The Labour Force Outlook in the Australian Minerals Sector: 2008 to 2020

Report prepared for the Minerals Council of Australia

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1 EXECUTIVE SUMMARY

This study projects the demand for labour by the mineral sector for nine major commodities in Australia from 2008 to 2020. The labour demand projections are based on mineral output projections for the major commodities to 2020, supplied by Access Economics. In addition, the levels of employment for the major occupational categories are projected to 2020. This enables a comparison of the increase in projected demand for labour by occupation with the total size of employment in the corresponding occupational categories Australia-wide in 2020.

This report is an update to a previous report by NILS undertaken in 2006 for the Minerals Council of Australia (MCA) and the Chamber of Minerals and Energy, Western Australia(CME). The same methods have been used to produce this report but it has been necessary to identify some new data sources for the current project.

The structure of this report is designed to provide quick access to the main study results. This Executive Summary provides an overview and headline summary of the projections with brief commentary on interpretation and implications. The next section provides more detail on the projection results and the final section provides detail on methodology and data sources. We first discuss projections of the size of the national workforce by occupational category and then describe the results of the labour demand projections.

We projected to 2020 the number of persons employed Australia-wide in nine level-1 Australian Standard Occupational Categories (ASCO). Of these nine categories the following six represent the overwhelming majority of employees at Australian mines:

- Managers and Administrators
- Professionals
- Associate Professionals
- Tradespersons and Related Workers
- Intermediate Production and Transport Workers
- Labourers and Related Workers

The economy-wide projections of these six major occupational categories present the following characteristics:

- The total number of persons in Australia in these six ACSO occupational categories is expected to grow by around one million persons in the 12 years to 2020 or by 15%;

- The two fastest growing occupational categories in Australia, by a significant margin, are 'Managers and Administrators' and 'Associate Professionals' which are projected to grow at 36 and 28% respectively. This contrasts markedly with the national figures for the groups 'Tradespersons and Related Workers', 'Intermediate Production and Transport Workers' and 'Labourers and Related Workers', which are projected to grow at 2, 5 and 4% respectively.

These varying relative growth rates across occupations reflect the general growth trends of the economy and its changing industry structure, for example, the relative growth of services compared with manufacturing.

We project demand to 2020 in the 'mineral sector'. For the purposes of this study the employment in the mineral sector means operational employees at mines (including contractors) for the nine commodities in scope. This will include employees in some refining and handling operations where these are integrated with extraction but the focus is on the demand for labour for operational activities at the mines. We have not included the entire minerals industry labour force.

Our projections indicate a significantly increased demand for labour in the mining sector leading up to 2020. Key findings include the following:

- To achieve currently predicted increases in output and assuming no significant changes in labour productivity, the mining sector will need to employ 86,000 more workers, from 128,000 in 2008 to 215,000 in 2020, an increase of 68%;

- The largest state increase, by a significant margin, will be in WA with a projected increase of 47,700 persons or 85% growth in demand for labour and representing a 55% share of the total national increase in demand;

- By mineral commodity, the largest increases are projected to be in iron ore (20,814 persons or 106%) and coal (18,896 or 53%);

- The greatest increase in the demand for labour in absolute terms by occupational category is projected to be in the 'Tradespersons' and 'Semi-

skilled workers' categories with these together accounting for an increase of 61,386 or 71% of the overall increase.

It is clear from the combined demand and employment projections that the occupational categories for which demand from the mineral sector is expected to grow most rapidly are those for which total economy-wide employment is projected to grow most slowly - 'Tradespersons and Related Workers' and 'Intermediate Production and Transport Workers'. This is perhaps the most significant single observation from comparing the total employment and labour demand projections.

In terms of the mining industry's capacity to attract sufficient labour there are two ways to interpret this projected outcome. The negative interpretation is that the pool of potential employees in these occupational categories will grow only slowly and will shrink relative to total employment and that this will make it more difficult for the mineral sector to attract the labour it needs. Before settling on this interpretation, however, it is necessary to consider why the numbers in these categories are likely to be in relative decline. One of the main reasons is likely to be that the *demand for workers in these occupational categories is declining economy-wide*. Therefore, on a more positive interpretation, the fall in demand for these occupational categories from sectors such as manufacturing represents an opportunity for the mining industry to attract workers from these other sectors. In addition, it must be emphasised that the total number of new workers required by the minerals sector is still relatively small compared to the total number of workers nation-wide in these occupational categories. This interpretation implies that there is likely to be sufficient capacity in the labour market in the two key occupational categories to meet the industry labour demand.

A key issue that is not analysed in this study is the geographic dimension of the labour demand in the mineral sector. Workers in the trades and semi-skilled occupations reside predominantly in the cities and the mining industry will need to devise incentives to attract them to the remote mining centres of Australia.

Another issue that is outside the scope of this analysis is the potential mismatch between the existing skills of workers that could be attracted to the mining industry and the skills that are required by the industry. It is clear that workers from, for example, the manufacturing sector will need some level of training before they are able to take on mining jobs. A comment on the issue of productivity is warranted at this point. As described, the projection methodology employed for this study makes the assumption that there are no significant changes in labour productivity over the

12 years to 2020. This begs the question: what are the prospects for productivity change in the mining industry over this period? The industry is clearly undertaking significant investment at this time and this can be expected to lead to higher levels of productivity. Potentially offsetting this effect, however, is the fact that the industry will need to employ many persons who have never before worked in mining. This will mean that, as new relatively inexperienced workers make up a growing proportion of the mining workforce, the average level of mining-specific skill, experience and expertise will fall. The impact of this effect is likely to be a fall in productivity.

To illustrate the impact of a productivity change we can consider scenarios where productivity increases or decreases by 10 per cent over the 12 year period. The number of extra workers required by 2020 under the no productivity change is around 86,000. If productivity were to increase by 10 per cent this figure would fall to an extra 65,000 persons required. If, however, productivity were to fall by 10 per cent the industry would need to find an additional 108,000 workers by 2020. It can be clearly seen that productivity changes of this size have a significant impact, and we note that a 10 per cent productivity change over 12 years is equivalent to approximately 0.797 per cent per year compounding. Mining companies and the industry could potentially develop policies to achieve this level of productivity gain thereby reducing their labour requirements.

The foregoing discussion suggests two approaches to productivity improvement: the industry should continue to give emphasis to labour saving technology as it undertakes mine investment. The motivation for this is the traditional one – to minimise ongoing labour costs – but our projections suggest that, in addition, the industry should give regard to the possibility that, in some cases, mining operations that require large numbers of workers may face disruption because of the sheer scarcity of labour. A second emphasis that is suggested is that the industry needs to focus on continuing beyond the current high level the intensive training and up-skilling of new employees from outside the mining industry. This will potentially lead to significant productivity payoffs and will also benefit mine workers who will be more likely to be retained in the industry if they are developing new skills and enjoying associated improvement in remuneration. The labour projections made are for new workers, they do not include the replacement of workers due to turnover from on-going positions. Therefore, minimising employee turnover will be critical for the industry as the relative scarcity of labour grows with growing production levels.

2 PROJECTIONS OF PERSONS IN OCCUPATIONAL CATEGORIES – ECONOMY WIDE

In this section we provide the results of the projection of total Australian workforce by occupation. Projections are of the levels of employment by ASCO level-1 occupational categories to 2020 in the Australia-wide labour market.

For the 2006 NILS study, economy-wide employment levels for all Australian states were projected. For this study only the total national projections were developed. Table 1 shows the results of these projections.

