RESOURCES AND INFRASTRUCTURE

Industry Workforce Analysis and Forecast

skillsDMC

DRILLING • MINING • QUARRYING • CIVIL INFRASTRUCTURE

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EXECUTIVE SUMMARY

Objectives

The *2016 Resources and Infrastructure Industry Workforce Analysis and Forecast* is produced by SkillsDMC, a global leader in developing workforce strategies and defining competency standards in the Resources and Infrastructure Industry. The document provides information and reasoned forecasts regarding the Australian Resources and Infrastructure Industry's current and future skilling needs, challenges and opportunities. It also aims to prepare Industry, governments and the Australian National Training System via a robust and informed understanding of the issues facing the Resources and Infrastructure Industry Sector, and the likely path of demand for the Sector's diverse skills base. In effect, this report serves as a long term planning document for the rapidly transitioning Resources and Infrastructure Industry, and to prepare Industry participants for both the challenges and opportunities ahead.

The report utilises original research and forecasts to predict the skills demand for key occupations in the Resources and Infrastructure Industry, based on the outlook for Industry investment, production and the analysis of the existing skilled workforce. In effect, it provides a rigorous and, importantly, quantifiable measure of the magnitude of potential workforce gaps or oversupply in the Resources and Infrastructure Industry by key occupation. There are considerable ramifications for the continuous improvement of the Resources and Infrastructure Industry competency frameworks and training service providers in response to the skilling needs of Industry.

Key findings and messages discussed in this report are:

- **The current period is characterised by the transition of the mining boom from investment to production driven growth. Amid the current climate of lower commodity prices, an increased focus on productivity and efficiency will see rising demand for a higher skilled operational workforce**.
- **However, a projected downturn in mining investment and constraints on public Infrastructure investment will impact negatively on the demand for Construction-related skills in the Resources and Infrastructure Industry in the short term.**
- **The increasing use of automation within the Resources Industry is likely to result in further changes to the workforce practices and requirements. Central control centres are being developed to ensure that efficiency and productivity gains are identified, analysed and shared across 'whole of operations' within the Mining industry. Meanwhile, workers onsite will require further upskilling in the latest technology, operation supervision and maintenance.**

- **The industry is at risk of losing some of its skills base to retirement or other industries over the next few years as market conditions have deteriorated. It is critical the industry continues to invest in skilling the workforce through the entire course of the cycle to ensure capacity is there when conditions improve and activity rises. The period from 2018/19 to 2021/22 is identified as a period of risk.**
- **Opportunities to improve industry capacity are available. Greater inclusion and participation of female and Indigenous populations can have a very positive beneficial impact on securing long term labour supply.**

The Resources and Infrastructure Industry continues to be a key driver of the Australian economy, often at the forefront of intense policy discussions across governments, the media, and various associations and stakeholders. Through capacity-enhancing investment activity, workforce requirements are determined and consequently should be met by a pool of appropriately skilled employees and contractors. These Industries also undergo productivity and efficiency changes and as a result are frequently in the forefront of industry dynamics that lead to changes in workforce requirements.

The Resources Industry has a substantial impact on the Civil Infrastructure Industry via the need to build and maintain related infrastructure assets; from 'pit to port' infrastructure that includes railways, ports and harbours, roads and the additional requirements for water, sewerage, pipelines, energy and telecommunications. Consequently, a strong positive relationship exists between the Resources and Civil Infrastructure Sectors, and this relationship is expected to continue as Australia experiences further cycles in public and private investment.

However, the challenges for the Resources Industry have worsened with the current decline in commodity prices, which have fallen in response to slower growth in demand and strong increases in supply from low cost producers. As a result, supply fundamentals will continue to impact the current weaker demand environment to constrain commodity prices. In addition, the completion of major projects over the next few years will exceed the value of new commencements, leading to the downturn

in mining and related infrastructure construction – with implications for the Civil Construction sector as a whole. In the meantime, publicly funded civil infrastructure investment is also curbed by restrictions on budgets, which has subsequently reduced public funding for projects.

The commodity price boom in the previous decade drove investment to record levels, enabling industry transformation to larger and more complex operations. However, under the current low price environment, producers are now focused on balancing costs and capability. This new period of transition is also expected to provide opportunities for various groupings within the workforce to undertake further training and upskilling based on the requirements of newer and more efficient operations. Additionally, the transition time becomes critical, allowing an opportunity for the workforce to retrain and upskill on the theoretical and practical aspects necessary to meet new workforce requirements. It is expected that a skilled, versatile and agile workforce will be well placed to meet the demand during the structural changes within the Industry. Rising competitiveness will also be an undercurrent to the transformation to an efficient operation.

Technological advances, automation, along with greater inclusion of females and the Indigenous population in mining operations will ensure that Australia maintains a leading position as a key exporter in global commodity trade. This has significant ramifications for the future planning of skills demand, where a part of the broad toolkit of solutions will be to increase the pool of skilled workers.

The findings in Section 3 of the report identify a skills surplus in the short term (i.e. a negative skill deficit). However, participants in these labour markets will make adjustments if unemployed for a significant period and, as such, there is a substantial risk the industry could permanently lose some of these skills. **The loss of these skills could leave the industry vulnerable when conditions begin to improve and there is an upturn in activity. It is critical the industry continues to invest in skilling the workforce through the entire course of the cycle to ensure capacity is there when industry conditions improve.**

SECTION ONE: CURRENT MARKET OUTLOOK

– Resources and Infrastructure Industry

Industry overview

The Resources and Infrastructure Industry experienced significant growth over much of the past decade. A sharp increase in commodity prices (mainly due to increased demand from emerging Asian economies) led to a mining investment boom. Engineering construction activity in Australia reached a peak of $130.8 billion in 2012/13 (all figures are in 2013/14 constant prices), around 189 per cent higher than the 2004/05 total[1].

Resource construction in Australia was mainly driven by investment in coal, iron ore and liquefied natural gas (LNG) projects. The resource investment boom also included a significant increase in the amount of work done on associated infrastructure (mainly railways, ports and gas pipelines). Also during this period, road construction accelerated, underpinned by major projects, and investment in the utilities (electricity, water and sewerage) also increased significantly.

The decline in commodity prices, particularly since 2013, led to a number of changes, mainly impacting exploration, investment and employment levels. Company revenues and profits suffered. A number of new projects were deferred as feasibilities deteriorated. The lower revenue environment forced producers to reduce operating expenditure, which often included cutting workforce numbers and implementing structures to increase efficiency and productivity. Marginal mining operations have been placed on care and maintenance.

Iron ore and coal investment started to decline significantly after 2012/13, but overall mining and heavy industry construction held up at strong levels due to major LNG projects, most of which started prior to 2013. Mining and heavy industry engineering construction levels peaked in 2013/14 at $60.9 billion, and then declined by 12 per cent over 2014/15[2]. The decline in the resources sector has also led to a significant fall in related civil infrastructure projects over the two years to 2014/15, particularly in the railways and harbour sectors. Electricity and road construction also fell significantly over this period.

