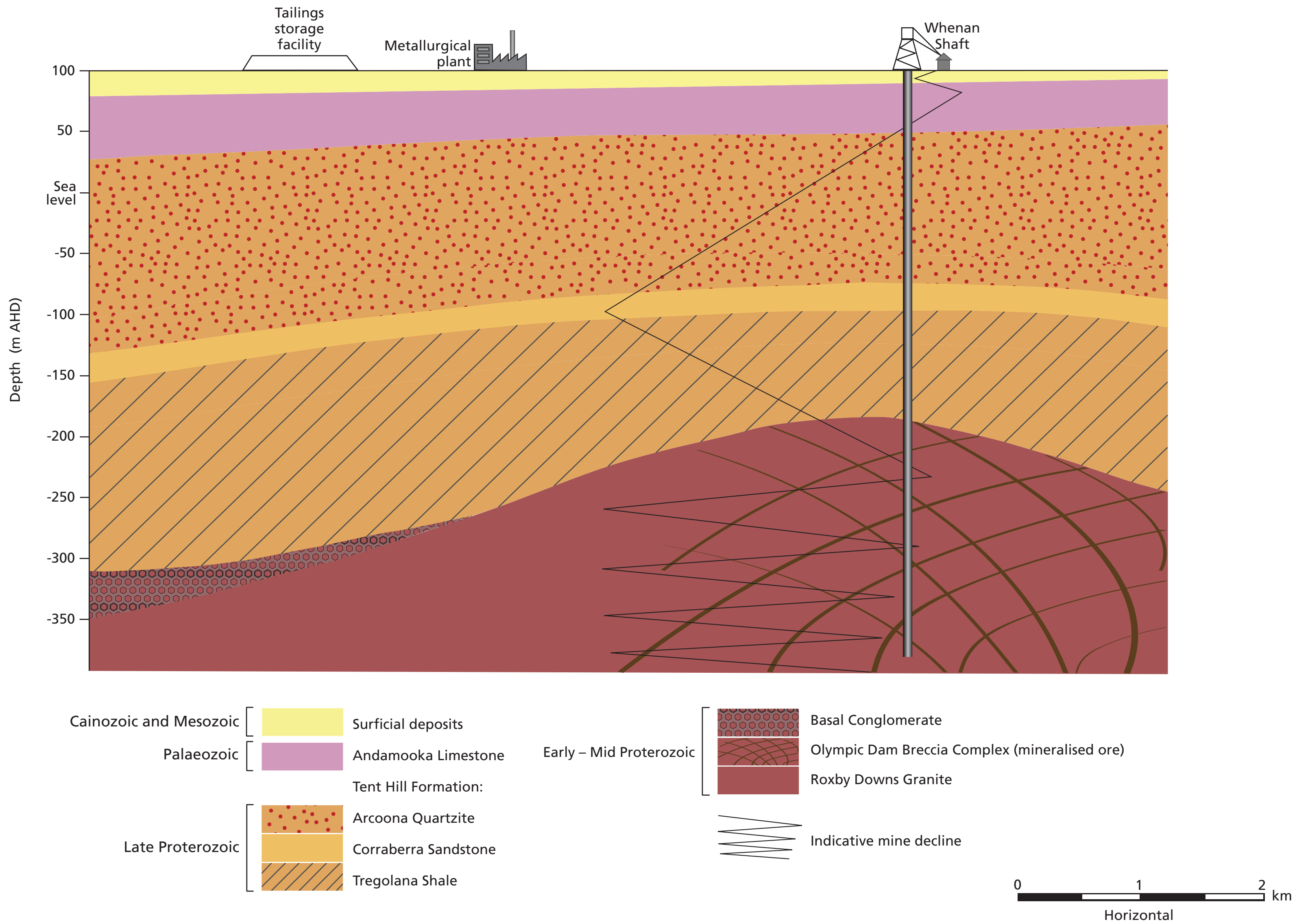

Figure 2.4 Schematic geological cross-section of Olympic Dam

Plate 2.1 Resource definition drilling at Olympic Dam

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The deposit contains variable concentrations of iron, copper, uranium, gold, silver, barium, fluorine and rare earths, although only the extraction and processing of copper, uranium, gold and silver are currently considered to be commercially viable. Ore grade mineralisation is broadly of two types: copper-uranium (the dominant ore type, which also contains some gold and silver), and gold.

Copper and uranium mineralisation occurs throughout the ODBC, commonly forming scattered grains or discrete aggregates, less commonly as small veins, or rarely in a massive form. Copper is present as bornite-chalcocite mineralisation (approximately 35% of resource tonnage) with an average grade of over 2% copper and as chalcopyrite mineralisation (approximately 65% of resource tonnage) with an average grade closer to 1% copper. Uranium mineralisation generally occurs with copper mineralisation, with higher uranium grades tending to occur with higher copper grades within the bornite-chalcocite zone. Gold and silver are more commonly associated with chalcopyrite mineralisation.

The gold ore also occurs in discrete zones within the granite-rich or haematite-rich breccias. These zones may have high concentrations of gold, particularly around the margins of the haematite-quartz breccias that form the core of the ore body. Figure 2.5 illustrates the extent of the presently known ore body and gives a cross-section.

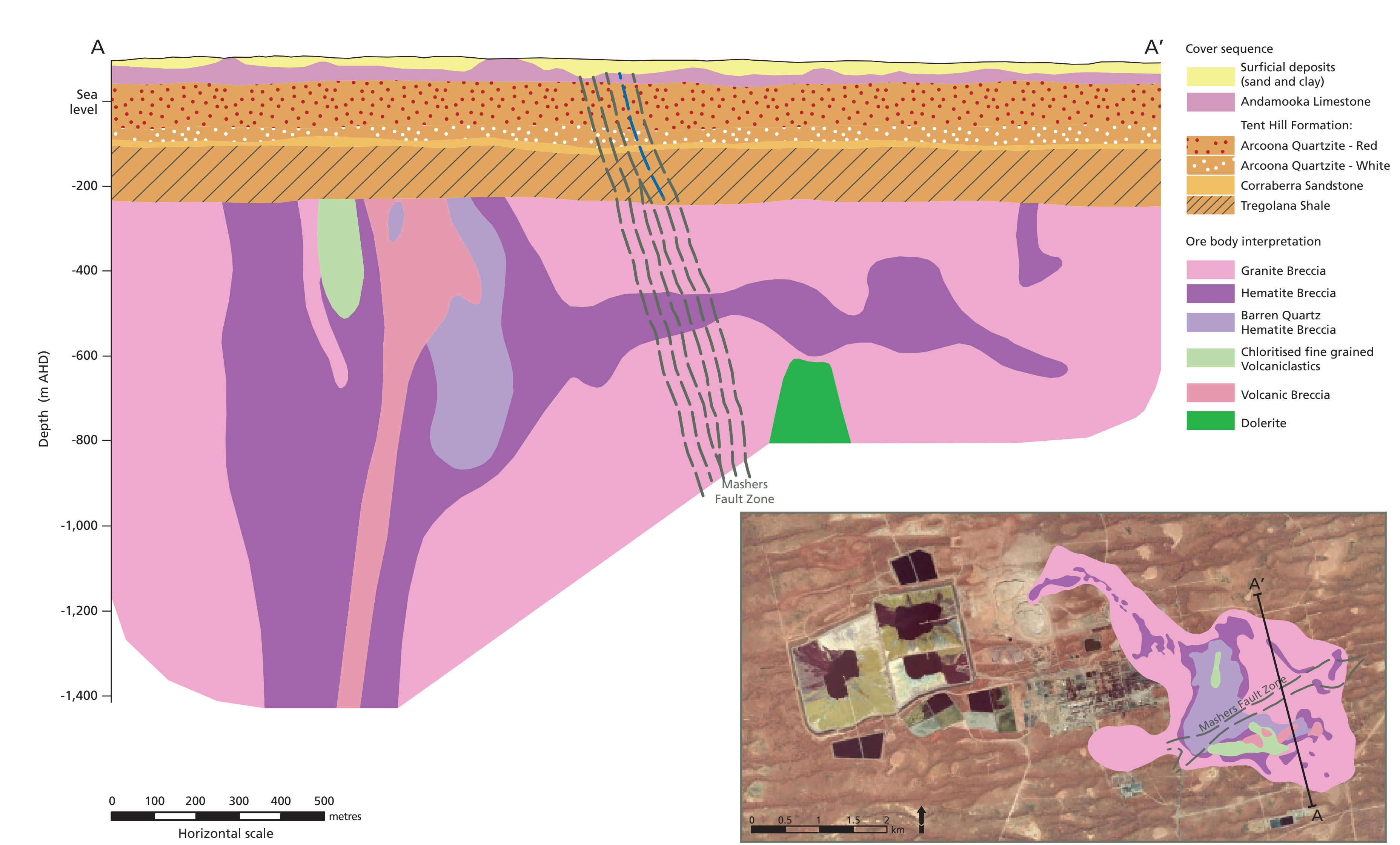
Mineral resource and ore reserve estimates are determined annually, and updates are published in the BHP Billiton Mineral Resource and Ore Reserve Declaration (see Plate 2.1 for resource definition drilling being undertaken at Olympic Dam). Resource estimates are provided in Table 2.2 for the measured, indicated and inferred mineral resource (where measured, indicated and inferred respectively relate to the decreasing level of certainty associated with the spatial distribution and continuity of the mineralisation).

In addition, a non-sulphide gold only resource was identified during recent drilling, with the resource estimate provided in Table 2.3.

Proved and probable ore reserve estimates are provided in Table 2.4 (where 'proved' is the mineable part of the measured resource, and 'probable' is the part of an indicated mineral resource likely to be mineable).