This nine-category projection for the national labour force can be reduced to the six-category set shown in Table 2. These categories correspond to the 2006 study's six-categories. The omitted categories are largely irrelevant to the mine site operations of the minerals industry and pertain to sub-categories of clerical occupations.

Table 2 shows that the two fastest growing occupational categories nationally, by a significant margin, are 'Managers and Administrators' and 'Associate Professionals' which are projected to grow at 36% and 28% respectively. This contrasts markedly with the categories 'Tradespersons and Related Workers', 'Intermediate Production and Transport Workers' and 'Labourers and Related Workers' which are projected to grow at 2, 5 and 4% respectively. These changes are analysed in more detail and compared with labour demand projections in Section 4.

For comparison, we provide in Table 3 the economy-wide employment projections of the 2006 NILS study. It can be seen that the common set of projected figures, for example, for 2015 are quite close in value. We would not expect the two sets of projections to result in exactly the same results for the following reasons:

- the projections in the 2006 study were based on employment data for the period 1996 to 2004 whereas for the 2008 projections the base period was 1996-2008, that is, the 2008 projections incorporate more recent data
- for the 2006 study employment was projected for each state and these were added to calculate the Australian total whereas for the 2008 study the Australian totals were calculated directly from the Australian base data
- calculations for the 2008 projections were based on employment data at 10-year age intervals whereas 5-year intervals were used in the 2006 study.

Table 1: National (economy-wide) projected employment by nine occupational categories, 2008-2020

9ASCO	Managers and Administrators	Professionals	Associate Professionals	Tradespersons and Related Workers	Advanced Clerical and Service Workers	Intermediate Clerical, Sales and Service Workers	Intermediate Production and Transport Workers	Elementary Clerical, Sales and Service Workers	Labourers and Related Workers	TOTAL EMPLOYMENT (persons)
2007	825,381	1,973,505	1,289,462	1,260,040	374,448	1,669,842	839,046	944,049	864,290	10,040,063
2008	849,074	2,019,982	1,325,984	1,267,145	372,579	1,689,093	844,984	946,075	867,222	10,182,138
2009	873,000	2,064,626	1,361,035	1,273,312	371,028	1,707,671	850,820	947,420	870,589	10,319,500
2010	897,243	2,107,768	1,394,819	1,278,899	369,854	1,725,906	856,718	948,374	874,491	10,454,071
2011	921,492	2,148,840	1,426,966	1,283,656	368,940	1,743,394	862,459	948,800	878,637	10,583,183
2012	945,224	2,186,801	1,456,791	1,287,098	368,094	1,759,314	867,638	948,353	882,558	10,701,872
2013	968,330	2,221,668	1,484,304	1,289,321	367,298	1,773,701	872,258	947,132	886,209	10,810,221
2014	991,097	2,254,334	1,510,104	1,290,911	366,676	1,787,255	876,662	945,587	889,889	10,912,515
2015	1,013,652	2,285,324	1,534,543	1,292,219	366,278	1,800,380	881,024	943,974	893,738	11,011,132
2016	1,035,680	2,314,131	1,557,323	1,292,989	365,990	1,812,622	885,123	942,108	897,495	11,103,460
2017	1,056,776	2,340,082	1,577,962	1,292,857	365,675	1,823,428	888,672	939,727	900,838	11,186,017
2018	1,076,905	2,363,330	1,596,591	1,291,927	365,327	1,832,880	891,699	936,905	903,770	11,259,334
2019	1,096,583	2,385,177	1,614,095	1,290,927	365,123	1,841,951	894,677	934,169	906,748	11,329,450
2020	1,115,962	2,406,114	1,630,817	1,290,109	365,106	1,850,959	897,748	931,685	909,897	11,398,397

Table 2: National (economy-wide) projected employment by six key occupational categories, 2008-2020 - the '2008 projections'

6 ASCO	Managers and Administrators	Professionals	Associate Professionals	Tradespersons and Related Workers	Intermediate Production and Transport Workers	Labourers and Related Workers	Total
2008	849,074	2,019,982	1,325,984	1,267,145	844,984	867,222	7,174,391
2009	873,000	2,064,626	1,361,035	1,273,312	850,820	870,589	7,293,382
2010	897,243	2,107,768	1,394,819	1,278,899	856,718	874,491	7,409,938
2011	921,492	2,148,840	1,426,966	1,283,656	862,459	878,637	7,522,050
2012	945,224	2,186,801	1,456,791	1,287,098	867,638	882,558	7,626,110
2013	968,330	2,221,668	1,484,304	1,289,321	872,258	886,209	7,722,090
2014	991,097	2,254,334	1,510,104	1,290,911	876,662	889,889	7,812,997
2015	1,013,652	2,285,324	1,534,543	1,292,219	881,024	893,738	7,900,500
2016	1,035,680	2,314,131	1,557,323	1,292,989	885,123	897,495	7,982,741
2017	1,056,776	2,340,082	1,577,962	1,292,857	888,672	900,838	8,057,187
2018	1,076,905	2,363,330	1,596,591	1,291,927	891,699	903,770	8,124,222
2019	1,096,583	2,385,177	1,614,095	1,290,927	894,677	906,748	8,188,207
2020	1,115,962	2,406,114	1,630,817	1,290,109	897,748	909,897	8,250,647

Table 3: National (economy-wide) projected employment by six key occupational categories, 2005-2015 – the '2006 projections'

6 ASCO	Managers and Administrators	Professionals	Associate Professionals	Tradespersons and Related Workers	Intermediate Production and Transport Workers	Labourers and Related Workers	Total
2005	770,335	1,868,367	1,235,378	1,214,244	793,138	867,413	6,748,875
2006	792,228	1,919,548	1,279,798	1,225,143	793,947	866,894	6,877,559
2007	813,626	1,967,971	1,321,970	1,235,348	794,271	865,479	6,998,665
2008	834,638	2,014,015	1,362,073	1,245,215	794,448	863,602	7,113,991
2009	855,462	2,058,310	1,400,520	1,255,170	794,827	861,711	7,226,000
2010	876,169	2,101,171	1,437,505	1,265,419	795,585	860,054	7,335,902
2011	896,455	2,142,047	1,472,668	1,275,594	796,521	858,470	7,441,754
2012	915,818	2,179,891	1,505,304	1,285,042	797,258	856,599	7,539,912
2013	934,191	2,214,714	1,535,428	1,293,736	797,799	854,487	7,630,355
2014	951,887	2,247,421	1,563,683	1,302,156	798,445	852,491	7,716,084
2015	969,073	2,278,508	1,590,442	1,310,540	799,344	850,792	7,798,700

3 LABOUR DEMAND PROJECTIONS – MINERALS SECTOR

Tables 4, 5 and 7 provide the main raw aggregate results of the projection of demand for labour in the minerals sector to 2020 by state, by commodity and by occupational classification. Each of these tables is followed by an analysis of the changes between 2008 and 2020 and a chart showing the distribution of changes between the various categories.