As the current round of LNG projects reaches completion, mining and heavy industry construction is expected to fall to $18.9 billion in 2018/19, 65 per cent below the 2014/15 level[3]. The expected increase in roads, public railways and telecommunications construction over the medium term will not be able to offset the decline in the resources sector. Total engineering construction activity is forecast to fall to a trough of $75.4 billion by 2018/19, around 30 per cent (or $32.6 billion) below 2014/15 levels [4].

1 Australian Bureau of Statistics (2015), *Engineering Construction Activity, Australia September 2015,* ABS catalogue no. 8762.0, http://www.abs.gov.au/AUSSTATS
2 Australian Bureau of Statistics (2015), *Engineering Construction Activity, Australia September 2015*, ABS catalogue no. 8762.0, http://www.abs.gov.au/AUSSTATS
3 Australian Bureau of Statistics (2015), *Engineering Construction Activity, Australia September 2015*, ABS catalogue no. 8762.0, http://www.abs.gov.au/AUSSTATS
4 Australian Bureau of Statistics (2015), *Engineering Construction Activity, Australia September 2015*, ABS catalogue no. 8762.0, http://www.abs.gov.au/AUSSTATS

While investment is forecast to decline significantly over the next few years, mining production is expected to keep rising. The completion of the current round of projects will continue to add to output (more than offsetting the closure of marginal mining operations), with production expected to grow by a further 30 per cent to $182 billion in 2019/20[5].

The shift in the composition of Australia's engineering construction industry will ultimately have consequences for the demand for skills and human resources. As mining and heavy industry construction falls—which in 2014/15 accounted for a little less than half of overall engineering construction activity—the sector will become a smaller share of total activity. It is expected that, by 2016/17, mining and heavy industry construction will account for just over a quarter of overall engineering construction. Section Two investigates the trends that are likely to emerge and the impact this will have on the demand for human resources, skills and training.

It is noted that the most recent declines in commodity prices have been more severe than anticipated. As a result, in the wake of the changes to the demand and supply fundamentals, BIS Shrapnel's commodity price and investment forecasts have been revised downwards when compared to a growth outlook analysis developed in 2014. However, mining production is still expected to grow strongly over the next five years, as new projects reach completion, more than offsetting the closure of smaller mining operations.

Commodity prices

Commodity prices are one of the key determinants of investment within the industry. The current climate of low commodity prices is set to continue in the short to medium term given the poor demand environment driven by a slowdown in China and an increase in production across several commodities.

Most metals and energy prices peaked during 2011, and have fallen sharply since then. Global crude steel production weakened and demand for energy slowed while supply has increased significantly. Base metal prices have also shown relative weakness throughout 2015 as the systemic impact of a demand slowdown and robust production levels from low cost producers weigh down prices.

Iron ore price momentum has been trending downwards, extending the declines from the 2014/15 financial year to end 2015 at a low of below $US40 per tonne—levels not seen since May 2009[6]. The low iron ore prices are expected to persist owing to the rapid increase in supply from Australia's Pilbara operations, and a marked decline in demand from the largest consumer, China. Iron ore prices are forecast to remain low

5 Australian Bureau of Statistics (2015), *Australian National Accounts: National Income, Expenditure and Product*, 5206.0, September 2015, ABS catalogue no. 5206.0, http://www.abs.gov.au/AUSSTATS

6 BIS Shrapnel (2015), *Mining in Australia 2015-2030*, North Sydney

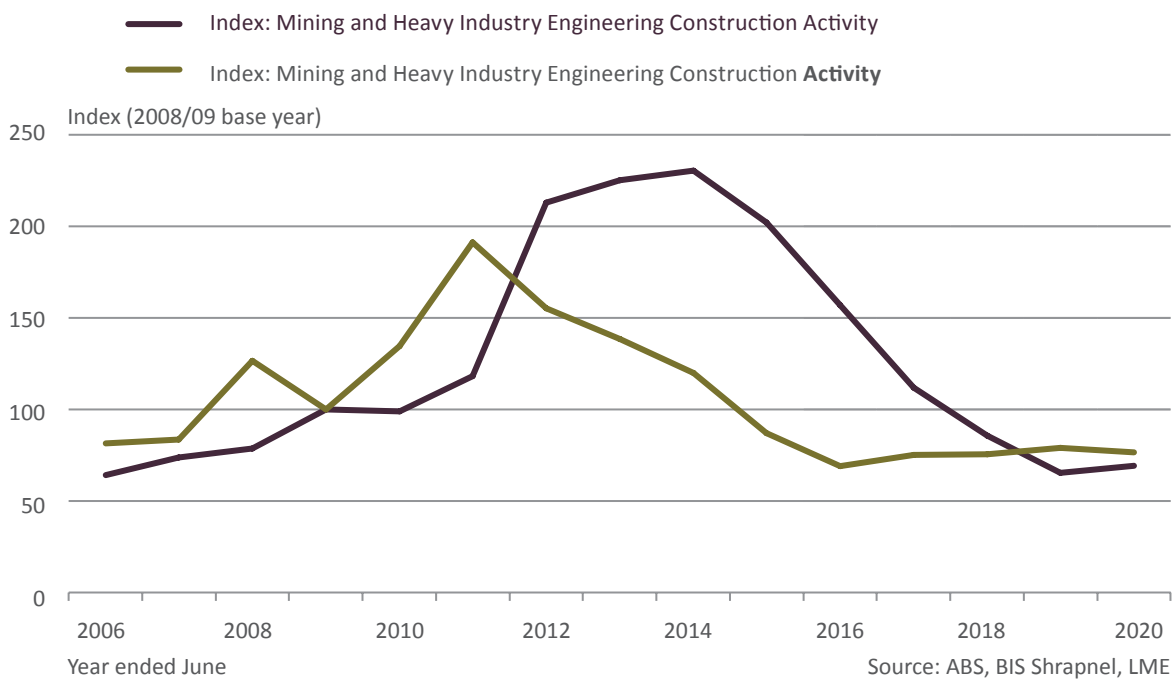
over the next three years, and will only start rising once global steel production grows strongly towards the end of the decade.

Both thermal coal and metallurgical coal have also fallen in price, progressively continuing to decline since 2011. Low coal prices are expected to remain and the industry faces pressure to reduce costs further. Thermal coal prices are expected to remain subdued over the medium term as growing supply and the rise of alternative energy sources continues to carve up a larger portion of total energy composition. On the other hand, metallurgical coal prices are set to increase gradually to 2019/20, as global steel production levels recover.

In the oil sector, strong growth in global oil production (and the expectation of further growth) has placed significant downward pressure on prices, which have fallen to the lowest levels in a decade. It should be noted that oil prices are important for Australia's LNG sector, as LNG prices in the Asian region are linked to oil prices. Since mid-2014, the price of oil has fallen by 68 per cent (based on the West Texas Intermediate). Oil prices continue to be sensitive to political instability in a number of OPEC countries and the uncertainty is likely to persist as Iran emerges as an oil exporter and unconventional production continues in the US.

Base metals prices have also been impacted by the systemic downturn in the commodity market, finishing 2015 at depressed prices. While the demand and supply fundamentals differ for each base metal, in general, prices are expected to increase towards 2019/20, when demand is expected to gather pace.