Table 2.2 Mineral resource estimates (BHP Billiton 2008)

Resource/Reserve indicator	Millions of dry metric tonnes	Copper (%)	Uranium oxide (kg/t)	Gold (g/t)	Silver (g/t)
Measured resource	1,329	1.11	0.33	0.32	2.17
Indicated resource	4,514	0.89	0.28	0.34	1.59
Inferred resource	2,497	0.73	0.25	0.25	1.00
Total resource	**8,339**	**0.88**	**0.28**	**0.31**	**1.50**



Simplified geological plan at -300 m AHD (approximately 400 metres below the surface)

Figure 2.5 Schematic cross-section through ore body

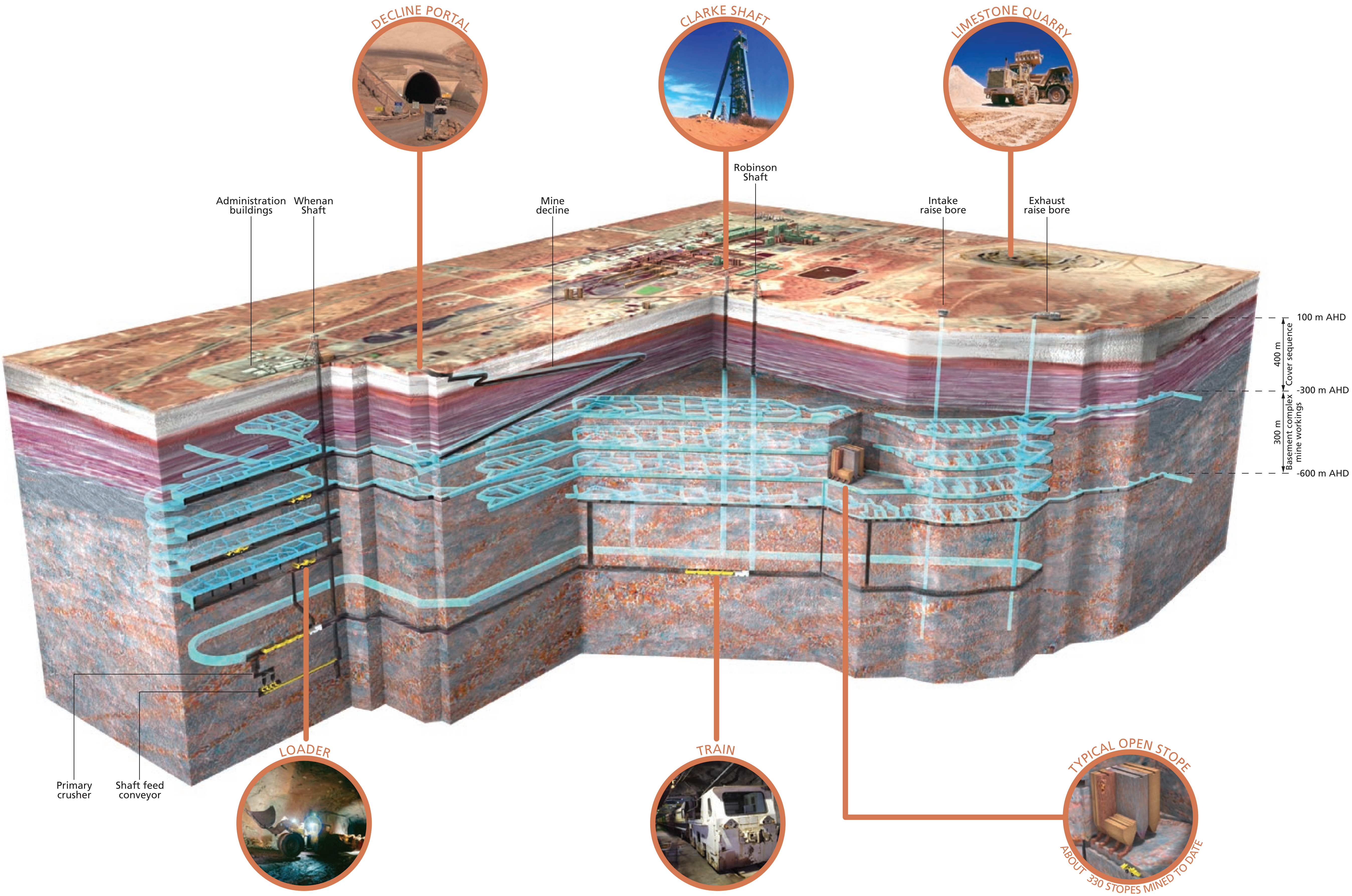


Figure 2.6 Conceptual cross-section of existing underground mine workings

Table 2.3 Non-sulphide (gold only) mineral resource estimates (BHP Billiton 2008)

Resource/Reserve indicator	Millions of dry metric tonnes	Gold (g/t)
Measured resource	30	1.12
Indicated resource	104	0.99
Inferred resource	16	0.89
Total resource	**151**	**1.00**

Table 2.4 Ore reserve estimates (BHP Billiton 2008)

Resource/Reserve indicator	Millions of dry metric tonnes	Copper (%)	Uranium oxide (kg/t)	Gold (g/t)	Silver (g/t)
Proved reserve	221	1.97	0.59	0.73	3.99
Probable reserve	253	1.77	0.61	0.79	3.91
Total reserve	**473**	**1.86**	**0.60**	**0.76**	**3.95**

The information contained in Tables 2.2, 2.3 and 2.4 that relate to the Mineral Resource Estimation for the Olympic Dam Deposit is based on information compiled by Shane O'Connell who is a member of the Australasian Institute of Mining and Metallurgy. Shane O'Connell has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and the activity which he is undertaking to qualify as a Competent Person as defined in the 2004 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC 2004). Shane O'Connell consents to the inclusion in these tables of the matters based on his information in the form and context in which it appears.

Plate 2.2 Underground ore loading

2.3 MINING

The existing mining operation employs a sublevel open stope method of underground mining as represented in Figures 2.6 and 2.7. This method is detailed in the 1997 EIS (Kinhill 1997), and summarised below.

Sections of the ore body to be mined are divided into a series of blocks called stopes. These vary in size from 25,000 m^3 to 160,000 m^3 depending on mineralisation, geology and various planning and practical engineering considerations. Prior to mining, a stope is developed by excavating drives to gain access, constructing ore drawpoints, establishing sublevels for drilling, and cable-bolting to secure the ground and prevent rockfall in areas where people work. Rock containing economic quantities of mineralisation excavated during development is sent to the ore stockpile and rock with sub-economic or zero mineralisation (mullock) is used to backfill some stopes after they have been mined.

Plate 2.3 Tipping ore into the primary crusher grizzly

Once development is complete, blast holes are drilled into the stope at close intervals upward and downward from a drive. A series of controlled blasts breaks the ore, which then falls into the drawpoints at the bottom of the stope. The ore is then taken from the drawpoints, using a modified front-end loader, and hauled in trams or trucks to an ore pass (see Plates 2.2 and 2.3).

The ore gathering system is located in the lower part of the mine. It includes the ore passes, train loading chutes, electric trains, a gyratory crusher, ore bins and load-out equipment for the hoisting of ore to the surface. The rail haulage infrastructure is on a common level below the ore passes, and electric trains regularly empty the ore passes (see Plate 2.4).

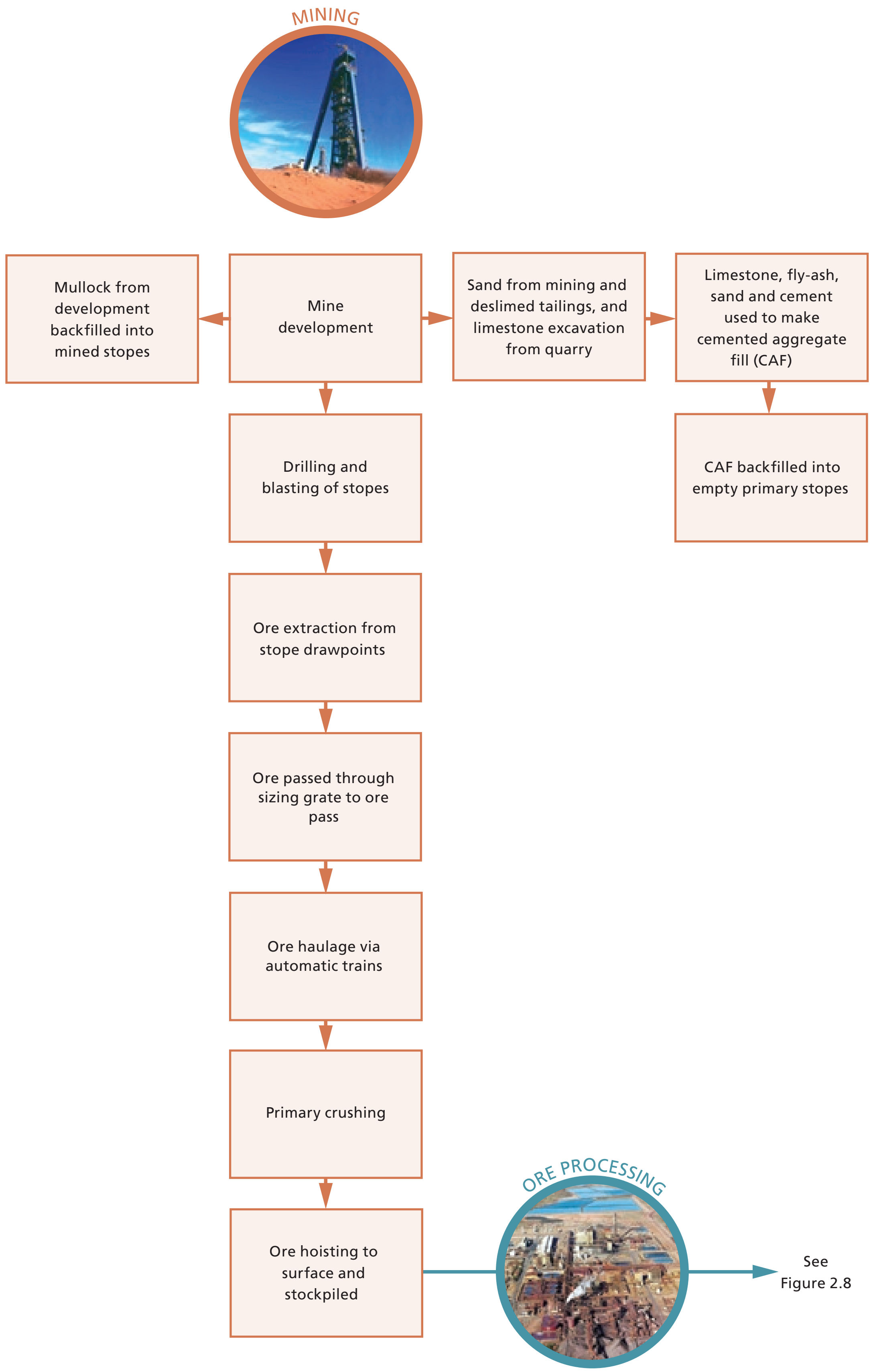


Figure 2.7 Existing mining method

Plate 2.4 Underground electric ore train

The ore is delivered to a primary crusher that can crush up to 2,200 tonnes per hour. The crusher is remotely operated and incorporates a rock breaker. Once ore has passed through the crusher, an apron feeder and conveyor belt moves it to ore bins. Ore is drawn from the bins by vibrating feeders that feed onto two conveyor belts, which transport the ore to the loading pocket of either the Clarke or Whenan shafts. The ore is then hoisted to the surface. Almost all ore hoisting occurs through the Clarke Shaft, although the Whenan Shaft is used when the ore is in close proximity (see Plate 2.5). The Robinson Shaft has been decommissioned as an operating shaft, and is now used as an air intake to assist mine ventilation.

When the stope has been depleted of ore, it is backfilled with cemented aggregate fill (CAF), which has sufficient strength to support the walls and roof of a new, adjacent stope. The CAF is manufactured on-site in a surface facility (the backfill plant) from a mixture of crushed stone (either mullock from the mine or quarried limestone), deslimed tailings, sand, fly-ash and cement. The CAF is placed in the stopes through a hole bored from the surface.