Table 4: Mineral sector - projected labour demand by state, 2008-2020

Year	NSW	VIC	QLD	SA	WA	TAS	NT	AUST
2008	16,557	1,528	43,843	5,687	56,190	1,802	2,637	128,244
2009	17,230	1,892	46,453	7,095	65,184	1,867	2,840	142,562
2010	17,724	2,233	48,760	8,647	72,667	1,774	3,012	154,816
2011	18,578	2,256	50,962	9,283	77,244	1,717	3,428	163,469
2012	19,860	2,258	53,696	9,323	79,667	1,712	3,434	169,951
2013	20,785	2,337	55,709	9,113	83,816	1,721	3,244	176,725
2014	21,141	2,319	57,158	9,373	85,638	1,754	3,330	180,713
2015	21,583	2,368	58,718	9,681	88,419	1,804	3,448	186,020
2016	22,053	2,447	60,211	9,995	91,765	1,862	3,570	191,902
2017	22,534	2,519	61,778	10,308	95,202	1,921	3,694	197,956
2018	23,032	2,588	63,429	10,626	98,805	1,982	3,822	204,284
2019	23,547	2,654	65,155	11,017	102,567	2,079	3,952	210,971
2020	24,044	2,717	66,878	11,376	103,888	2,116	4,077	215,096

Changes

	NSW	VIC	QLD	SA	WA	TAS	NT	AUST
2008	16,557	1,528	43,843	5,687	56,190	1,802	2,637	128,244
2020	24,044	2,717	66,878	11,376	103,888	2,116	4,077	215,096
increase	7,486	1,189	23,035	5,689	47,698	315	1,440	86,851
% increase	45%	78%	53%	100%	85%	17%	55%	68%
% of total increase	9%	1%	27%	7%	55%	0%	2%	100%

From Table 4 and the associated analysis of changes it can be seen that the total projected increase in mining industry labour demand is 86,851 persons or an increase of 68% over the 12 year period. Clearly, WA dominates the increases with an increased demand of 47,698 or 85%. WA accounts for 55% of the total Australian growth in demand for labour. Queensland's demand is projected to increase by 23,035 or 53% with all other states, in terms of absolute numbers trailing well behind. South Australia is projected to experience the fastest percentage growth rate of 100% and it is highly likely that this will be a conservative figure given the planned Olympic Dam expansion. The figures for South Australia are based on the current level of output and employment rather than the possible expanded operation.

Chart 1: Mineral sector - Projected labour demand by state, 2008-2020, absolute change, persons

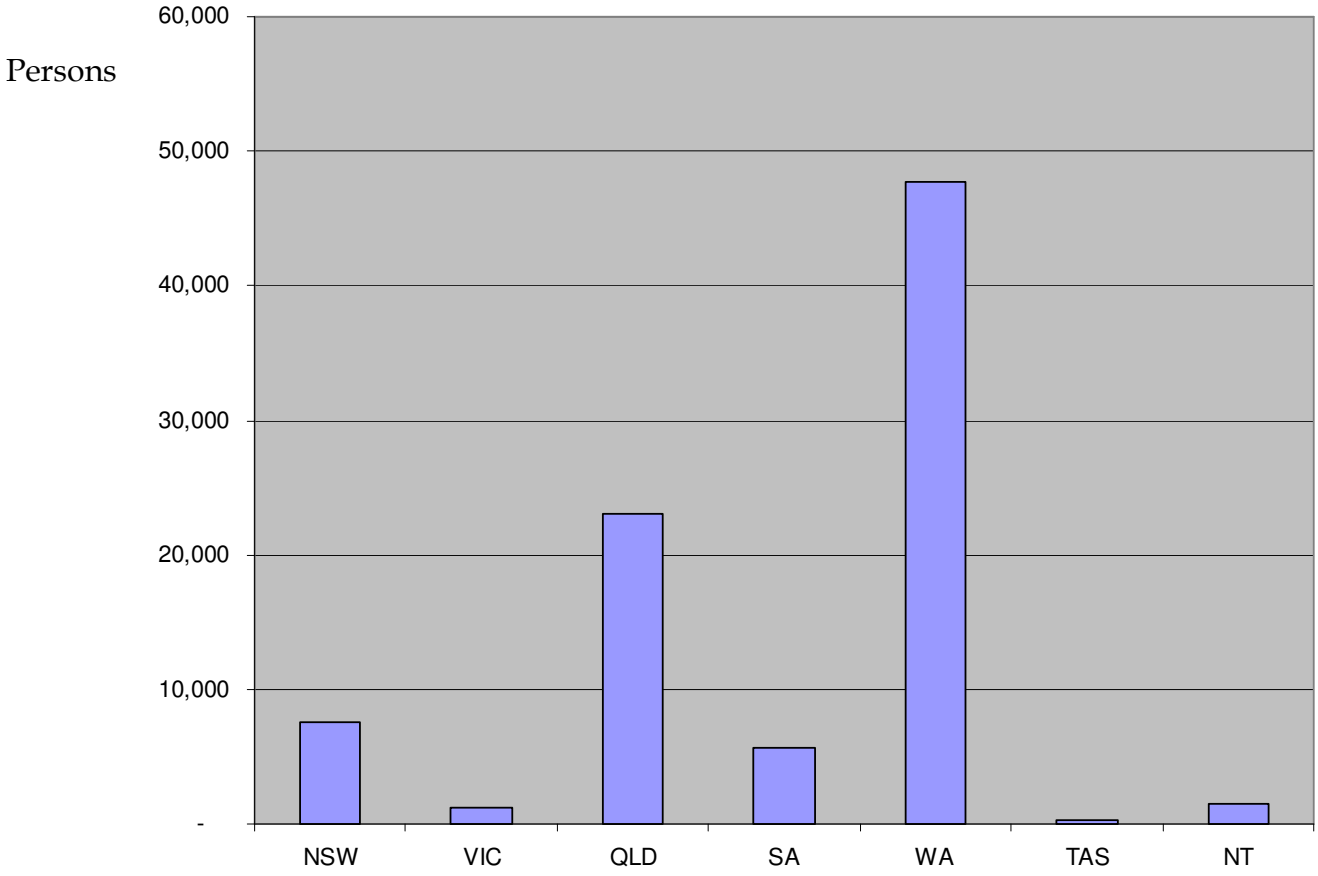


Table 5: Mineral sector - Projected labour demand by commodity, 2008-2020

Year	Coal	Bauxite/ Alumina	Copper	Gold	Iron Ore	Lead	Zinc	Nickel	Uranium	TOTAL
2008	35,837	21,001	10,484	17,765	19,631	1,613	7,554	11,420	2,940	128,244
2009	38,082	21,149	12,105	19,932	21,824	1,900	8,898	15,515	3,156	142,562
2010	39,698	21,397	14,124	22,557	24,241	2,069	9,706	17,689	3,335	154,816
2011	41,839	21,631	15,223	23,113	27,038	2,379	10,010	18,561	3,673	163,469
2012	45,231	21,930	15,715	22,803	29,622	2,372	9,905	18,367	4,006	169,951
2013	47,612	22,242	15,855	21,689	32,149	2,467	10,085	20,508	4,118	176,725
2014	48,533	23,172	16,269	20,783	33,096	2,499	10,609	21,440	4,311	180,713
2015	49,483	24,144	16,698	21,010	34,086	2,533	11,150	22,412	4,505	186,020
2016	50,461	25,042	17,064	21,765	35,189	2,511	11,665	23,508	4,698	191,902
2017	51,485	26,002	17,448	22,369	36,373	2,485	12,211	24,692	4,892	197,956
2018	52,558	27,028	17,852	22,898	37,644	2,456	12,791	25,972	5,085	204,284
2019	53,662	27,921	18,496	23,351	40,248	2,391	13,400	26,224	5,279	210,971
2020	54,732	28,846	19,155	23,728	40,446	2,314	14,012	26,390	5,472	215,096

Changes

	Coal	Bauxite/ Alumina	Copper	Gold	Iron Ore	Lead	Zinc	Nickel	Uranium	TOTAL
2008	35,837	21,001	10,484	17,765	19,631	1,613	7,554	11,420	2,940	128,244
2020	54,732	28,846	19,155	23,728	40,446	2,314	14,012	26,390	5,472	215,096
increase	18,896	7,846	8,671	5,964	20,814	701	6,458	14,970	2,532	86,851
%increase	53%	37%	83%	34%	106%	43%	85%	131%	86%	68%
% of total increase	22%	9%	10%	7%	24%	1%	7%	17%	3%	100%

From Table 5 and the associated analysis of changes it can be seen that iron ore accounts for both the largest absolute and second largest percentage increase in mining sector labour demand: 20,814 and 106% respectively. It accounts for 24% of the overall increase in demand for labour. Next, in absolute terms, is coal with a projected increase of 18,896 or 53% accounting for 22% of overall increased demand for labour. Nickel is the fastest source of growth in percentage with 131% increase or 14,970 persons.