Chart 1.1: Mining and Heavy Industry Construction and commodity prices



Source: ABS, BIS Shrapnel, LME

Investment

Mining investment has been significantly impacted by the low commodity price environment as producers curb costs and reduce investment. The high cost of development in Australia also contributed to the falling levels of investment since 2012/13.

Initially, the investment downturn was led by the coal and iron ore sectors. These commodities have seen major expansion plans (committed at the top of the price cycle) run their course and become operational just as prices started to fall. The declines were accumulated as falls in the price of base metals reduced investment within the mining industry further. Investment within the mining and heavy industry sector fell to $53.4 billion in 2014/15, down 12 per cent from the peak in investment the year prior.

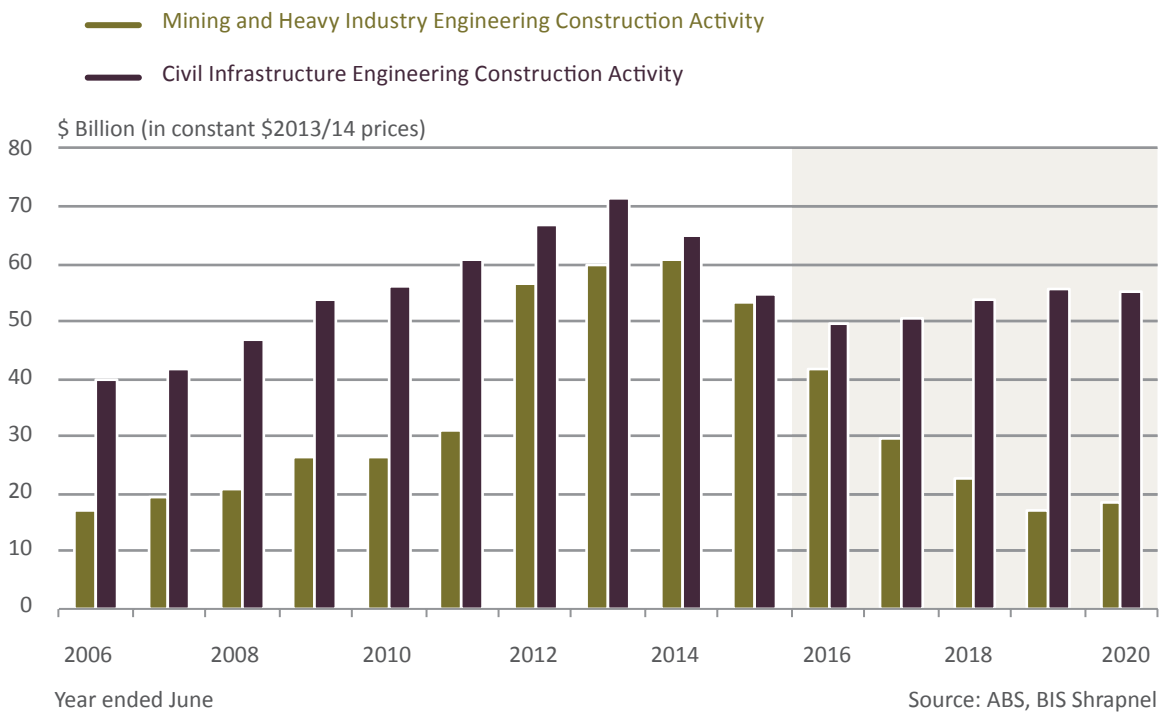
As the major LNG projects (collectively worth around $175 billion) reach completion over the next three years, further declines are expected in overall construction. While the depressed commodity prices are expected to persist over the short term, developments within the industry will be hinged on economic growth in Australia's trade partners. The slower economic growth in China has dampened prospects in the short term for the resources industry. It is forecasted that mining and heavy industry construction will trough in 2018/19 at $18.9 billion, around 65 per cent lower than the 2014/15 level.

Resource investment is expected to improve in the long term as rising demand in developing economies and a supply shortfall will lead to a rise in prices and investment. However, construction activity is unlikely to climb back to the peak levels seen in previous years.

The forecast decline in mining investment will continue to have a negative impact on the private resource-related infrastructure sectors of railways, harbours and gas pipelines. However, civil infrastructure construction will be boosted by projects in the roads, public railways and telecommunications sectors. Projects along the eastern seaboard of Australia will lead road investment activity, including the WestConnex, NorthConnex and Pacific Highway upgrades in New South Wales, Bruce Highway upgrades in Queensland and Western Distributor in Victoria. The largest railway projects are also in New South Wales (North West Rail Link, Sydney Rapid Transit and CBD and South East Light Rail project) and Victoria (Melbourne Metro Rail and Level Crossing Removal Program), while telecommunications will be dominated by a ramp up of the National Broadband Network rollout.

The increase in civil engineering construction activity will not be able to offset the decline in mining and heavy industry construction over the four years to 2018/19. Total engineering construction activity is forecast to fall to a trough of $75.4 billion by 2018/19, around 30 per cent (or $32.6 billion) below 2014/15 levels.

Chart 1.2: Mining and Civil Engineering Construction in Australia



Source: ABS, BIS Shrapnel

7 Australian Bureau of Statistics (2015), *Mining Operations, Australia, 2013--14*, ABS catalogue no. 8415.0, http://www.abs.gov.au/AUSSTATS

8 BIS Shrapnel (2015), *Mining in Australia 2015--203*0, North Sydney

9 BIS Shrapnel (2015), *Engineering Construction in Australia 2014/15--2029/30*, North Sydney

10 Australian Bureau of Statistics (2015), *Engineering Construction Activity, Australia September 2015*, ABS catalogue no. 8762.0, http://www.abs.gov.au/AUSSTATS

Mining production and output

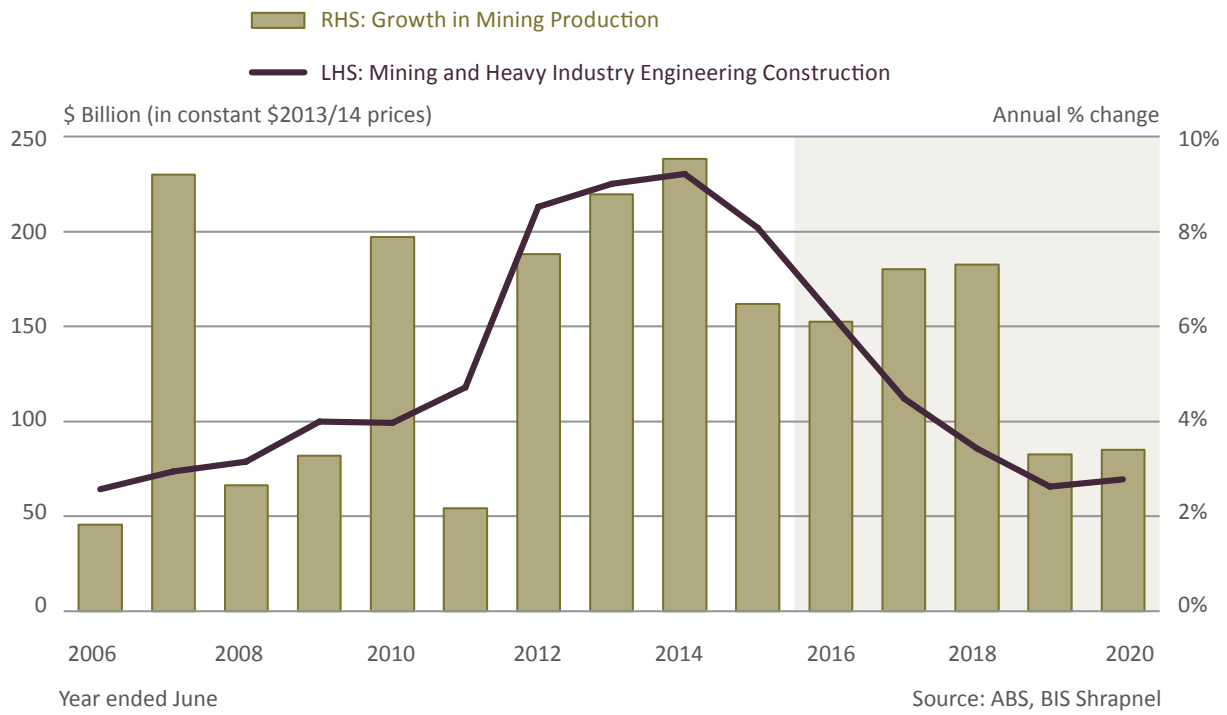
Despite low commodity prices and falling investment levels, the after effects of the mining investment boom are allowing the industry to ramp up production levels, with the value of output rising to $139 billion in 2014/15, up from $100 billion in 2009/10[11].