A ventilation system provides fresh air throughout the underground mine and prevents the build-up of heat, diesel engine exhaust emissions, blasting fumes, dust and radon (together with its decay products). Large-diameter raise bores with large centrifugal fans draw air down from the surface, through the intake raises, and into the working areas. Air is directed to some working areas by auxiliary fans and flexible ducting and is then emitted from a number of exhaust raise bores.

2.4 PROCESSING

2.4.1 OVERVIEW

The existing operation uses a concentrator, smelter and refinery to produce high quality copper cathode, gold and silver. The addition of a hydrometallurgical plant allows for the recovery of additional copper and for the recovery of uranium, maximising the production of metals from the mined ore. This method is summarised in Sections 2.4.2 and 2.4.3 and illustrated in Figure 2.8 (see Kinhill 1997 for details).

2.4.2 CONCENTRATOR

The concentrator separates the bulk of the copper-bearing minerals from the mined ore, producing a copper-rich flotation concentrate stream and a uranium-rich flotation tailings stream.

Ore is transferred from the mine shafts onto overland conveyors which transport the crushed ore to an ore stockpile adjacent to the concentrator plant. The ore stockpile and reclaim area act as a storage buffer between the mine and the process plant to manage variability in the mine. It is also the area where ore is blended to reduce variability in the ore. The ore is mixed with water and milled in autogenous grinding (AG) mills to create a slurry of fine particles (see Plate 2.6). The process uses vibrating screens and hydrocyclones to recycle oversized particles back to the mill feed for further grinding. The cyclone overflow – the final product of the grinding circuit – is directed to the flotation area.

Plate 2.5 Whenan Shaft is one of the two operational shafts at Olympic Dam

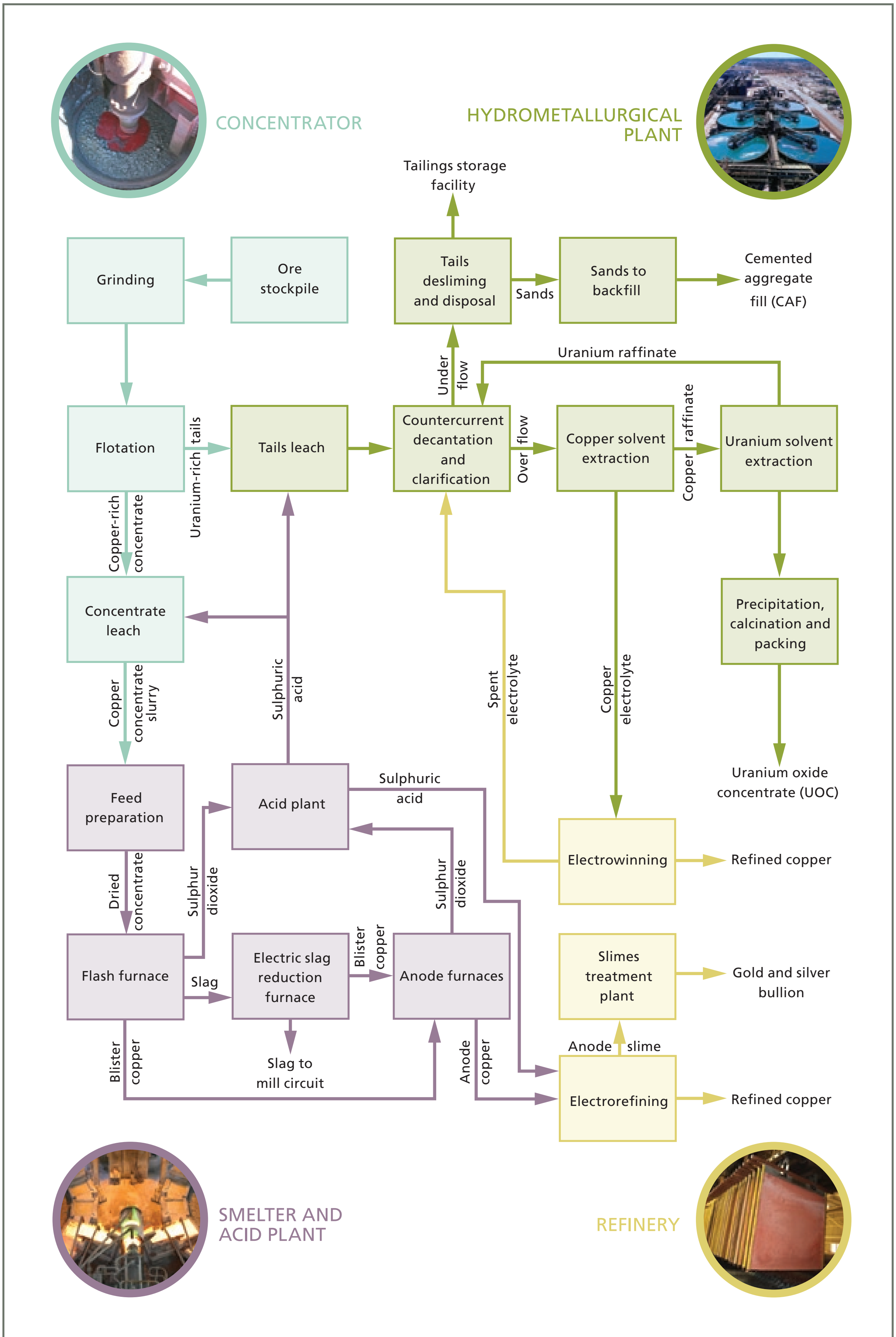


Figure 2.8 Existing metallurgical processes

Flotation is used to recover copper-bearing sulphide particles by mixing the ore slurry with reagents in a series of agitated and aerated tanks. Most copper particles attach to bubbles and float to the surface, producing a copper-rich concentrate (plus gold and silver) stream (see Plate 2.7) leaving a uranium-rich tailings stream behind. The copper-rich concentrate is sent to the concentrate leach area for further processing and the uranium-rich tailings are sent to the tails leach section in the hydrometallurgical plant.

Sulphuric acid produced in the acid plant is used to extract the residual uranium from the copper-rich concentrate in the concentrate leach section of the concentrator. This uranium is directed to the hydrometallurgical plant and the leached copper-rich concentrate slurry is sent to the feed preparation area in the smelter.

2.4.3 HYDROMETALLURGICAL PLANT

The hydrometallurgical plant removes residual copper and uranium from the uranium-rich flotation tailings, and concentrates them into streams that, via electrowinning and precipitation processes respectively, produce final product for sale, enabling additional value to be created from the mined ore.

The tails leach circuit mixes sulphuric acid and reagents with the uranium-rich flotation tailings in rubber-lined tanks heated to 70 °C with steam generated by the waste-heat boiler at the smelter. This leaching process extracts uranium and residual copper from the solids in the slurry. The leached product is then washed and the liquor separated from the solids in a countercurrent decantation (CCD) circuit. The washed slurry (underflow) is sent to the desliming circuit to recover larger sand particles in tailings prior to thickening and disposal to the tailings storage facility (TSF). The coarse sand is added to CAF and used as mine backfill. The uranium and copper-rich overflow (pregnant liquor solution, or PLS) is fed to a clarification circuit that removes residual solids from the liquor prior to the solvent extraction process. The overflow from this process is directed to the copper solvent extraction plant.

Copper solvent extraction (CuSX) removes the copper from an aqueous copper and uranium-rich PLS (from tails leach) and transfers it to an organic (solvent) stream. The loaded solvent is then scrubbed with water to remove impurities before the copper is stripped from the solvent by an acid stream (spent electrolyte) that is returned to the hydrometallurgical plant. The remaining copper-poor process stream, called copper raffinate, is sent to the uranium solvent extraction (USX) plant.

The USX plant uses pulse columns to transfer uranium from the aqueous raffinate to a barren solvent solution. The loaded solvent is then scrubbed with water and the uranium is stripped in mixer settlers before being precipitated to ammonium diuranate (ADU, $[(NH_4)_2U_2O_7]$, commonly referred to as yellowcake). The precipitate is washed and thickened prior to being pumped to centrifuges for further dewatering. The recovered barren strip solution is filtered to remove residual particulates and returned to the USX circuit. The dewatered

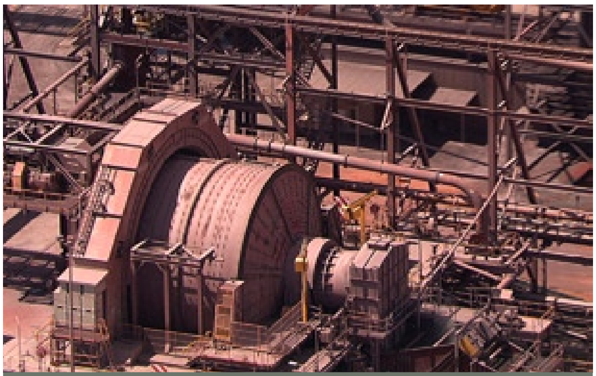


Plate 2.6 A primary semi-autogenous grinding mill

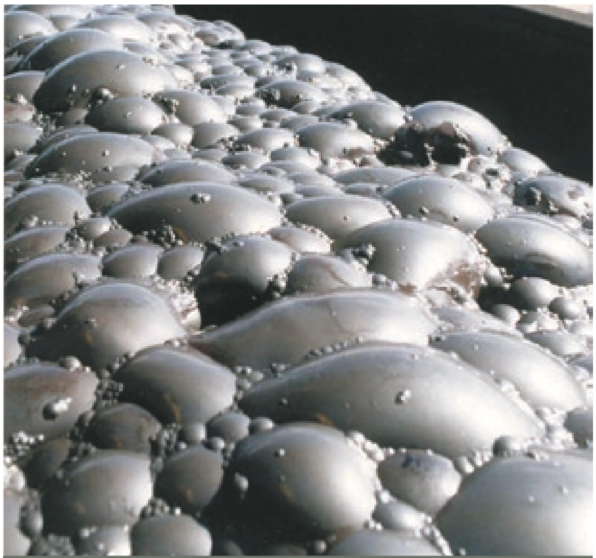


Plate 2.7 Copper flotation at Olympic Dam

ADU is fed via a screw conveyor to the diesel-fuelled multi-hearth furnace (calciner) and converted to uranium oxide (U_3O_8). The U_3O_8 is packed into 200 litre steel drums that are automatically filled, weighed and sampled in a sealed enclosure.

Plate 2.8 shows an aerial view of the CCD tanks with the concentrator and ore stockpiles in the distance.

Plate 2.8 Countercurrent decantation circuit

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2.4.4 SMELTER AND ACID PLANT

The smelter processes the copper-rich concentrate at high temperature, removing the bulk of impurities including iron and silica and producing a relatively pure (99%) copper anode that is subsequently purified further in the electrorefinery.