For comparison we show in

Table 6 the projections by commodity from the 2006 NILS study. It can be seen from the total for 2015, 162,276 from the 2006 study and 186,020 from the 2008 study, that the 2008 projections indicate a substantially increased level of growth over the 2006 projections. The big increases in the 2008 projections are attributable to the increases in demand from iron ore and nickel and to a lesser extent, copper and coal. Note that the figures for zinc and lead are not directly comparable with the 2006 projections because of a slightly different method used but taken together they also show considerable increase. We also note the increase in uranium and again emphasise that

we believe that even this increase is conservative. The potential for increased demand for labour at Olympic Dam is still uncertain at this point and if this mine is expanded then copper and uranium demand for labour will increase significantly more.

Table 6: Mineral sector - Projected labour demand by commodity, 2005-2015

Year	Coal	Bauxite/ Alumina	Copper	Gold	Iron Ore	Lead	Zinc	Nickel	Uranium	TOTAL
2005	28,904	10,244	6,532	18,335	15,131	1,321	3,800	7,211	639	92,116
2006	30,596	11,030	7,753	21,481	16,630	1,635	4,103	7,682	649	101,559
2007	32,398	11,873	8,745	25,020	18,230	1,775	4,728	8,298	654	111,721
2008	33,511	13,023	9,635	25,851	19,532	1,932	5,255	9,929	657	119,326
2009	34,848	14,731	10,413	27,045	20,190	1,944	5,261	11,197	663	126,294
2010	35,589	15,614	11,127	27,801	21,047	1,947	5,359	11,705	666	130,854
2011	37,409	16,682	12,282	27,320	22,552	2,011	5,517	12,575	666	137,013
2012	39,229	17,751	13,438	26,839	24,057	2,075	5,674	13,444	666	143,172
2013	41,049	18,819	14,593	26,358	25,562	2,138	5,832	14,314	875	149,540
2014	42,869	19,888	15,749	25,877	27,067	2,202	5,989	15,184	1,014	155,839
2015	44,689	20,956	16,904	25,396	28,572	2,265	6,147	16,053	1,293	162,276

Chart 2: Mineral sector - Projected labour demand by commodity, 2008-2020, absolute change, persons

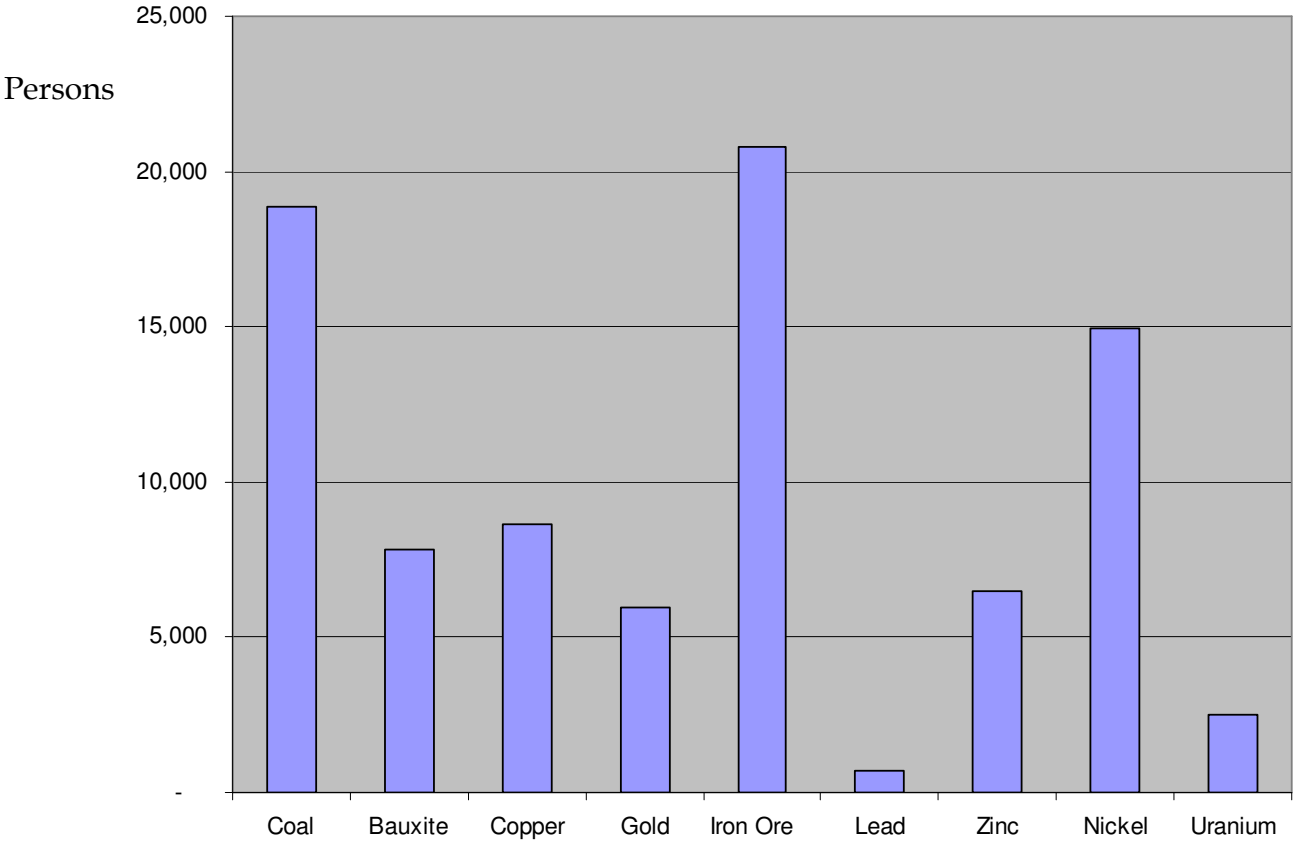


Table 7: Mineral sector - Projected labour demand by occupational category, 2008-2020

Year	Managers and Admin	Professionals	Technicians	Tradespersons	Semi-skilled workers	Labourers and related	Total
2008	6,469	13,219	6,334	46,116	44,526	11,580	128,244
2009	7,191	14,695	7,041	51,265	49,497	12,873	142,562
2010	7,810	15,958	7,646	55,672	53,752	13,980	154,816
2011	8,246	16,850	8,073	58,783	56,756	14,761	163,469
2012	8,573	17,518	8,393	61,114	59,006	15,346	169,951
2013	8,915	18,216	8,728	63,550	61,359	15,958	176,725
2014	9,116	18,627	8,925	64,984	62,743	16,318	180,713
2015	9,384	19,174	9,187	66,892	64,586	16,797	186,020
2016	9,680	19,780	9,477	69,007	66,628	17,328	191,902
2017	9,986	20,404	9,776	71,184	68,730	17,875	197,956
2018	10,305	21,057	10,089	73,460	70,927	18,447	204,284
2019	10,642	21,746	10,419	75,865	73,249	19,050	210,971
2020	10,850	22,171	10,623	77,348	74,681	19,423	215,096