The completion of the current round of projects will continue to add to output, with production expected to grow by a further 30 per cent to $182 billion in 2019/20[12]. The effect of the investment boom is visible with regards to iron ore and coal extraction volumes lifting significantly in recent years, while the boom in LNG is still poised to accelerate in the second half of this decade. This acceleration is likely to make Australia the largest LNG exporter in the world by 2020.

In spite of the volatility in the commodity markets, Australia's mineral commodities still have good standing in the export markets. For example, iron ore produced in the Pilbara (Western Australia) serves as a low cost, high quality product to the steel producers in China, while Australia's metallurgical coal exports continue to dominate, accounting for 62 per cent of seaborn trade[13]. Australia's logistical network, relatively stable regulatory risk environment and close proximity to the regional trade partners ensures that commodity exports from Australia continue to remain favourable.

Iron ore, coal and LNG combined represented $109.9 billion in Australia's export revenue in 2014/15, representing 43 per cent of Australia's total exports. The mining industry as a whole exported $168.5 billion during the same period[14].

Chart 1.3: Mining and Heavy Industry Construction and Mining Production

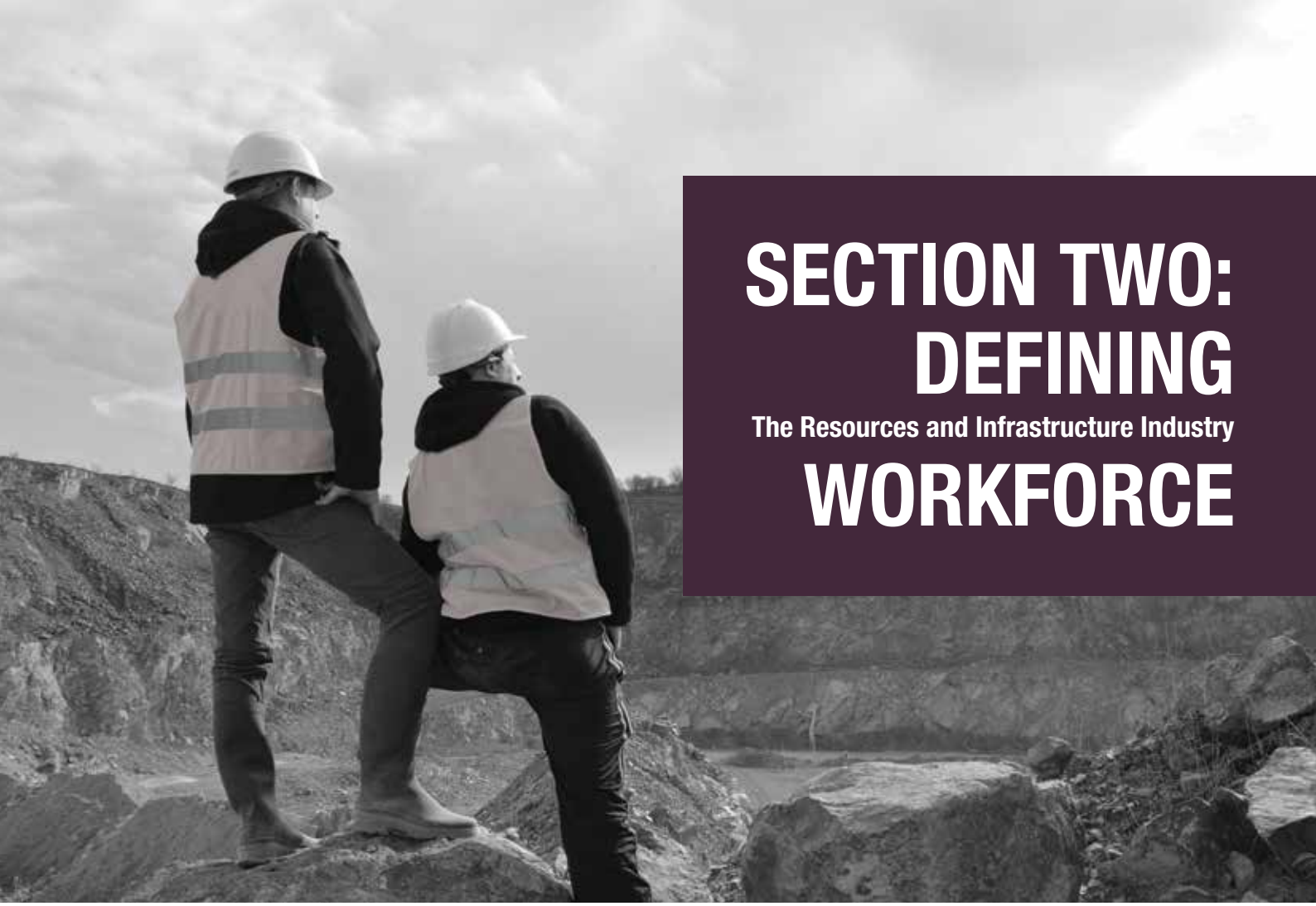


11 Australian Bureau of Statistics (2015), *Australian National Accounts: National Income, Expenditure and Product, 5206.0*, September 2015, ABS catalogue no. 5206.0, http://www.abs.gov.au/AUSSTATS

12 BIS Shrapnel (2015), *Mining in Australia 2015--2030*, North Sydney

13 Department of Industry, Innovation and Science (2015), *Resources and Energy Quarterly – December 2015*, http://www.industry.gov.au/oce

14 Australian Bureau of Statistics (2015), *Balance of Payments and International Investment Position, Australia, September 2015*, ABS catalogue no. 5302.0, http://www.abs.gov.au/AUSSTATS



SECTION TWO: DEFINING

The Resources and Infrastructure Industry

WORKFORCE

The following analysis of employment considers 'Total Mining', which is the combination of the Coal, Drilling, Metalliferous Mining and Quarrying Sectors, and 'Heavy and Civil Engineering Construction', which includes Heavy Engineering Construction in addition to the Civil Construction Sector. The analysis is conducted in this manner as the Australian Bureau of Statistics does not split employment data into the five Industry Sectors which fall under SkillsDMC's coverage.