Before smelting, a feed preparation stage dewaters the copper-rich concentrate slurry using thickeners, filters and steam-coil drying. Silica flux (sand) and dust from the waste-heat boiler (and dust collectors) is added to the dried concentrate before it passes to the flash furnace. The reaction of the copper-rich concentrate and oxygen in the flash furnace separates the material into a high-copper blister and a low-copper slag.

The slag is directed to the electric slag-reduction furnace via a manual tapping process, which uses a coke reductant to capture most of the remaining copper. The molten blister copper is tapped from both the flash and electric furnaces (see Plate 2.9) where it is directed via launders to one of two anode furnaces, where the remaining impurities are removed. The copper is then cast into copper anodes (see Plate 2.10).

Plate 2.9 Blister copper tapping in the smelter

Plate 2.10 Copper anode casting in the smelter

Off-gas from the electric furnace and anode furnaces is treated in gas cleaning systems before being discharged. Sulphur dioxide-rich gases from the flash furnace and the anode furnaces (produced during the oxidation cycle) are directed to the acid plant for conversion to sulphuric acid used in the refinery and hydrometallurgical plant. Dust captured by the gas cleaning system is either recycled to the flash furnace, or directed to the tails leach circuit within the hydrometallurgical plant. Waste heat from the flash furnace off-gas is captured in a waste-heat boiler, and the resultant steam is used to heat process materials in the concentrator and hydrometallurgical circuits.

2.4.5 REFINERY

Copper anodes containing 99% copper and small amounts of gold and silver are transferred to the refinery where an electrorefining process is used to convert anode copper to London Metal Exchange (LME) A-grade cathode copper. Copper anodes are placed in a bath of dilute sulphuric acid and copper sulphate. A direct electric current (30,000 amperes) is passed through each bath from the anode to a stainless steel mother plate (cathode). The copper at the anode dissolves and is redeposited on the mother plate as 99.99% copper (see Plate 2.11). Insoluble impurities such as gold, silver and lead collect in the bottom of the electrolytic cells as anode slime. The slime is then processed in the slimes treatment plant to recover the gold and silver. The copper is stripped from the mother plates and strapped together in three tonne bundles for transport to customers.

Plate 2.11 Copper cathode in the electrorefinery

The electrowinning plant deposits copper directly on the mother plate from a copper sulphate solution (electrolyte) produced in the solvent extraction plant. The spent electrolyte is returned to the hydrometallurgical plant for reuse in the CCD circuit. Copper is stripped from the mother plates, bundled and transported as LME A-grade copper.

The anode slime residue from the electrorefining process is sent to the slimes treatment plant where it is passed through a series of processes to recover gold and silver. Initially, contaminants such as selenium are removed by leaching, before the slimes are neutralised and treated with sodium cyanide to leach the gold and silver into solution. A zinc powder is added and the precious metals attach to the zinc to form a solid precipitate. This material is filtered to produce a filter cake and mixed with flux before smelting in a rotary furnace to produce gold/silver (doré) anodes. The used cyanide solution is neutralised and detoxified and pumped to the tailings disposal section of the hydrometallurgical plant. The anodes are electrorefined in a similar way to copper in the refinery. The silver in the anodes is dissolved and deposited onto cathode plates, while the insoluble material is retained as a gold mud. Silver is scraped from the cathodes for melting into bullion bars. The gold mud is washed with acid, melted in a furnace and cast into gold anodes. The anodes are electrorefined into pure gold cathodes. The cathodes are then smelted and cast as gold bullion.

2.5 ON-SITE WASTE MANAGEMENT

The Olympic Dam operation has two principal waste management facilities – the TSF and the waste management centre. Smaller facilities and intermediate product stockpiles are located throughout the operation. The location of the current Olympic Dam waste management infrastructure is shown in Figure 2.2.

2.5.1 TAILINGS RETENTION SYSTEM

Tailings are the waste product stream from the metallurgical operations. They consist of a slurry of fine rock particles and acidic liquor from which the economically-recoverable minerals have been extracted. The slurry is pumped to the TSF, where the tailings solids settle and the tailings liquor is reclaimed to evaporation ponds. The facility currently consists of four TSF cells covering about 400 ha, which are used as the primary storage for the tailings solids. Five high-density polyethylene (HDPE) lined evaporation ponds covering an area of about 133 ha are also used to store and evaporate excess tailings liquor (see Figure 2.2 and see Plates 2.12 and 2.13). The design and operation of the existing TSF is detailed in Appendix F1 and summarised below.

About eight million tonnes of tailings solids and about 8.5–9.0 GL of liquor from the processing operations are discharged to the TSF per annum. The tailings slurry from the hydrometallurgical section of the metallurgical plant is thickened to about 55% solids and deslimed to remove the sand-sized particles used to produce CAF for backfilling the mined-out stopes. Approximately 400,000 tpa of tailings are used to manufacture CAF. Processing wastes, including acidic effluent from the acid plant and other minor effluent streams, are added prior to pumping to the TSF, reducing the pumped tailings to about 47% solids concentration. The tailings are deposited in thin layers in the TSF to promote evaporation, reduce seepage and aid consolidation.

The TSF walls are raised at a rate of less than 2 m per annum, and are constructed of compacted tailings with rock armouring (see Figure 2.9). The first three TSF cells constructed were unlined. The fourth TSF cell has a central HDPE liner under the decant area in the centre of the cell. The TSF cells have been constructed with a base layer of clay and are located over limestone geology.

The free liquor generated during settling is collected in ponds at the centre of each cell and then pumped to one of four evaporation ponds. This reduces the potential for seepage from the base of the TSF, and maximises the potential to reuse the liquor. The evaporation ponds are shallow ponds (3–5 m in depth)

Plate 2.12 The existing tailings storage facility cell 4

Plate 2.13 Lined evaporation ponds at Olympic Dam

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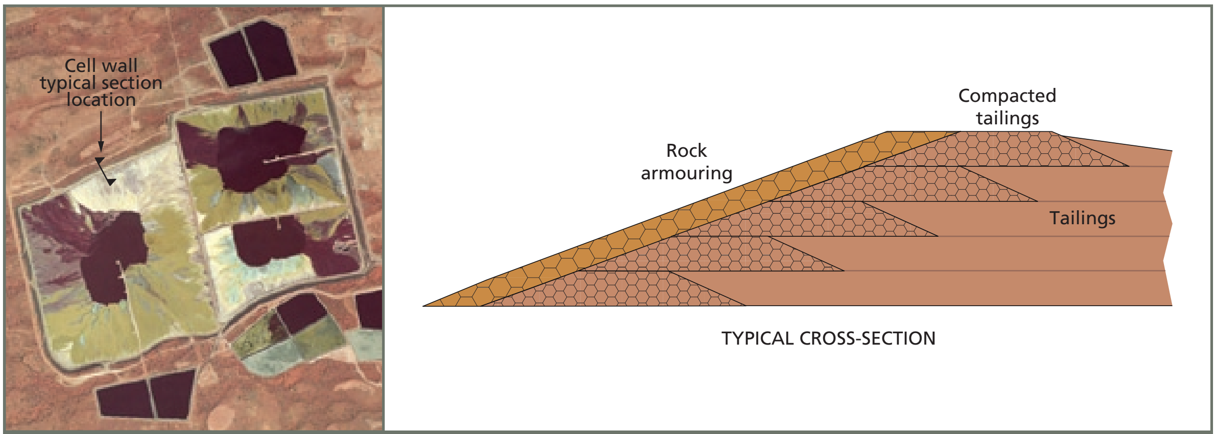

Figure 2.9 Existing tailings storage facility wall design

which promote evaporation to minimise the volume of liquor pooled at the centre of each TSF cell. Some of the liquor (about 1.2–3.1 ML/d) is recycled back to the metallurgical operations, to control tailings density within the deslimes circuit and in the hydrometallurgical process, where dissolved metals concentrated in the liquor, as a result of evaporation, are recovered. Some of the tailings liquor (about 0.5–1.5 ML/d, largely from the older TSF cells) seeps to groundwater, where it interacts with calcareous clays and limestone and ultimately mounds beneath the TSF.

Some hazardous materials, including process spillage material and low-level radioactive wastes, such as personal protective equipment used in the uranium packing shed and laboratory wastes produced on-site, are also disposed of in the TSF. The Hazardous Materials Coordinator liaises with the Environment and Radiation Department to authorise the disposal of bulk hazardous waste materials in the TSF. The Radiation Protection Division of the South Australian Environment Protection Authority audits the process

2.5.2 WASTE MANAGEMENT CENTRE

The site waste management centre manages approximately 4,420 tpa of general waste materials produced at Olympic Dam (see Plate 2.14). The facility incorporates a general solids landfill, in which about 66% of all general wastes are disposed and a waste transfer station where appropriate materials are diverted for reuse or recycling. About 32% of all general wastes are recycled, with the remaining 2% stockpiled pending recycling or reuse opportunities. Landfill waste material is covered with clean fill from various earthworks activities throughout the operation and then compacted. Once completed, sections of the landfill are capped with clay to contain litter. This provides a low permeability seal that reduces the potential for water to seep through the landfill mass and generate leachate (see Figure 2.2 for location).

Plate 2.14 Site recycling, part of the waste management centre

Bulk materials such as large items of scrap metal and concrete are disposed of in a separate area of the waste management centre from the general solids landfill. These items are excluded from the landfill because their large size and high strength causes problems with the compaction and consolidation of the landfill mass.

Some hazardous wastes such as cyanide bags and boxes are disposed off-site in licensed facilities. Bulk solvent containers (1 m^3) are washed at the waste management centre to be reused on-site, sold off-site, or compacted and disposed on-site as the last option.

2.5.3 SEWAGE DISPOSAL FACILITIES

Site sewage and grey water are screened and disposed of in two unlined sewage treatment ponds to the north of the operation, where the water evaporates and the solids settle (see Figure 2.2 for location of facilities). Pond capacity is such that the ponds have not required solids removal to date. About 0.2 to 0.3 ML/d is disposed of to this system.

2.5.4 MISCELLANEOUS LIQUID WASTES

Stormwater run-off from the areas surrounding the existing metallurgical plant is directed to one of a number of unlined tertiary containment ponds (see Figure 2.2), from where it is reclaimed to the concentrator.

Caustic liquors that are unsuitable for depositing in the TSF are stored in the caustic disposal pond for evaporation. Waste oil is stored temporarily in the waste oil storage facility before being transported off-site for treatment and reuse.

2.5.5 INTERMEDIATE PRODUCT STOCKPILES

Intermediate product stockpiles are used for short-to-medium term storage of high-copper slag produced in the smelter before regrinding or resmelting it to recover additional copper.

2.6 WATER SUPPLY

Olympic Dam and Roxby Downs currently receive their primary supply of water from wellfields in the Great Artesian Basin (GAB). This water is slightly brackish and, while suitable for stock and industrial purposes, requires desalination prior to human consumption (about 2.2 ML/d) and use in some processing operations (about 12.1 ML/d).