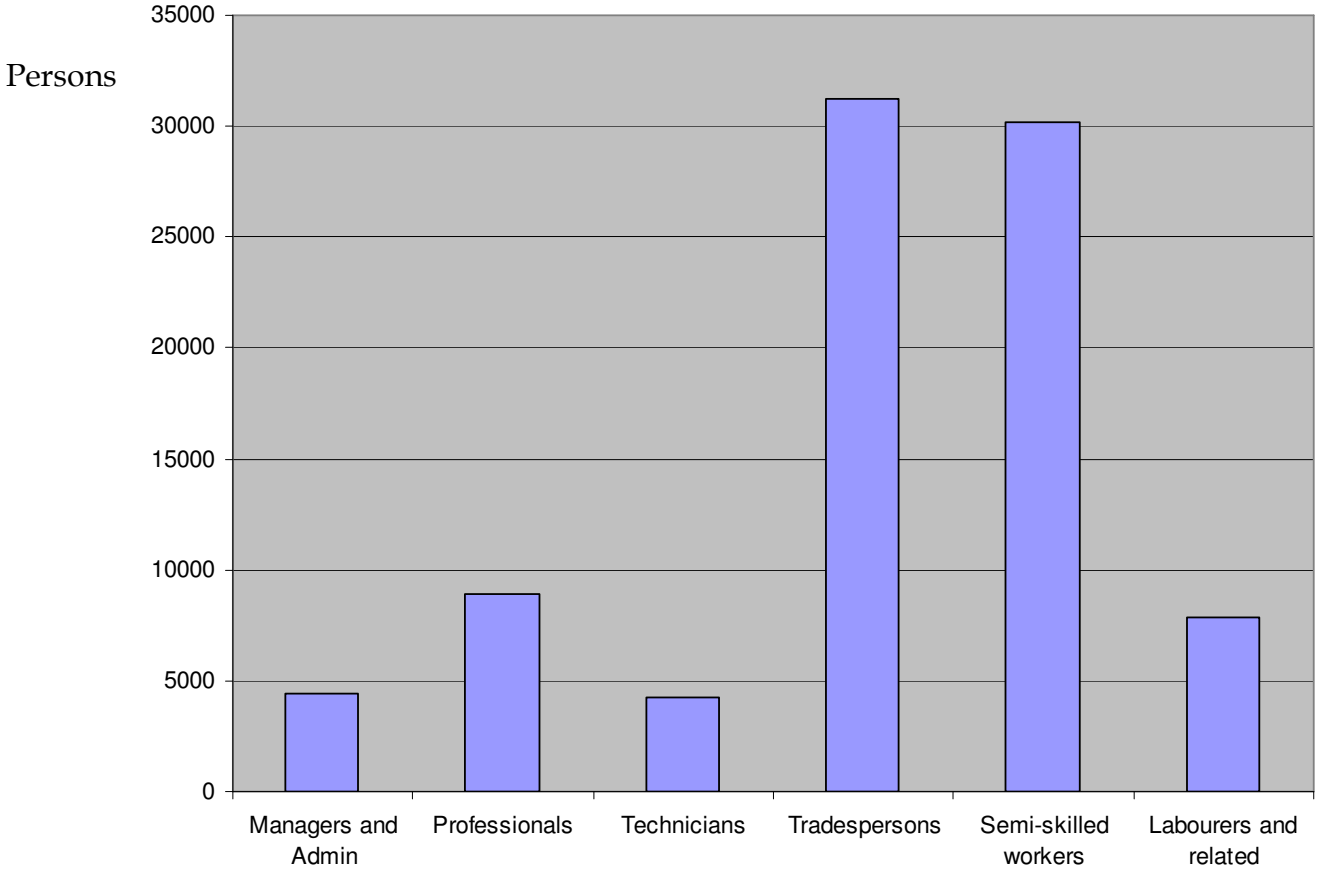
Changes

	Managers and Admin	Professionals	Technicians	Tradespersons	Semi-skilled workers	Labourers and related	Total
2008	6,469	13,219	6,334	46,116	44,526	11,580	128,244
2020	10,850	22,171	10,623	77,348	74,681	19,423	215,096
increase	4,381	8,952	4,289	31,232	30,155	7,843	86,851
%increase	68%	68%	68%	68%	68%	68%	68%
% of total increase	5%	10%	5%	36%	35%	9%	100%

Table 7 and the associated analysis of changes clearly shows that the greatest increase in workers in the mining sector's demand for labour is projected to be in the 'Tradespersons' and 'Semi-skilled workers' categories with these together accounting for an *increase* in labour demand of 61,387or 71% of the overall increase in demand. The percentage increase in all occupational categories is 68%, equal to the overall growth rate. This is because the occupational distributions for each commodity are applied equally in all years of the projections.

'Professionals' are critical to mine operation. It is notable that the projected increase in demand for 'Professionals' is slightly larger than the increase for 'Labourers and related' a point which provides perspective on the balance between projected skilled and unskilled labour demand. However, it should be remembered that the projections for Professionals is only those professionals engaged at mine sites. This projection makes no allowance for the growth needs of head office staff in the capital cities and specialist consultants that service the industry.

Chart 3: Mineral sector - Projected labour demand by occupational category, 2008-2020, absolute change, persons



4 COMPARISON OF EMPLOYMENT AND LABOUR DEMAND PROJECTIONS

In this section we compare the results of the national economy-wide employment projections with the labour demand projections for the minerals sector.

Table 8 summarises the changes over the period 2008 to 2020 for the national economy-wide employment projections by occupational category. This table makes very clear the bifurcation of expected growth into high and low rates. 'Managers and Administrators', 'Professionals', and 'Associate Professionals' are fast growing categories that make up 89% of the overall growth in employment in these six categories. In contrast 'Tradespersons and Related Workers', 'Intermediate Production and Transport Workers', and 'Labourers and Related Workers' together contributed only 11% to total growth in these six categories over the projection period.

Table 8: National (economy-wide) projected employment by six key occupational categories, 2008-2020

6 ASCO	Managers and Administrators	Professionals	Associate Professionals	Tradespersons and Related Workers	Intermediate Production and Transport Workers	Labourers and Related Workers	Total
2008	849,074	2,019,982	1,325,984	1,267,145	844,984	867,222	7,174,391
2020	1,115,962	2,406,114	1,630,817	1,290,109	897,748	909,897	8,250,647
increase	266,888	386,132	304,833	22,964	52,764	42,675	1,076,256
% increase	31%	19%	23%	2%	6%	5%	15%
% of total increase	25%	36%	28%	2%	5%	4%	100%

Table 9 brings together the labour demand and employment by occupation projections. It shows that the occupational categories that are projected to experience the highest increase in demand in the mineral sector are also those which will experience the lowest growth in national employment.