Snapshot of employment in the Resources and Infrastructure Industry

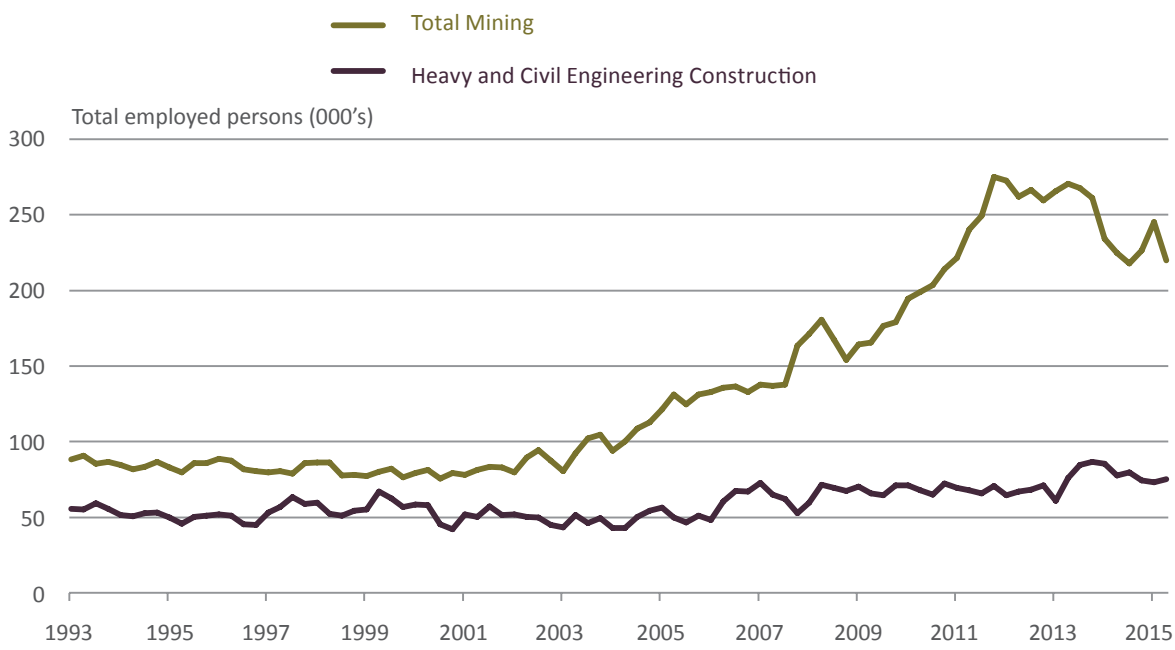
The Resources and Infrastructure Industry employed 294,000 persons as at November 2015. This composes of 220,000 in mining and 74,000 in Heavy and Civil Engineering in November 2015. Mining employment surpassed 200,000 in February 2011, gradually increasing to a record high of 275,000 employees in May 2012. Since this peak, employment has gradually trended down, falling to a trough of 218,000 employees in February 2015 as low commodity prices reduced margins for miners, forcing cost cutting measures and productivity improving strategies including rationalising its workforce.

Employment in Heavy and Civil Engineering Construction has historically been subdued, ranging from a trough of 42,000 (in February 2001) and a peak of 87,000 (in February 2014). Since August 2006, employment has gradually trended upwards.

15 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS

16 BIS Shrapnel (2015), *Mining in Australia 2015--2030*, North Sydney

Chart 2.1: Total Mining and Heavy and Civil Engineering Construction Employment

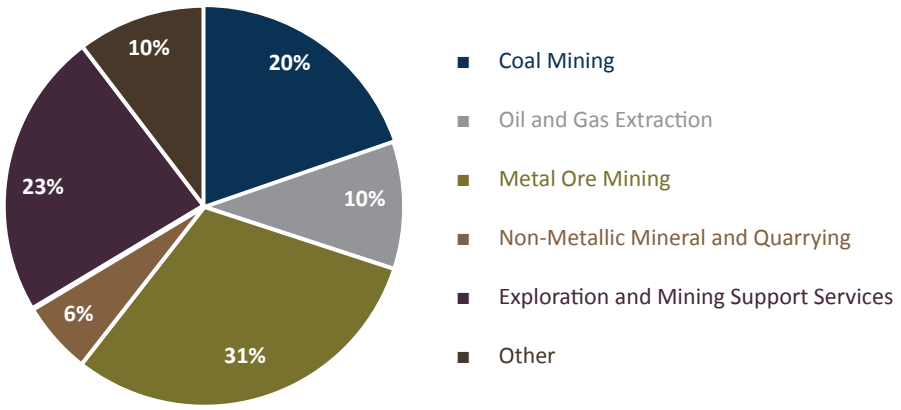


Year ended May

Source: Australian Bureau of Statistics

Metal Ore Mining continues to be the largest employment category within Mining, accounting for 31 per cent of the sector, representing 67,000 employees. This is closely followed by Exploration and Mining Support Services accounting for 23 per cent or 51,000 employees. Employment in Coal Mining comes at 20 per cent or 43,000 employees, while Oil and Gas Extraction accounts for 10 per cent of employment[17].

Chart 2.2: Total Mining employment by sub-sector, November 2015



Year ended May

Source: Australia Bureau of Statistics

17 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS

Western Australia and Queensland continue to lead all states as the largest markets for the Mining industry, collectively accounting for approximately 71 per cent of total employment within Mining. This is followed by New South Wales with 18 per cent of total Mining employment. While Mining employment generally is located in regional areas near the mineral endowments, employment within the Heavy and Civil Engineering Construction industry is typically more concentrated in urbanised areas, driven by the growth in population levels and the infrastructure requirements within each region. In-line with overall population, New South Wales and Victoria account for approximately 55 per cent of total Heavy and Civil Engineering Construction employment levels, followed by Western Australia and Queensland which combine to represent 34 per cent of the total[18].

Table 2.1 Employment by state and commodity
Year ended 2015

	State						
Commodity	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**
Coal	22,165	4,939	25,862	270	646	44	0
Iron Ore	0	0	0	551	42,196	155	0
Copper	1,577	0	2,201	2,090	1,411	23	0
Gold	2,492	470	1,126	775	12,722	144	974
Mineral Sands	0	1,485	552	717	1,848	0	0
Silver / Lead / Zinc	612	0	3,844	52	398	330	632
Other Metal Ores	0	0	628	392	4,157	53	1,484
Quarrying	1,287	1,978	3,171	873	4,513	277	156
Oil and Gas	0	4,273	678	1,443	15,873	0	3,041
Drilling/Exploration	739	105	3,096	1,418	8,633	80	1,498
Total	28,872	13,250	41,158	8,581	92,397	1,106	7,785

Source: Australian Bureau of Statistics, BIS Shrapnel

Note: The Australian Bureau of Statistics reports labour force data in several publications. Due to differences in sampling, estimates of Industry employment may differ across publications. The data produced in the charts and figures above are from the Labour Force Survey which is collected quarterly. Due to the timeliness of this publication it is used here in preference to the census which was last collected in August 2011.