Water from the GAB is extracted from Wellfields A and B, located approximately 120 km and 200 km north-east of the operation, respectively (see Figure 2.10). A flow of about 37 ML/d is pumped from the wellfields to the mine site, with some additional extracted water (up to 0.6 ML/d) fed to pastoral stations along the pipeline route. A reverse osmosis desalination plant at Olympic Dam desalinates approximately 14 ML/d (see Plate 2.15). The high-salinity water (brine) generated during the process is returned to the process water stream, and used in the metallurgical plant for milling and flotation operations. Potable water is supplied to Olympic Dam Village, Roxby Downs and Andamooka, and is used for some hydrometallurgical operations and within the refinery. Information regarding water supply and use is presented annually in the site Environmental Management and Monitoring Report.

A secondary supply of low-quality water obtained from a saline wellfield south of the mine (see Figure 2.10) is typically used for dust suppression and in the production of CAF, with some water also supplied from mine dewatering activities and abstraction from the groundwater mound beneath the TSF. Some supernatant liquor from the TSF is recycled to the metallurgical plant to supplement freshwater usage.

2.7 ENERGY SUPPLY

The current energy requirements for the Olympic Dam operation are met by liquid fuels, including diesel, fuel oil and liquefied petroleum gas (LPG), and electricity from the national electricity market (i.e. the grid). Energy usage at Olympic Dam by source for 2007 is detailed in Table 2.5. Diesel, fuel oil and LPG are used for heating in the smelter and other site furnaces, including the calcining furnaces and the slimes treatment gold and silver furnaces. Diesel is also used as engine fuel at the wellfield pump stations, and for the underground mining fleet and surface transport vehicles. The liquid fuels are delivered by road to storage facilities at Olympic Dam and at both wellfields.

Plate 2.15 The on-site desalination plant produces about 14 ML/d of desalinated water

Electricity is supplied via a BHP Billiton owned and operated 275 kV transmission line, which runs from Davenport (near Port Augusta) to Olympic Dam. In addition, there is a 132 kV line from Pimba, which is fed from an Electranet 132 kV line that runs from Port Augusta to Pimba (see Table 2.6, Figure 2.1 and Plate 2.16).

Table 2.5 Olympic Dam energy consumption by source in 2007

Energy source	Usage[1]
Electricity (MWh)	866,890
Diesel (L)	25,131,540
LPG (t)	16,950
Kerosene (L)	6,564,780
Petrol (L)	263,940
Fuel oil (t)	5,175
Coke (t)	9,940

[1] Product transport and Roxby Downs township energy use is excluded.

Table 2.6 Existing energy system components

Electricity voltage	Maximum capacity	Utilisation (load) factor
132 kV	100 MW (Pimba to Olympic Dam) 40 MW (Port Augusta to Pimba)	Nil
275 kV	240 MW (Port Augusta to Olympic Dam) Current peak demand 125 MW	88%

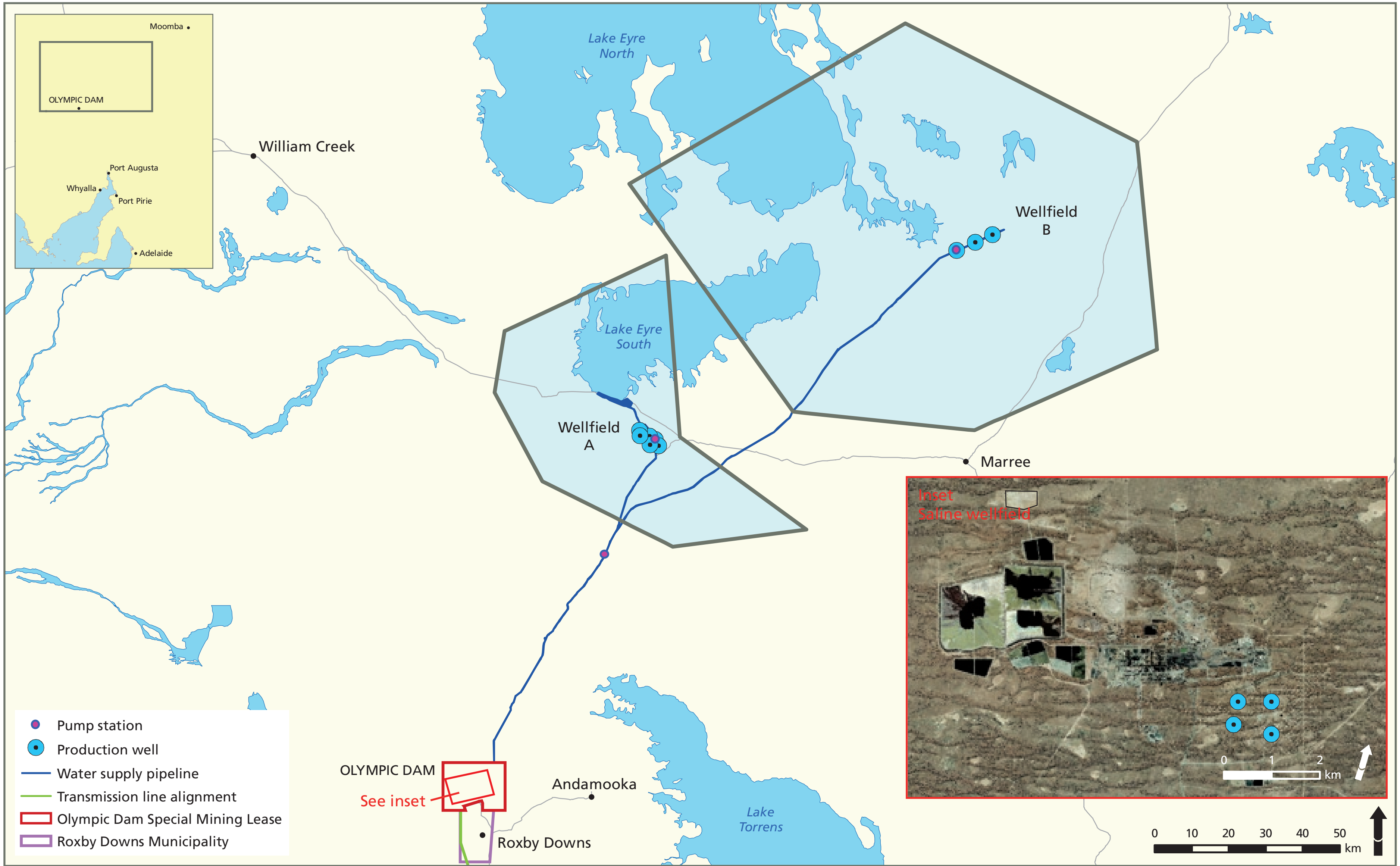

Figure 2.10 Existing water supply infrastructure

The existing 132 kV line can supply 40 MW to Olympic Dam in emergency situations, however, due to a phase shift, this line cannot be synchronised with the 275 kV line which must be de-energised before the 132 kV supply can be utilised. Small on-site diesel generators are installed at Olympic Dam for short-term emergency supply and in total these have the capacity to generate approximately 10 MW to power essential on-site systems in the event of an outage.

Electricity is provided to Olympic Dam Village and Roxby Downs via a transmission line from the on-site substation to smaller substations within each location.

2.8 TRANSPORT INFRASTRUCTURE

2.8.1 ROAD AND RAIL

All major consumables and commodities are currently transported in and out of Olympic Dam by road, with a total of about one million tonnes mobilised each year. Approximately 750,000 tonnes of materials and reagents are imported to site each year, the most significant being:

- cement (about 130,000 tpa)
- fly-ash (about 150,000 tpa)
- sulphur prill (about 80,000 tpa)
- sulphuric acid (about 50,000 tpa)
- quicklime (about 40,000 tpa).

Up to 240,000 tonnes of material is exported from site per annum, including:

- copper cathode (up to 235,000 tpa)
- uranium oxide (up to 4,500 tpa)
- silver (around 23 tpa)
- gold (about 2.3 tpa).

Rail transport is currently limited to the import of materials from interstate locations to Adelaide, copper cathode and other general freight from Adelaide to interstate locations and for transferring uranium oxide from BHP Billiton storage facilities at Port Adelaide to the Port of Darwin for export.

2.8.2 PORT INFRASTRUCTURE

BHP Billiton has intermediate storage facilities at Port Adelaide in South Australia. These facilities consist of a copper handling and freight loading and unloading facility, with covered storage areas for chemicals and outbound copper cathode. An intermediate storage facility, consisting of a large covered sulphur storage shed and an outdoor chemical storage area, is located about 1.5 km to the east of the Port Adelaide berth facility (see Figure 2.1 and Plate 2.17). Additionally, uranium oxide is transferred by rail from Port Adelaide to third-party freight loading facilities at the Port of Darwin prior to export overseas.

2.8.3 AIRPORT

The airport at Olympic Dam Village is approximately 7 km north of Roxby Downs on the southern edge of the SML boundary.

The airstrip is a sealed runway of 1,600 m length by 18 m width. For ease of construction, the airstrip was built between two lines of parallel dunes on an ENE/WSW orientation and is suitable for light jet (charter or business) and regional turboprop aircraft (see Plate 2.18).

Plate 2.16 The existing 275 kV and 132 kV transmission lines

Plate 2.17 Aerial view of the existing BHP Billiton Port Adelaide loading and unloading facility at Berth 25

Plate 2.18 Commercial passenger services at Olympic Dam airport

Passenger numbers at Olympic Dam airport were about 57,600 during 2006–07, with approximately 2,600 aircraft movements per annum (BITRE 2007). Alliance Airways operates regular public transport flights between Adelaide and Olympic Dam during daylight hours only, with the number of flights shown in Table 2.7. They use Fokker 50 aircraft with seating for 56 people.

Gold and silver bullion is exported from Olympic Dam to the Perth mint via dedicated charter flights, with general airfreight being limited to small volumes (e.g. site mail) on commercial passenger flights.

2.9 WORKFORCE AND ACCOMMODATION

2.9.1 WORKFORCE

The Olympic Dam workforce currently consists of approximately 4,150 employees, split between permanent employees (about 1,700) and contractors (about 2,450). Additionally, about 1,050 short-term employees carry out maintenance works at Olympic Dam as required.

At present, about 1,700 (or 40%) members of the Olympic Dam workforce are not residents of the local area, consisting of about 1,100 short-term contractors and about 600 permanent employees. Of the non-residential permanent employees, over 90% reside in the Upper Spencer Gulf region or other parts of South Australia and about 10% interstate.

The remaining 60% of the total workforce lives in the local area (Roxby Downs, Andamooka or Woomera), with around 1,025 permanent employees living in Roxby Downs (see Table 2.8).