It may be tempting to conclude this outcome means that it will be increasingly difficult for the mining industry to attract the labour it needs. The 'negative' interpretation is that the pool of potential employees in these occupational highly-demanded occupational categories will grow only slowly and will shrink relative to total employment and that this will make it more difficult for the mineral sector to attract labour. However, this interpretation does not consider why the numbers of employees in the trades, intermediate labour categories are falling over time. The

dominate reason is that the *demand for workers in these occupational categories is declining economy-wide*. The relative decline in these occupational groups reflects decreasing demand from other sectors of the economy, primarily manufacturing. Therefore, on a more positive interpretation, the fall in demand for these occupational categories from sectors such as manufacturing represents an opportunity for the mining industry to attract workers from these other sectors.

Table 9: Mineral sector and National Projected employment by six key occupational categories, 2008-2020

	Managers and Administrators	Professionals	Associate Professionals	Tradespersons and Related Workers	Intermediate Production and Transport Workers	Labourers and Related Workers	Total
Minerals sector Projected labour demand							
2008	6,469	13,219	6,334	46,116	44,526	11,580	128,244
2020	10,850	22,171	10,623	77,348	74,681	19,423	215,096
increase	4,381	8,952	4,289	31,232	30,155	7,843	86,851
National Projected employment							
2008	849,074	2,019,982	1,325,984	1,267,145	844,984	867,222	7,174,391
2020	1,115,962	2,406,114	1,630,817	1,290,109	897,748	909,897	8,250,647
increase	266,888	386,132	304,833	22,964	52,764	42,675	1,076,256

In addition, it must be emphasised that the total number of new workers required by the minerals sector is still relatively small compared to the total number of workers nation-wide in these occupational categories. This interpretation implies that there is likely to be sufficient capacity in the labour market in the key occupational categories to meet the industry labour demand.

These are high-level, economy-wide conclusions. Attracting the right worker, with the right skills, at the right time in the right place is a different problem. A key issue which is not analysed in this study is the geographic dimension of the labour demand in the mineral sector. Workers in the trades and semi-skilled occupations reside predominantly in the cities and the mining industry will need to devise incentives to attract them to the remote mining centres of Australia.

Another issue that is outside the scope of this analysis is the potential mismatch between the existing skills of workers that could be attracted to the mining industry and the skills that are required by the industry. In the trades, the construction industry has generated strong demand for some tradespersons while the relative

decline of manufacturing has meant a relative decline in demand for automotive and mechanical trades. The point is that the picture for trades is not homogenous. Obviously, mismatches between existing and required skills raise the question of training strategy, which is discussed further below.

A comment on the issue of productivity is warranted at this point. As described, the projection methodology employed for this study assumes that there are no significant changes in labour productivity over the 12 years to 2020. This begs the question: what are the prospects for productivity change in the mining industry over this period? The industry is clearly undertaking significant investment at this time and this can be expected to lead to higher levels of productivity. Potentially offsetting this effect, however, is the fact that the industry will need to employ many persons who have never before worked in mining. This will mean that, as new relatively inexperienced workers make up a growing proportion of the mining workforce, the average level of mining-specific skill, experience and expertise will fall. The impact of this effect is likely to be a fall in productivity.

To illustrate the impact of a productivity change we can consider alternative scenarios where productivity increases or decreases by 10 per cent over the 12 year period. The number of extra workers required by 2020 under the no productivity change is around 86,000. If productivity were to increase by 10 per cent this figure would fall to an extra 65,000 persons required. If, however, productivity were to fall by 10 per cent the industry would need to find an additional 108,000 workers by 2020. It can be clearly seen that productivity changes of this size have a significant impact, and we note that a 10 per cent productivity change over 12 years is equivalent to 0.797 per cent per year compounding. Mining companies and the industry could potentially develop policies to achieve this level of productivity gain.

The foregoing discussion suggests two approaches to labour attraction and productivity improvement: the industry should continue to give emphasis to labour saving technology as it undertakes mine investment. The motivation for this is the traditional one – to minimise ongoing labour costs – but our projections suggest that, in addition, the industry should give regard to the possibility that, in some cases, mining operations that require large numbers of workers may face disruption because of the sheer scarcity of labour – an inability to attract sufficient labour to make a particular mining project viable. A second emphasis that is suggested is that the industry needs to focus on continuing beyond the current high level the intensive training of new employees from outside the mining industry and up-skilling of existing workers. This will potentially lead to significant productivity payoffs and will

also benefit mine workers who will be more likely to be retained in the industry if they are developing new skills and enjoying associated improvement in remuneration. Minimising employee turnover will be critical for the industry as the relative scarcity of labour grows with growing production levels.

The mining industry has traditionally focused on on-the-job training. Our projections make it clear that the labour attraction problem is long term and growing. A more holistic long term strategy would include greater emphasis on entry career-oriented, entry level and certified training designed to encourage workers to 'shift careers' on a permanent or at least long term basis into the mining industry.

5 METHODOLOGY AND DATA

5.1 Projection: interpretation and limitations

It should be acknowledged at the outset that forecasting and speculation regarding future technological, economic and social developments needs to be interpreted with caution, since it is not always a simple matter to understand the present let alone predict future trends and impacts. The analysis undertaken in this document involves what we prefer to describe as making 'projections' about employee and skill requirements to 2020, rather than 'forecasting' or 'predicting' per se. The emphasis of this distinction is the degree of certainty about the projections, particularly in the longer term. Using this assumption we can anticipate that if the output of mineral products increases then the number of employees needed to mine them will increase in similar proportion.

Our projections are based on Access Economics' commodity output forecasts together with estimates of current base year (2007) employment data from a number of sources. The Access Economics data is reported in "Infrastructure 2020 – Can the domestic supply chain match global demand?", report by Access Economics for Minerals Council of Australia, 23 May 2008, (www.minerals.org.au). The supply side projections are the "holding the line" market share scenario. The projections use ABARE production forecasts to 2013 and AE_Global model projections to 2020. They take full account of global market conditions and domestic market conditions such as proposed emissions trading schemes. Employment data used reflects mine operational labour (mine and contractor), not head office and support industries or construction labour.

In the simplest terms, our method for projecting the demand for labour is to establish the levels of employment in a base year and then to use projections of the output of mineral commodities by state to derive growth annual growth rates for production. These growth rates are then applied to the base year employment to project future employment levels. By assuming that the rate of growth of employment will be equal to the rate of growth of output we have effectively assumed that the impact of technological and management change on mining output per employee will be small.

Again, in simple terms, our projections of Australian persons employed are non-linear extrapolations of past growth rates combined with census data of ten-year age cohorts.

These projections should be interpreted in the context of the fundamental assumptions upon which the production forecasts are based and that the labour market of the future will be like the world in the past. A range of disruptive changes from large changes in the price of key inputs (such as oil) to unexpected global conflicts could cause changes which might invalidate this assumption and possibly lead to the projections being more inaccurate than they would otherwise be.

5.2 Demand projection methodology

In this section we present an outline of the measures and assumptions used in calculating the 2008 to 2020 labour demand estimates. The methodology consists of three main parts: estimation of base employment level, distributing employment to occupations and projecting employment levels. Each of these is discussed below.

5.2.1 Projections of base year (2007) mine employment

The first step in the projection method is to establish the current levels of employment at Australian mines. This is considerably more difficult than at first might be expected. It is not possible to use ABS data because mining industry employment data includes employees of mining companies that work in the cities in management and administration roles.

The 2006 report prepared by NILS made significant use of the 'Minelist 2006' data set produced by the Perth-based Resources Information Unit (RIU) 2006. The Minelist dataset is a list of all registered Australian mines with a number of parameters and values associated with each mine. From our perspective, the parameters of interest are: numbers of employees, main commodity and state.