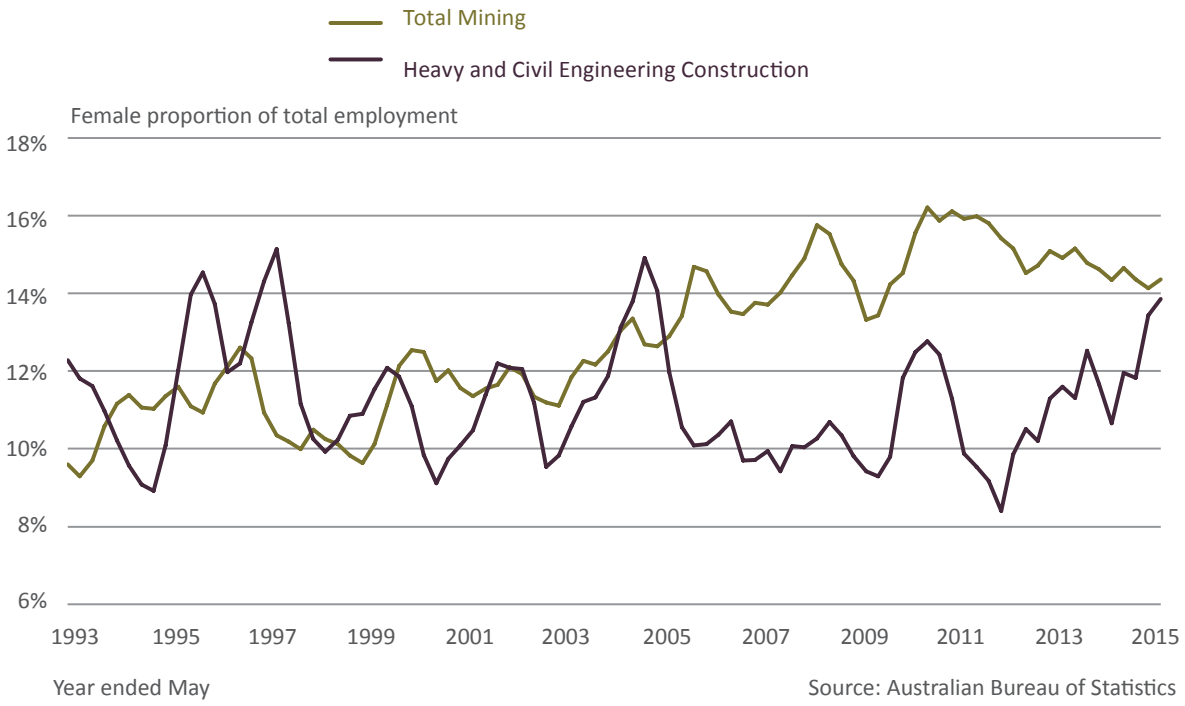
Female employment

Since the early 1990s, the proportion of females in the workforce for both Mining and Civil Engineering Construction remained within the ranges of 8 and 17 per cent of total employment. In the 1990's, the proportions fluctuated without a clear trend, however the onset of the mining boom in the early 2000s pushed the proportion of female workforce upward, reaching a peak of almost 16 per cent between November 2010 to May 2012. In fact, between 1993 and 2015, the pace of growth in female employment increased rapidly (almost by a factor of four) compared to male employment (an increase by a factor of 2.5). However, in 2015, a weaker commodity market resulted in a 15 per cent decline in total employment in Mining compared to the previous year, the first fall in employment since 2000. As a proportion, females employed fell slightly more than the males within the Mining industry with female employment declining 18 per cent and male employment declining 15 per cent against 2014[19].

18 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS

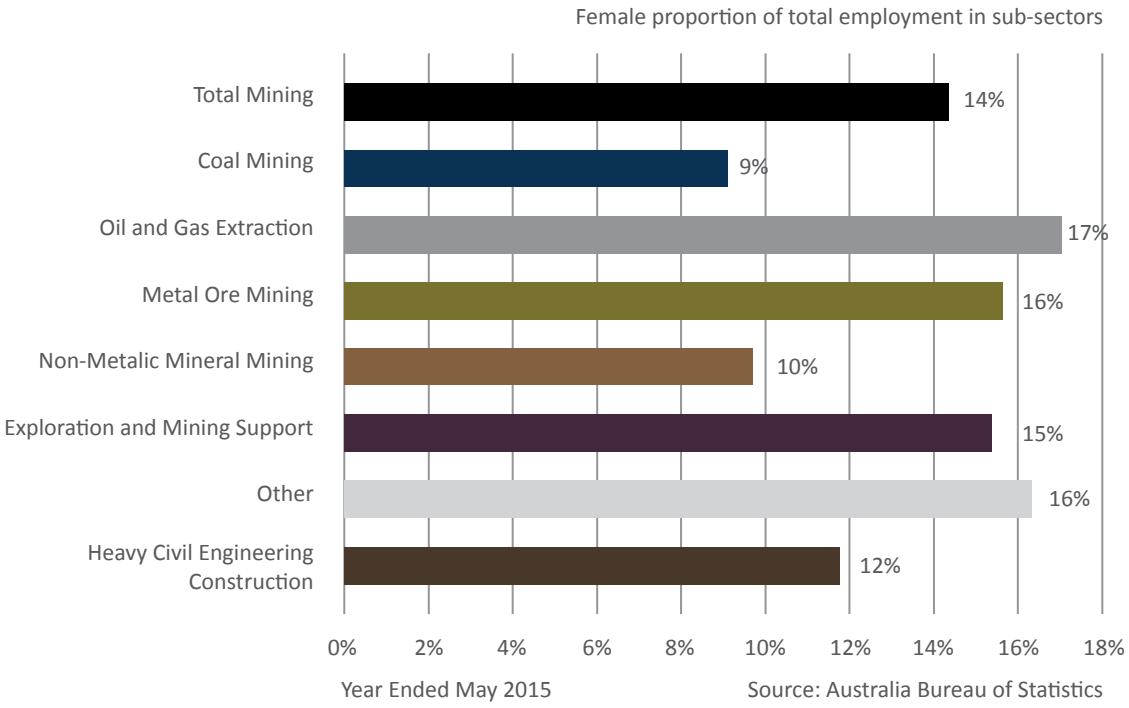
19 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS

Chart 2.3: Female Employment as a proportion of total Sector employment
Total Mining and Heavy and Civil Engineering Construction



Within the Heavy and Civil Engineering Construction industry, the proportion of females to the total workforce has continued to remain within historical ranges. Females have averaged around 11 per cent of total employment over the past two decades although percentage changes from year to year for female workers have fluctuated more than that of the male counterparts. As at November 2015, the number of females employed in Heavy and Civil Engineering Construction totalled around 8,800 – representing 14 per cent of total employment[20].