Table 2.7 Public transport flight schedule for Olympic Dam

Day	Number of flights
Monday	5
Tuesday	5
Wednesday	5
Thursday	5
Friday	4
Saturday	2
Sunday	3
Total	**29**

A detailed discussion of the existing workforce numbers and accommodation statistics is provided in Chapter 19, Social Environment.

2.9.2 ACCOMMODATION

The bulk of the residential workforce is accommodated in either Roxby Downs township (see Plate 2.19) or Roxby Village accommodation camp. While on-site, the non-residential workforce reside at one of the two workforce accommodation villages: Roxby Village and Olympic Village. A smaller accommodation camp (Camp 4) is used by contractors working at Arid Recovery. Existing accommodation infrastructure is shown in Figure 2.11.

Roxby Downs township

Roxby Downs township was first established in 1988 to service the Olympic Dam operation, and was extended, largely to the south, in the mid-to-late 1990s to address the previous mine expansion. The current population of Roxby Downs is around 4,500. The housing profile for Roxby Downs is shown in Table 2.9.

Roxby Village

Roxby Village is a BHP Billiton-managed accommodation camp for residential employees and some long-term non-residential employees. It is located within Roxby Downs and consists of about 500 ensuite rooms. Services include a mess facility, barbecue facilities, a social room and laundry facilities.

Plate 2.19 Roxby Downs (looking west)

Table 2.8 Workforce and accommodation summary

Accommodation	Number of employees		
	Permanent	Contractors	Total
Roxby Downs	1,025		
Woomera	40	1,350	2,450
Andamooka	35		
LDC – USG[1]	200		
LDC – SA	350	1,100	1,700
LDC – interstate	50		
Total	**1,700**	**2,450**	**4,150**

[1] LDC = long distance commute, USG = Upper Spencer Gulf.

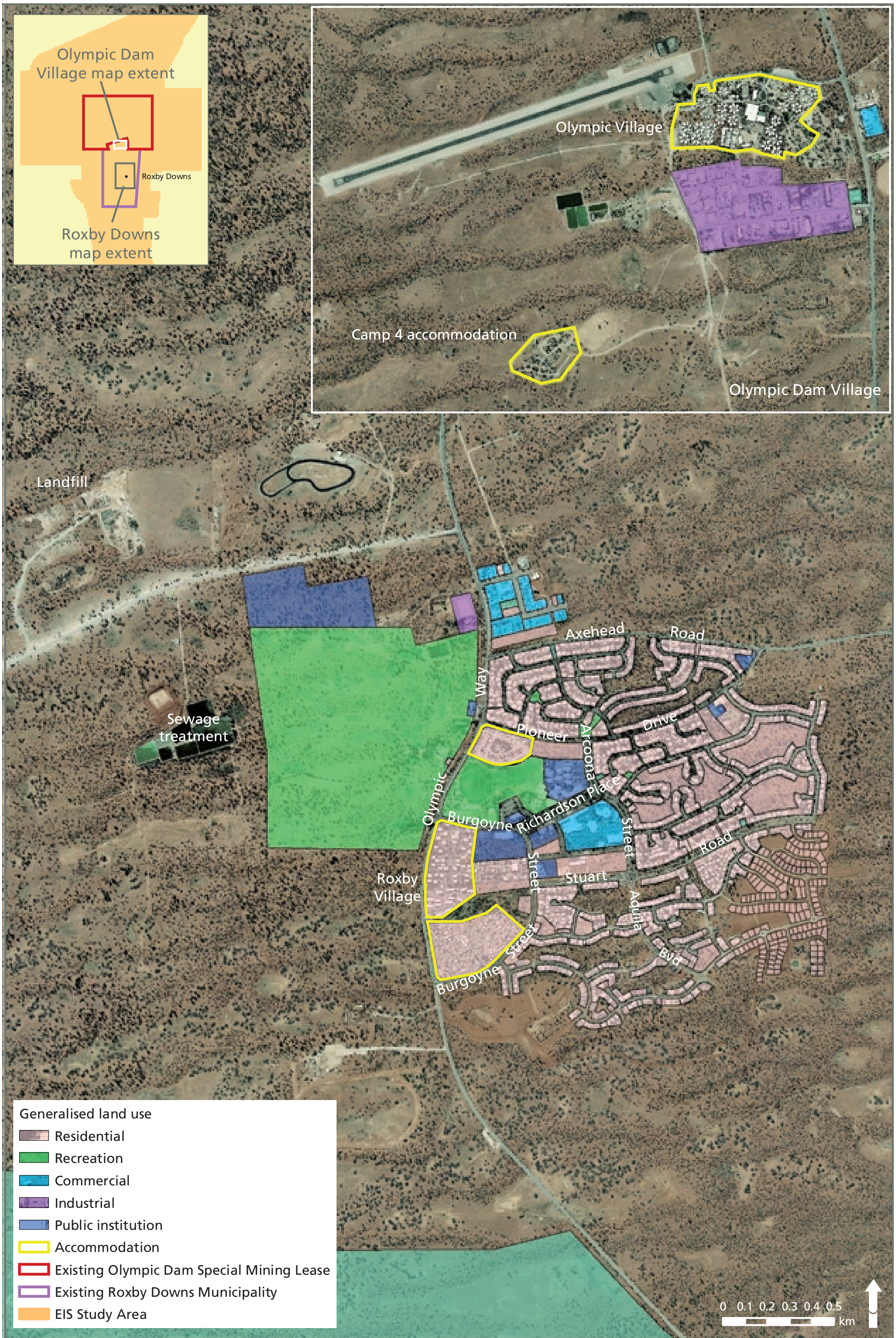

Figure 2.11 Existing accommodation and residential infrastructure at Roxby Downs and Olympic Dam Village

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Table 2.9 Housing profile in Roxby Downs LGA[1]

Number of bedrooms	Number of dwellings	Proportion of total properties (as a %)
1 bedroom	60	4.1
2 bedrooms	136	9.4
3 bedrooms	608	41.9
4 bedrooms	408	28.1
5 or more bedrooms	43	3.0
Not stated/other	196	13.5
Total occupied private dwellings	**1,451**	**100**

[1] Based on 2006 census data (ABS 2007a), includes visitor only and other not classifiable households, excludes village and hotel/motel accommodation, includes additional dwellings associated with the new Copper Sands development.

Olympic Village

Olympic Village, located adjacent to the airport at Olympic Dam Village, provides 1,365 rooms for long- and short-term non-residential employees and contractors. Facilities within Olympic Village include a mess, tavern, gym, tennis courts and laundry facilities.

2.9.3 OFF-SITE WASTE MANAGEMENT

Domestic waste

Roxby Downs residents and local industry generate about 1,400 tpa of domestic waste, which is collected and disposed of in a local landfill facility managed by the Roxby Downs Council (see Figure 2.11). Activities within the heavy industrial area at Olympic Dam Village, and Olympic Village generate approximately 100 tpa of wastes, which are also disposed of in the landfill.

A limited recycling scheme operates in Roxby Downs, where residents can deliver recyclables including paper, cardboard, cans and glass to the recycling depot located in the light industrial estate to the north of the town. These materials are transported to Adelaide for recycling.

Sewage disposal facilities

The waste water treatment system consists of a series of clay-lined lagoons, including three primary lagoons, two secondary lagoons, two storage lagoons and one final lagoon. The system manages all Roxby Downs and Roxby Village sewage waste and can also receive stormwater flows in high rainfall events. Treated effluent is chlorinated and sent to the reclaimed waste storage tanks for reuse on the golf course, public ovals and gardens. The Roxby Downs Council manages this facility (see Figure 2.11).

BHP Billiton manages a screening and lagooning sewage treatment system for the sewage from Olympic Village and some of the businesses within the heavy industrial area, the remainder of which manage sewage wastes within their allotment.

2.10 OPTIMISATION DESCRIPTION

The existing operation has conditional approval to produce up to 350,000 tpa of copper and associated products. Various optimisation studies and projects occur within these approvals. This section describes the most significant of these under consideration, which if it proceeded would be the optimisation of the existing operation to produce up to 12 Mtpa of ore mined. The optimisation may include:

- an expansion of the underground mine workings using a variation of the room and pillar mining method in preference to the current sublevel open stoping method
- de-bottlenecking of the metallurgical plant, including installation of additional concentrator, hydrometallurgical and smelter capacity
- construction of additional accommodation capacity within Olympic Village, Roxby Village and Roxby Downs township
- upgrade of the existing Olympic Dam airport.

Each of these is detailed further in the following sections.

2.10.1 MINE OPTIMISATION

Investigations to expand the existing underground mining operation from 9 Mtpa of ore to about 12 Mtpa are continuing. This would see the mining of tunnels (development drives) through the ore body to establish adequate ventilation, followed by the extraction of ore from the development drive ceiling via blasting methods similar to those currently used (see Figure 2.12). The mined ore would be loaded using tele-remote loaders into haul trucks which would truck the ore to the surface using the existing access decline.

Development drives would initially be 5 m in height and about 8 m wide, with upholes drilled and blasted about 15 m into the roof of the drive. About six of these 'panels' would be in development at any one time. Following ore extraction, the vacant spaces (rooms) would be barricaded to aid ventilation flow in working areas of the development but would not be backfilled as per existing stopes. Initial ventilation would be provided by the existing Raise Bore 13, which would have its flow reversed to become an exhaust raise rather than an intake raise. An additional two intake and two exhaust shafts would be constructed to provide ventilation for the expanded underground workings.