The Minelist data is based on a survey of Australian mines and in 2006 it had approximately 70 per cent coverage of the sector. 2006 was the first year that data (for 2005) on numbers of employees had been collected. The 2008 (conducted in January 2008) achieved a slightly lower coverage (about 65 per cent) and a significant number of mines, including some of the larger ones, did not include numbers of employees in the Minelist survey. This required that data on current mine employment levels had to be obtained from a number of other sources in order to ensure completeness.

The Minerals Council of Australia provided some assistance in securing the data from the companies where employment numbers for specific mines were not provided in the Minelist data.

A number of other data sources were used to check either specific mine totals or 'by-commodity' state totals. Where by-commodity state totals could be found from reliable sources, these were used in preference to the Minelist totals. This was also the case with specific mine employment levels. In cases where the by-commodity state totals were *lower* than the totals established in the 2006 projections, the 2006 estimates were used, the rationale being that it is unlikely that employment would have fallen over the period and that the lower totals for the 2007 base year were likely to be the result of less complete coverage in the 2008 Minelist data.

A detailed account of the additional data sources can be found in the 'base employment' spreadsheet provided with this report. This spreadsheet provides by-state and by-commodity details of data sources and assumptions. A copy of this is provided in Appendix 1. The additional sources are:

- The Queensland Mines and Quarries Safety Performance and Health Report 2005-2006.
  http://www.dme.qld.gov.au/zone_files/publications/annual_report0506.pdf

- Safety performance in the Western Australian mineral industry
  http://www.docep.wa.gov.au/ResourcesSafety/PDF/Reports/Industry%20performance%20reports/SafetyPerformance_20.pdf

- 2007 NSW Minerals Council - State of the Industry Report
  2007http://www.nswmin.com.au/__data/assets/pdf_file/0007/8638/MIN101_IndRep_Text_FA63.pdf accessed 23/04/08

- Annual Review 2003/2004 Mineral Resources Tasmania

- Specific per mine employment levels obtained by MCA to supplement missing data from the Minelist survey data.

As described above, a number of sources were used to establish individual mine or by-commodity state totals. In cases where mines produce multiple commodities, the employees at that mine were, in general, attributed to the main commodity produced at that mine. Olympic Dam employees were distributed evenly to copper and uranium.

From this consolidated data set, sub-totals for employment by state and by commodity were calculated resulting in the base employment series for 2007.

5.2.2 Distributing employment level across occupations

Once a projected employment level by state and by commodity had been established for 2005 to 2020, it was next necessary to distribute these totals across occupational groups. This project used a six-category occupational distribution:

- Managers
- Professionals
- Technicians
- Tradespersons
- Semi-skilled workers (miners and plant operators)
- Labourers and related workers.

In 2006, NILS conduced a survey of 14 Australian mining companies (with coverage of 33,304 employees; approximately one third of employees in the commodities of interest) and this provided information about the distribution of occupations across all of the commodity groups. For each year from 2008 to 2020 the projected total level of employment in each commodity grouping was distributed across the six occupational classifications in the same proportions. The results of this survey are provided in Table 10 which includes, for comparison, the results of the Argus report[1] Survey. The Argus Report occupational distributions were based on all mining commodities and, in addition, included oil and gas. The NILS 2006 survey of mine occupational distributions shows that there are significant differences in these distributions between commodity groups. We expect that these differences reflect the differing characteristic of mining activity for the various commodity groups with one of the most important characteristic being whether the mining activity is predominantly open-cut or underground.

[1] Argus Report (2004) Western Australian Development Projects: Employment Demand and Predicted Skill Requirements 2003-2007, Report prepared for the Western Australian Department of Education and Training, April 2004.

Table 10: Occupational Structure by Commodity compared to Argus Model

OCCUPATIONAL CATEGORIES	*Argus Report*	COAL	IRON ORE	BAUXITE	COPPER	GOLD	NICKEL	URANIUM	LEAD	ZINC	W/AVERAGE
Managers	*5*	9.2	4.3	0.4	4.7	1.8	2.3	0.3	1.5	1.5	4.7
Professionals	*25*	7.8	15.2	16.4	9.6	9.5	5.9	3.8	12.7	12.7	9.6
Technicians	*13*	2.6	9.6	12.6	4.5	2.2	3.1	1.5	5.9	5.9	4.5
Tradespersons	*21*	26.0	22.9	10.4	42.0	64.6	77.4	84.2	72.0	72.0	42.0
Semi-skilled workers	*32*	49.9	43.8	32.0	30.9	10.8	8.9	0.5	3.7	3.7	30.9
Labourers & related workers	*4*	4.5	4.3	28.2	8.3	11.1	2.4	9.8	4.4	4.4	8.3

Note: Lead and Zinc were calculated together since we received raw data for the commodities in combined form only.

5.2.3 Projecting demand for resource employees

As described above, commodity output forecasts were supplied by Access Economics. These projections were in the form of annual estimates of physical output for commodities by Australian state from 2007 (or earlier) to 2020.

To project labour demand from the 2007 base year, annual growth rates were calculated from the Access Economics output projections for 2008 to 2020. These growth rates were then applied to the 2007 base year employment figures to obtain projected employment by commodity, by state to 2020. Next, the by-commodity occupational distributions from the 2006 NILS survey were applied to the by-commodity, by-state aggregates to derive employee demand projections by occupation, by commodity, by state to 2020. From this data the summary tables in Section 3 were generated.

5.3 Projecting employment by occupational classification

5.3.1 Projecting employment by occupation: concepts and limitations

It is appropriate to begin this section on projecting employment by emphasising some fundamental conceptual and empirical limitations to such an undertaking. The first comment regards the interpretation of projected employment levels as the supply of labour. Since we have projected demand in six occupational categories, we would ideally like to have data for the supply of labour in corresponding categories. If we had two such sets of projections it would be possible to draw conclusions about the occupational classifications that are likely to experience the largest gaps between demand and supply.

However, there are conceptual limitations on the extent to which employment levels can be interpreted as the supply of labour. For example, for occupational categories that require lower levels of qualifications, what are the criteria for determining whether persons are included in a particular occupational category? Take, for example, the occupational category "unskilled workers". By definition almost any worker qualifies to work in this category. Should workers with, say, higher degrees or many years managerial experience be included in the supply for this category? Probably not, but where precisely should the cut-off point in terms of qualification and/or experience be? This conceptual problem places a significant limitation on our ability to meaningfully define supply.

Another complication, which is primarily empirical, is that employment data cannot be relied upon to indicate labour supply because the "short side dominates". This means that in situations where there is an excess supply of labour (demand is "short") measures of employment will reveal demand, and the excess supply will be manifested as unemployment. In situations where there is excess demand for labour (supply is "short") supply will be measured in the employment statistics (because some employment vacancies will remain unfilled). This means that observed numbers of employees cannot be relied upon to indicate the supply of labour.

Having stated these two caveats, our pragmatic approach is to use the numbers employed historically in each occupational category as a projected *indicator* of the labour market's capacity to respond to demand growth and thereby identify in what occupational categories supply bottlenecks are most likely to occur.

5.3.2 Differences between the 2006 and 2008 projections

There are some differences between the results of the 2006 and 2008 employment by occupation projections. This section discusses the reasons for these differences and provides guidance on interpretation.

One of the main differences between the two sets of projections is that the 2006 projections were undertaken for the ASCO 6 level-1 occupational categories whereas the 2008 projections were based on the ASCO 9 level-1 occupational categories. The 2006 projections excluded the 3 level-1 categories that are largely irrelevant to the mine sector of the mining industry – only a very small proportion of employment at mines fall into these occupational categories.