Chart 2.4: Female Employment as a proportion of total employment by sub-sector



20 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS

As a proportion of the total, female employment within Oil and Gas Extraction has remained above 15 per cent in most years since 2002, peaking in 2005 and 2013 at more than one-fifth of the total. In 2015, when the workforce employed within the Oil and Gas Extraction industry remained largely unchanged, the female workforce increased by 14 per cent from the previous period, compared to a 2 per cent decline in the male workforce[21].

Table 2.2: Female employment as a proportion of total employment by sector and type of work, Year End

	Total Mining		Heavy & Civil Engineering Construction		All Industries	
	May-15	5 year Growth	May-15	5 year Growth	May-15	5 year Growth
Full Time	13%		7%		35%	
Part Time	44%		48%		69%	
Total	14%		10%		46%	

Source: Australian Bureau of Statistics

Nonetheless, female employees within Mining and the Heavy and Civil Engineering Construction industries remain below that of Australia as a whole. As shown in Table 2.2, the Resources and Infrastructure Industry has strong levels of female participation in part time employment however, they are considerably below the national level for full time employment. From the previous year's report, part time female employment also fell in the Mining industry from 58 per cent to 44 per cent.

Indigenous employment

Historically, Indigenous Australians have made up a small portion of employment in the Total Mining and Heavy and Civil Engineering Construction industries. Indigenous employees accounted for 3.1 per cent of total employees in the Mining industry, slightly more than the 2.1 per cent in the Heavy and Civil Engineering Construction Industry[21]. While the 2011 Census data continues to be the latest official figures on indigenous employment within the Mining and Heavy and Civil Engineering Construction industries, the industry has embraced initiatives to increase the participation of Indigenous Australian though training programs.

With increased engagement with the local Aboriginal community, there will be an increase in demand for further ongoing training and education in specific fields. **Progressive mining companies are taking a long-term view on the employability of Indigenous people, particularly in terms of an increased pool for a "job ready" workforce capable of taking on full time work.** The companies are also increasing their focus on recruitment and retention by way of teaching technical competencies and other skills training including goal setting, finance and negotiation.

When compared to other industries, both Total Mining and Heavy and Civil Engineering Construction have a higher proportion of Indigenous employees in their workforce. From the population counts from the 2011 Census, the Mining Industry had the highest proportion of indigenous people to total employees. It is anticipated that these levels will be elevated given the increased engagement by miners to engage with the indigenous population.

Table 2.3: Indigenous employment, 2011 Census

	Total Mining	Heavy and Civil Engineering Construction	All industries
Categories	('000)	('000)	('000)
Indigenous employment Total employment	5 177	2 81	148 10058
Indigenous as % of total	3.1	2.1	1.5

Source: Australian Bureau of Statistics

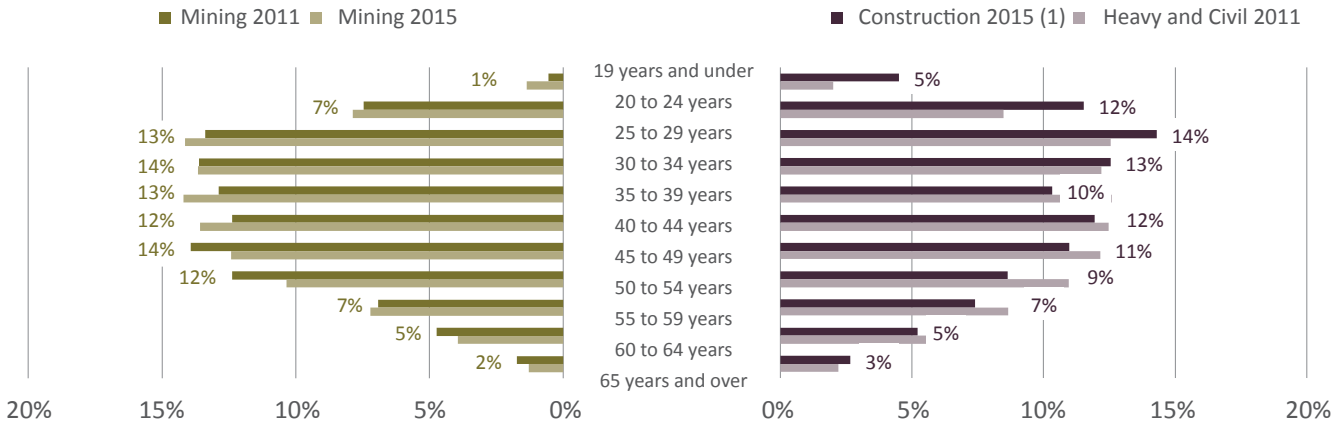
21 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS
22 Australian Bureau of Statistics (2011), *Census of Population and Housing, 2011,* http://www.abs.gov.au/AUSSTATS

Workforce age profile

The age distributions of the Total Mining and the Heavy and Civil Engineering Construction sectors share a number of similarities with respect to the 'bell distribution' that characterises the industry age profile. However, a closer look at the distribution between age categories reveals a greater resemblance between the Heavy and Civil Engineering Construction age profile and the Australian average than with Mining. For example, the 35 to 49 year age distribution within Heavy and Civil Engineering Construction accounts for around one-third of the total work force within the subsector and a similar proportion to the Australian workforce. However, within the Mining industry, the proportion jumps to 39 per cent of the total for the subsector[23].

Although the age distributions of the Mining and heavy and Civil Engineering are quite similar, the current transformation within the Mining industry could expose the industry's workforce to a greater risk of retirement and loss of skills/experience over the next 10 to 15 years. In particular, the pool of employees in the older age group could reduce further (either via retirement or retrenchment) if fewer older workers are willing to engage in upskilling or undergo training to meet new employment requirements.

Chart 2.5: Comparison of age profiles
Total Mining and Heavy and Civil Engineering Construction, Year Ended August 2015



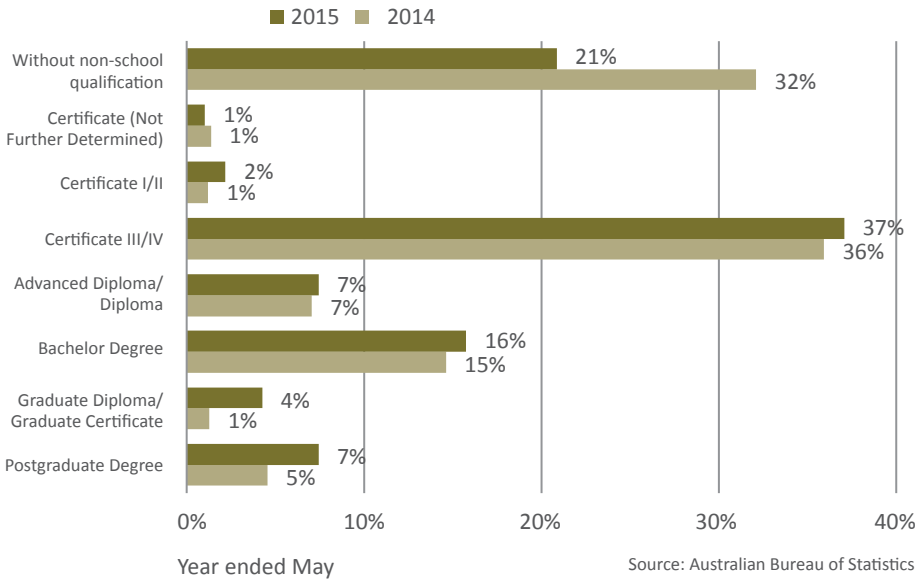
Source: Australian Bureau of Statistics

(1) Heavy and Civil is not available at this time

Education

The qualification structure of the Mining Industry is generally similar to that of Australia as a whole. Historically, employees within the Mining industry hold a higher number of Certificate III and IVs. Approximately, over 70 per cent of the Mining workforce has a non-school qualification compared with 62 per cent for both Total Construction and Australia as a whole[24].