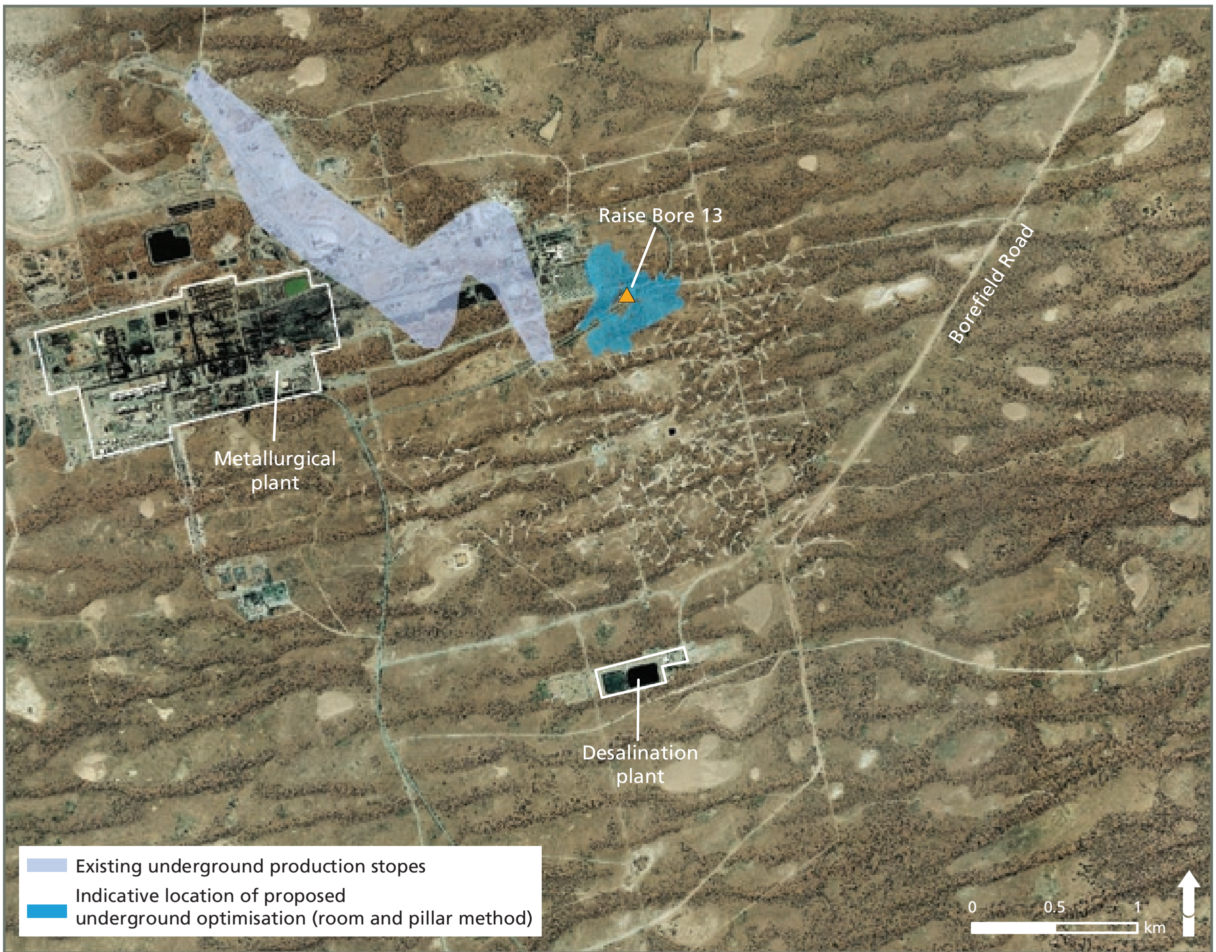

Figure 2.12 Existing operation mine optimisation

2.10.2 METALLURGICAL OPTIMISATION

In order to process the additional ore extracted from the expanded mining operation, an optimisation of the existing metallurgical plant would be undertaken. A description of the likely modifications is provided below.

Concentrator

A ball mill of about 6–7 MW capacity would be installed in series with the existing Fuller grinding mill. This, together with the existing grinding mills, would feed an expanded flotation circuit, where one new bank of flotation cells would be installed.

The existing copper-rich concentrate leach circuit has sufficient capacity for the optimised operation.

Hydrometallurgical plant

The existing uranium-rich tailings leach circuit has sufficient capacity for the additional throughput. However, one additional thickener of around 52 m in diameter would be installed in the CCD circuit, potentially operating at a greater solids concentration than the current six thickeners.

The existing CuSX, USX and uranium precipitation, calcination and packing infrastructure have sufficient capacity for the optimised operation.

Smelter

A new concentrate filter press would be added to the feed preparation area of the smelter. However, no additional drying capacity is required. Within the smelter, the flash furnace would have an upgraded reaction shaft installed, with minor modifications to the remaining electric and anode furnaces. Off-gas handling systems would not require modification.

A new acid plant would be installed to convert the greater volumes of sulphur dioxide generated from the flash furnace into sulphuric acid for use in the hydrometallurgical plant. It would be virtually identical in design to the existing acid plant, and would have about 1,500 tpd acid generating capacity. Additional duct work would connect the two acid plants to the existing waste-heat boiler and electrostatic precipitator.

Refinery

No significant modifications to the existing electrorefining and electrowinning tankhouses would be required, nor to the slimes treatment plant.

2.10.3 INFRASTRUCTURE OPTIMISATION

The optimisation of the existing operation would result in an increase in the volume of water and electricity required, in the volumes of consumables and commodities transported to and from the operation, and the number of workers required to service the optimised operation. The sections below discuss the likely infrastructure modifications.

Water supply

It is estimated that an additional 6 to 8 ML/d of water would be required for the optimised operation. A significant proportion of this water is expected to be obtained through water-saving projects that are currently being assessed, including:

- use of pressure filters or paste thickeners for liquor recovery
- treatment of acid liquors and recirculation to the plant
- steam recovery
- reducing evaporation from water storages
- dry cooling in the smelter.

Water would be sourced from the GAB under approvals from the South Australian Government or from local saline aquifers, which may include on-site desalination to improve water quality.

Electricity supply

Around 270,000 MWh of additional electricity would be required per annum for the optimised operation, primarily associated with additional mine ventilation and the addition of a new grinding mill and associated equipment. The existing transmission line has sufficient capacity to meet the required demand.

Transport infrastructure

No significant upgrade to road and rail infrastructure would be required in order to meet the needs of the optimised operation. However, new local roads would be provided around the expanded areas of the Roxby Downs township.

The existing Olympic Dam airport terminal would be replaced with a new 27 m long by 12 m wide terminal that would include amenities, disabled facilities and security infrastructure. The existing terminal facility would be modified to be used for baggage handling. In addition to the terminal upgrade, the runway and apron areas would be resurfaced.

Telecommunications infrastructure

The existing telecommunications network within Roxby Downs consists of a mix of optical fibre and copper connections, connected to Woomera via two optical fibre connections. The light industrial area of Roxby Downs is connected to the telecommunications system via copper connections.

At the time of writing, only Telstra offers 3G mobile services in the Roxby Downs region, with other carriers limited to 2G and 2.5G.

Workforce and accommodation

It is expected that a peak workforce of around 1,000 short-term contractors would be required during the construction of the infrastructure associated with the optimisation, with an additional 400 full-time equivalent people required following commissioning.

In order to accommodate the additional workforce, Roxby Downs township and both Roxby and Olympic Villages would be expanded as shown in Table 2.10 and in Figure 2.13. Additionally, a new privately owned and operated accommodation facility would be established (see Figure 2.13). Initially, this would consist of up to 500 predominantly single ensuite rooms with some double room units. The facility would have the potential to grow up to about 1,500 rooms. It would also consist of a dining and wet mess (bar), laundry and recreational facilities including a pool and gym.

2.11 ENVIRONMENTAL MANAGEMENT PRACTICES

Olympic Dam operates in accordance with an AS/NZS ISO 14001:2004 certified environmental management system (EMS). This is a set of policies, procedures and practices detailing the overarching approach adopted at Olympic Dam to protect environmental values at the site.

The site EMS consists of the BHP Billiton Group Sustainable Development Policy, an EMS procedure, the site environmental management program (EM Program) and supporting monitoring programs that are reviewed triennially, together with site environmental action plans that are reviewed annually. These systems are described in Sections 2.11.1–2.11.8 and their interaction represented in Figure 2.14.

An interim report detailing progress toward the goals and objectives of the EM Program is submitted annually to the South Australian Government as required by the Ratification Act and the Indenture. A detailed report is then submitted to government three years after the EM Program is approved as required by the Indenture.

Table 2.10 Additional accommodation for the optimisation

Accommodation	Number of new dwellings	Total number of dwellings
Roxby Downs township	150 houses	1,600 houses
Roxby Village	300 beds	800 beds
Olympic Village	1,500 beds	2,865 beds
Private sector mining and non-mining workers accommodation village	1,500 beds	1,500 beds