In addition, given the relatively short timeframe that was available to calculate the projections in the current study, 10-year age intervals instead of 5-year were used. In

2006 the projections were developed for every state and these were added to derive the Australian totals. In the 2008 projections, aggregated national data was used, which is a slightly less accurate method.

Thus, although the totals are very different, the numbers in the various occupational categories are quite close. The biggest difference within an occupational category is for 'Managers' at 4% in 2015, which is not large.

5.3.3 Outline of employment projection method

This section gives a simple description of the employment by occupation methodology. In the following section we discuss this methodology in more detail.

The basic concept behind the methodology used to project employment by occupation is to use relevant existing information about the labour force to make the projections as accurate as possible. This information includes: past trends in the occupational composition of the labour force, the current age structure of the population (and therefore the workforce) and the participation rates of workforce participants by age and gender. Age and participation rates are important because their interaction will have a significant effect on the overall number of workforce participants.

Perhaps the most simple projection technique is a simple liner extrapolation. A liner extrapolation of the number of persons in each occupational category would, however, ignore the effects of changing age composition and changes in gender balance which can be projected with a good degree of accuracy. Thus the projection technique used for the occupational projections in this study is *non-linear* and incorporates information about the likely future age and gender structure of the workforce and their impact on participation rates.

Employment share projection: technical methodology

The class of functions called growth curves or S-shaped curves is motivated by the fact that rates must be in the range [0,1] and therefore cannot grow as polynomials or exponentials. We find the curve that best fits the historical data and extrapolate along this curve under the assumption that the present trends capture the sum of the effects of diverse factors and will continue to do so in the future. These are 'Richards' Curves. 'Richards' curves are used in projections of employment share changes in occupations as well as within mining industry. With 'Richards' curves it is possible to model any growth in the sigmoid form and distinguish the three phases that underlie

these evolutions: emergent, inflexion and saturation, as well as the periods of expansion and contraction of economic phenomena.

The occupational employment shares for each occupation and for each age group were modelled as 'Richards' curves. These shares were predicted separately using non-linear least squares techniques applied to data on the level of employment in each of the main occupations, by age. Projections directly focused on finding the best fits of 'Richards' curves to the available data comprising the employment share for each occupation and for each age group. The projected employment shares for each occupation and for each age group were applied to the predicted overall employment and disaggregated employment by age group to compute the absolute numbers of employed persons in each occupation and in each age group. Similarly, the shares and numbers of employment in 2-digit mining industries and by age group were projected using the same projection techniques. The 'Richards' functions take the form:

$$y_t = c + a \times (1 + be^{gt})^{\lambda} \qquad [1]$$

Some restrictions were set up over the parameters $a+c$, b, c, g, and lambda (λ). The reason is that the limits at upper and lower infinity are $a+c$ and c, so that in constraining these to [0,1], which ensures that the curve stays in this range, b is also constrained to [0,1]. Lambda is constrained to [-1, -20], g is constrained to either [-20,0] or [0,20], depending on whether the curve is nominally increasing or decreasing. The ceiling ($a+c$) is the maximum occupational level either attainable in the past and present economic paradigm or to be reached in the future, whilst the floor (c) represents the minimum level, which might have been reached in the preceding paradigm or may be reached in the future. 'Richards' curves for each occupation or industry and for each age cohort have different coefficients, reflecting dynamics of occupational evolution and disparities in the employment experience and conditions of people involved in the occupations or industry. The changes and parametric values vary by occupation or industry and by age.

Data and sources (National economy-wide Labour Market)

The outcomes of the projections of the Productivity Commission (PC) and labour force survey data from the Australian Bureau of Statistics (ABS) are utilised extensively as data sources for the analysis and scenario constructions of projections in this chapter. The main data and sources used include:

Population and labour force projections (including civilian population, participation rates, and unemployment ratio) for Australia from 2004 to 2051, sourced from the website of the Productivity Commission, http://www.pc.gov.au/study/ageing/finalreport/data/index.html (accessed 10 October 2005); and

Data files "E07–Employed persons by sex, occupation, age, status in employment" and "E05–Employed persons by industry subdivision, sex, age, status in employment" from the ABS Labour Force, Australia, Detailed – Electronic Delivery, Quarterly (cat. no. 6291.0.55.001);

As longitudinal data on the size and distribution of labour supply or employment outcomes of people working in the six occupations are lacking, we used synthetic cohort datasets. These were derived from the quarterly data file "E07–Employed persons by sex, occupation, age, status in employment" from the ABS Labour Force, Australia from August 1996 to August 2005.

The derived data were used to develop the projections of occupational employment shares. 10-year-age groups were used for the projections. The interpolated age groups of datasets laid the basis for cohort analysis. The calculated annual employment in occupations across the period from 1996 to 2005 for Australia was smoothed using a Hodrick-Prescott filter. In doing so, the statistical noise of the original data was largely removed, revealing the general trends of employment shares by age group in the long run.

6 Appendix 1

2007		NSW	Vic	Qld	WA	SA	Tas	NT	TOTAL
All commodities	total	16614	1574	43139	53923	5214	1347	2566	118494
	open cut	6799	911	21727	1642	340	270	811	32500
	underground	7360	0	4965	427	3032	734	630	17150
Coal	total	13060	911	21400	771	220	78		36440
	open cut	6550	911	17081		220			24762
	underground	6510		4319			66		10895
Bauxite	total			11248	8398			1200	20846
	open cut			700	1020			75	1795
	underground								
Copper	total	685		5899	688	1950	250		3040
	open cut				573				573
	underground				115	2163	189		2467
Iron ore	total	356			16594	250	444		17644
	open cut					120	270		390
	underground	356							356
Lead	total	256		930	568	18	50	50	1872
	open cut	65		930	49			50	1094
	underground	117			17		32		166
Zinc	total	792		2311	2523		221	336	6183
	open cut	184		2311				336	2831
	underground	378			295		143		816
Nickel	total				11738				11738
	open cut								0
	underground								0
Uranium	total					2098		350	2448
	open cut							350	350
	underground					191			191
Gold	total	1465	663	1351	13192	678	304	630	18283
	open cut			704					704
	underground			646		678	304	630	2259

Key for data sources.
Note cells with a bold border are figures from the 2006 NILS study. These figures by commodity and by state were higher than the figures that could be established for the 2008 study. For further detail see the discussion in Section 5.2.1.

	Safety performance in the Western Australian mineral industry http://www.docep.wa.gov.au/ResourcesSafety/PDF/Reports/Industry%20performance%20reports/SafetyPerformance_20.pdf
	The Queensland Mines and Quarries Safety Performance and Health Report 2005-2006. http://www.dme.qld.gov.au/zone_files/publications/annual_report0506.pdf
	2007 - NSW Minerals Council - State of the Industry Report 2007http://www.nswmin.com.au/__data/assets/pdf_file/0007/8638/MIN101_IndRep_Text_FA63.pdf accessed 23/04/08 Loise 02 4931 6666 Martin Atkin HR Director - NSW Minerals Council -
	http://www.alcangove.com.au/home/content - Bauxite/alumina data source 2000 Bauxite: Aluminium and the Australian Economy A Report to the Australian Aluminium Council may 2000
	Annual Review 2003/2004 Mineral Resources Tasmania Lead/Zinc 234
	Numbers from Minelist 2008 distributed acorss Lead and zinc in proportion to the 2006 distributions
	Single mine for SA Lead Zine Silver
1950	Olympic Dam employees split evenly between SA Copper and Uranium mining