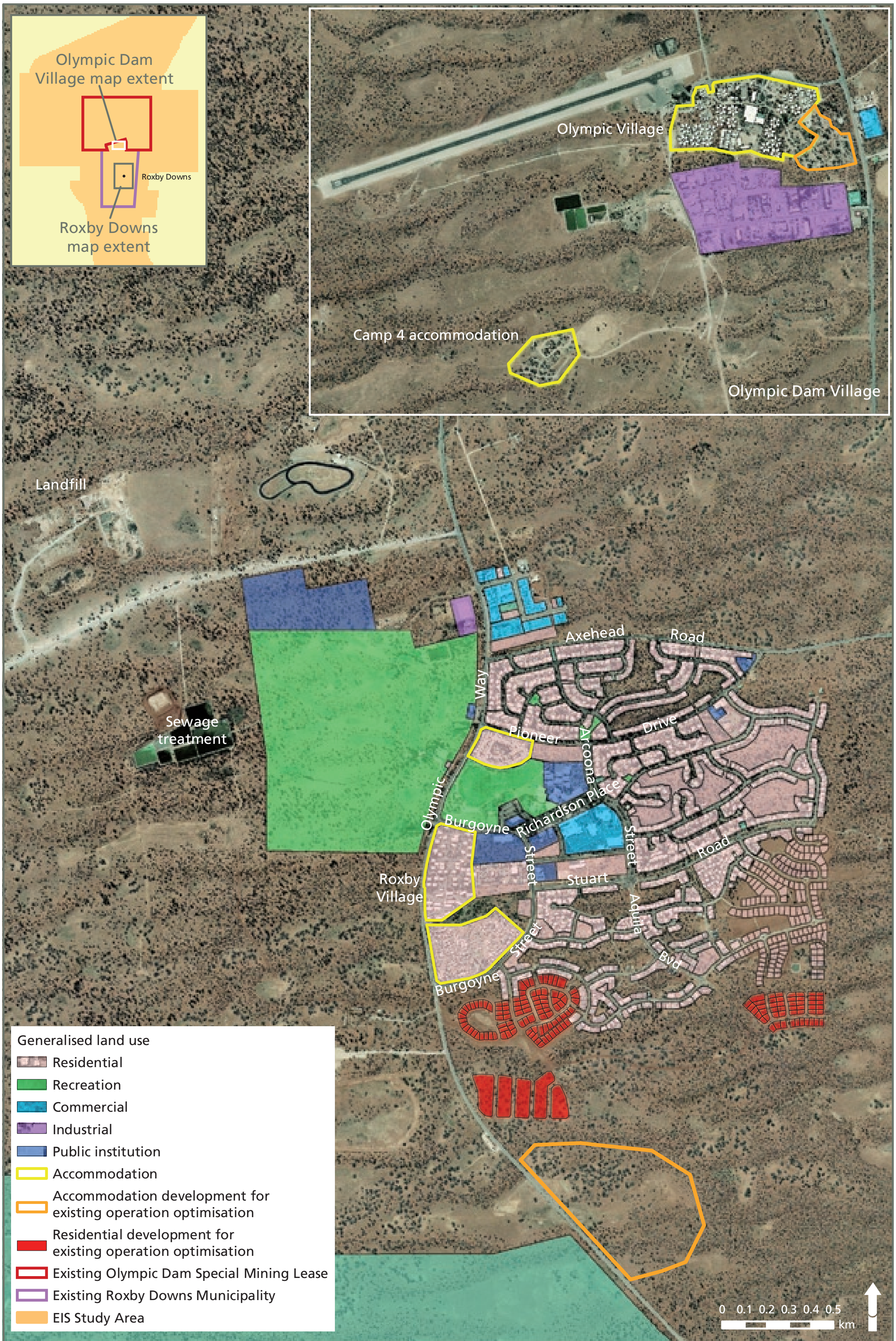

Figure 2.13 Accommodation for the optimisation of the existing operation

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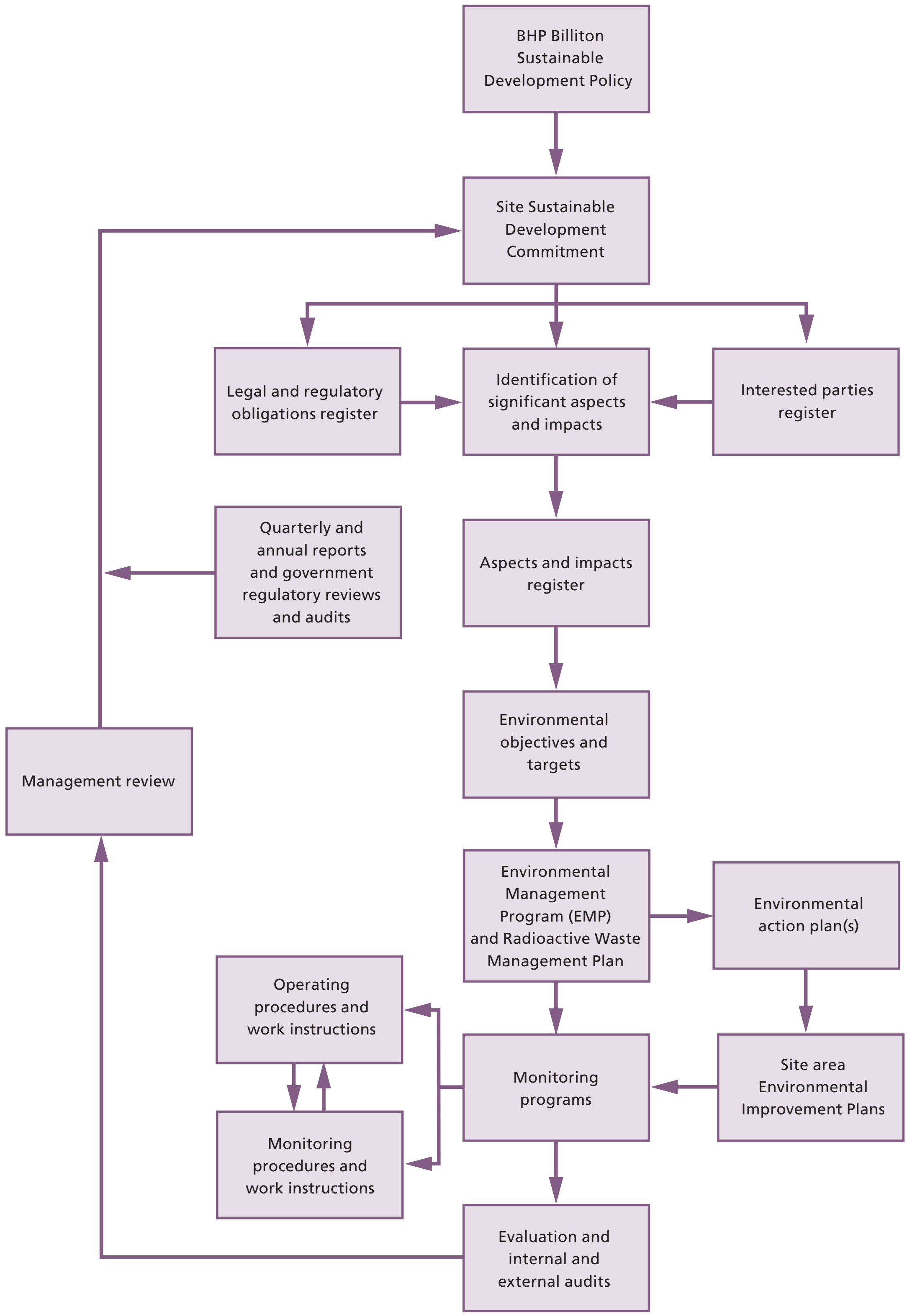

Figure 2.14 Existing Olympic Dam Environmental Management System

2.11.1 BHP BILLITON GROUP SUSTAINABLE DEVELOPMENT POLICY

The BHP Billiton Group Sustainable Development Policy outlines the company's goal of Zero Harm to its people, their host communities and the environment in which it operates. It details the company's commitment to ensuring it remains viable and contributes lasting benefits to society by considering the health, safety, social, environmental, ethical and economic aspects of the activities it undertakes.

In support of this policy, Olympic Dam has a site-specific sustainable development commitment, which is displayed at key locations across the operation.

2.11.2 ENVIRONMENTAL MANAGEMENT SYSTEM

The EMS sets out the legislative basis for the development of environmental objectives and targets for the site, the development of a register of site aspects (activities with the potential to result in positive or negative environmental outcomes) and impacts (the potential environmental benefit or harm that may be caused by an aspect), the integration of environmental objectives into operations and specific action plans, and the subsequent development and integration of the site EM Program and monitoring programs into operations.

Objectives and targets

A review of site objectives and targets is undertaken by BHP Billiton during the triennial review of the EMS procedure, while the site EM Program, monitoring programs and reviews are conducted annually. Objectives and targets are consistent with the BHP Billiton Group Sustainable Development Policy, Olympic Dam sustainable development commitments, and legal, financial, operational, business and other requirements. The views of interested parties are considered in their development.

Site objectives and targets are included in the EM Program with performance reported in the annual Environmental Management and Monitoring Report. Objectives and targets are formulated for appropriate departments and functions, with responsibilities and timelines documented in the EM Program.

Obligations register

Legal conditions and commitments specific to Olympic Dam are maintained on a site database which generates rules, reminders and timelines for relevant personnel regarding expiry, reporting and obligation requirements. Legislative and other obligations (e.g. public commitments) are incorporated into an obligations spreadsheet and considered when identifying and prioritising significant environmental aspects and impacts. Instances of non-compliance with legal and other conditions are recorded, actioned and managed through a hazard, incident and accident database.

Interested parties register

An interested parties register is maintained. This register identifies relevant regulatory bodies, non-government organisations, community bodies and other relevant stakeholders to be considered when identifying and prioritising significant environmental aspects and impacts.

Aspects and impacts register

Significant aspects and impacts are recorded in a register that is subject to a major review prior to the triennial review of the EM Program. Annual reviews of the register are also conducted to identify changes in risk over the previous year based on monitoring results, the performance of controls and the acquisition of new plant or equipment. Changes are incorporated into the annual review of the EM Program that is submitted to government.

Risk is assessed and managed at Olympic Dam through the BHP Billiton Group Risk Management Standards. This is a structured and consistent approach to risk management, aligning strategy, processes, people, technology and knowledge for the purpose of evaluating and managing uncertainties faced in the company's operations.

2.11.3 ENVIRONMENTAL MANAGEMENT PROGRAM

The EM Program details the current controls and mitigation measures in place to prevent or minimise the potential environmental impact of those activities assessed during the aspects and impacts review as representing a significant environmental risk. It also outlines continuous improvement opportunities for each identified potential impact. These constitute a statement regarding the potential environmental impact and a proposal for further work to mitigate the impact.

Annual action plans detail improvement targets and actions to be undertaken in order to meet the broader objectives of the program.

2.11.4 SITE AREA ENVIRONMENT IMPROVEMENT PLANS

The detail from the action plans within the EM Program and other actions for environmental improvement that are not ranked as representing a significant environmental risk, are included in area environment improvement plans for the operational department to which they relate (smelter, processing or mining). These environment improvement plans:

- designate responsibility for achieving the actions, objectives and targets at each relevant function and level of the operation
- set out the means and timeframe by which these actions, objectives and targets are to be met
- are reviewed regularly and revised if necessary to reflect changes in organisational objectives and targets.

2.11.5 MONITORING PROGRAMS

Monitoring programs assess performance against the EM Program standards, track progress against objectives and targets, assess the effectiveness of control mechanisms, and address legal and other requirements.

There are seven primary monitoring programs, which are referenced in the EM Program and submitted annually to government. These are:

- airborne emissions
- radiation dose to members of the public
- GAB
- groundwater
- flora
- fauna
- waste.

The results of these monitoring programs are compiled and submitted to government, predominantly in the:

- quarterly Environment Report
- annual Environmental Management and Monitoring Report
- annual GAB Wellfields Report.

The results are also considered in the following regular stakeholder meetings:

- quarterly environmental and occupational radiation reviews, including a site inspection by South Australian Government representatives
- Olympic Dam Environmental Consultative Committee (ODECC).

Existing smelters

Where monitoring indicates a significant potential impact or actual impact, an incident notice is raised. The incident is assessed by BHP Billiton to determine the severity and significance of the event, and the relevant legislative and regulatory requirements, including reporting to regulators and other stakeholders. This information is also considered in the annual review of environmental aspects and impacts.

Monitoring procedures and work instructions are maintained within the Olympic Dam document management system. Implementation, data analysis and reporting of data relating to monitoring programs, procedures and work instructions enable the periodic evaluation of compliance with relevant environmental legislation and regulations.

2.11.6 RADIOACTIVE WASTE MANAGEMENT PLAN

Before the year 2000, a separate tailings and waste management program had been submitted to government as part of the EMS. Since 2000, the requirements of the radioactive waste management plan have been integrated into the Olympic Dam EMS via the previously described monitoring programs.

2.11.7 EVALUATION AND AUDITS

On-site personnel manage the timing and frequency of HSEC audits at Olympic Dam. The results are recorded and brought to the attention of personnel directly responsible for the area being audited.

An accredited external auditor annually audits the performance of the EMS, with separate quality system and safety management system audits being undertaken. HSEC management documentation and WorkCover audits also assess the performance of the EMS to varying degrees. Other audits include:

- environmental compliance audits (i.e. internal or external audit focusing on legal/regulatory matters)
- verification audits (i.e. external audits of internal HSEC management documentation, implementation or sustainability reporting as required by the BHP Billiton Group)
- organic accreditation audits undertaken on BHP Billiton-operated pastoral stations (i.e. external audits of the performance of metallurgical plant emission controls).

2.11.8 MANAGEMENT REVIEW

Olympic Dam's leadership team reviews the EMS on a quarterly basis to ensure its continuing suitability, adequacy and effectiveness. The Manager, Radiation and Environment provides a quarterly presentation to the site leadership team at management review meetings, detailing audits completed for the quarter, instances of non-conformance and recommendations arising from audits. Progress towards rectifying non-conformance and implementing recommendations from previous audits is also assessed.