Chart 2.6: Level of highest non-school qualification, by sector, May 2015



Source: Australian Bureau of Statistics

23 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS

24 Australian Bureau of Statistics (2015), *Education and Work Australia, May 2015*, ABS catalogue no. 6227.0, http://www.abs.gov.au/AUSSTATS

However, given the current changes in workforce requirements in Mining, there is likely to be an increased need for industry engagement, particularly with regards to the specific skill set required within the Mining industry as it moves to more efficient, technologically advanced and productive operations. An increased demand for higher level skills acquisition and data interpretation will place importance on training courses with higher numerical content. An in-depth understanding of organisational structure will likely increase in importance, particularly when awareness of "whole of mine" data sharing becomes a vital component of an efficient operation.

With respect to Heavy and Civil Engineering Construction, the breakdown was unavailable, and as such Total Construction was used instead. There is a high likelihood that Heavy and Civil Engineering Construction will have a higher proportion of degree qualified labour (including engineers) than Total Construction.

Fly-in/ Fly-out (FIFO) & Drive-in/ Drive-out (DIDO)

There is currently no formal Australia wide data on the fly-in/ fly-out (FIFO) and drive-in/ drive-out (DIDO) workforce model within the mining industry because it is not a reporting requirement for industry. This lack of information provides opportunities for future government and industry wide surveys to be conducted across all states and subsectors such that investment and policy related decisions can be made on the FIFO/ DIDO workforce model.

The FIFO and DIDO workforce model has benefitted several, mainly remotely located mining operations since the mining boom began in earnest in the mid-2000s. During the period, intra-regional and interstate FIFO/ DIDO workers were used for the construction and the operation phases of mining. The opportunity to commute allows mine producers to leverage specialised skills and resources from all parts of Australia. Longer shifts and continuous working days are common under this arrangement as are higher wages for employees under this program. FIFO/ DIDO rosters can vary in length but typical rosters within the industry usually consist of 14 days on and 7 days off with the possibility of extension on a needs basis. The communities housing the FIFO/ DIDO operators also benefitted as a result of the increased demand for basic necessities and amenities by the transient workforce.

As the construction boom winds down, there is expectation of a fall in the FIFO workforce. The FIFO arrangement has been used more widely in Western Australia than in other states. In the study conducted by the Chamber of Minerals and Energy of Western Australia (November 2014), around three-quarters of the construction workforce is expected to be under the FIFO workforce model in 2020, declining from 87 per cent in 2014[25]. The study also highlighted that around two-thirds of workers in both the construction and production segments of mining are currently under FIFO workforce arrangements. In Queensland, forecasts conducted by the Queensland Government Statistician's Office highlight that future mine development in the Bowen and the Galilee Basins could result in the FIFO model becoming the standard.

25 Chamber of Minerals and Energy of Western Australia (2014), *2015-2025 Western Australian Resources Sector Outlook,* November 2014, Perth

While the FIFO/ DIDO arrangement has benefits for producers and employees, it also places financial burden on mine producers and a heavy burden on the employees at a psychological level. Employees in the FIFO/ DIDO system often spend a lengthy time away from home and from family and friends. Mental health issues have also been raised in various studies that analyse the impact of FIFO/ DIDO operations on the employees[26]. As a result, support services such as counselling, mentoring and psychologists are expected to be employed to reduce the impact of FIFO/ DIDO operations on employees. Policies to invest in regional areas is a critical consideration for both employers and government particularly in providing funding for enhancing physical infrastructure such as in airports/ aviation, accommodation and leisure activities for FIFO/DIDO workforces.

The future of the FIFO/ DIDO arrangements will be balanced between the economics of funding them in an increasingly cost efficient environment, and the need for skilled human resources during a period of increased production. In the current environment of weak commodity prices and the slow growth in demand for minerals and energy, the financial burden could reduce the demand for the FIFO/DIDO workforce model than there has been in the past. In addition, future workforce restructuring and employing skilled local residents could be an option impacting negatively on the FIFO/ DIDO model, provided sufficient training and support is available to residents to increase employability and retention.

Robotics and automation in mining

Mining companies are currently undergoing a wave of innovative changes by shifting to more efficient, cost effective operations. With the weak outlook for commodity prices, the shift has gathered momentum. One of the key trends developing is the implementation of automation in operations. While the shift to automation is in its early stages, there is potential for long term effects on the workforce, particularly with respect to the requirements at mine-site and the demand for new skill sets.

While all miners look to reduce their costs, automation and other robotic applications in mining are not necessarily the solution for all operations issues. These technological advances can be more applicable in larger, more remote operations and thus, the current transition into automated operations are pioneered by the companies that have large operations – particularly the bulk commodity operators such as Rio Tinto, BHP Billiton and Fortescue Metals. With the rapid flow of information within the industry globally, best practices and new methods of efficiency and productivity gains are likely to be adopted rapidly. Automation allows for real-time monitoring, enabling operators to be proactive rather than reactive to emerging operational situations. Automation and robotics are being adopted in the following areas:

26 Legislative Assembly, Parliament of Western Australia (2015), *The Impact of FIFO Work Practices on Mental Health, June 2015*, Parliament of Western Australia, Perth

Automated Haulage Systems	Automation of trucks and trains allows for continuous operations to increase productivity
Materials Handling	Allows increased throughput and increased safety measures. Automatic conveyor monitoring and implementation of predictive maintenance.
Robotic Extraction Point Profiling	Allowing measurements and readings to be sent to a control centre in an accurate way, reducing risk of injury, and easily replicated.
Site surveying	Where feasible and efficient, surveying is being done with drones. Drones replacing scaling up scaffolding during inspections, while underwater oil and gas sector is benefitting with subsea drones during operations and inspections.
Lab automation	The collection of samples and internal assay testing on the quality of the product, increasing accuracy and 'just-in-time' measurement.

The data output and the creation of central commands creates the need for additional workforce capability in interpreting the data. For example, both Rio Tinto and BHP Billiton have established command centres located remotely from the site of operation in the Pilbara. In fact, Rio Tinto highlights the mix of "people and technology" in its Mine of the Future Program as a testament to advancement in automation and the importance of people in the modern, technologically advanced operation. The Program was initially launched in 2008.

Additionally, Rio Tinto, BHP Billiton and Fortescue Metals are also automating haulage services which is expected to increase the number of 'data points' being recorded at central command. Inevitably the process of collecting, interpreting, analysing and actioning this additional data point will require the employment of skilled professional. As a result, it is expected that as the large miners increase automation in operations, human capital with developed skills will need to be employed to process information.

Training and regular skilling will become a necessary factor for miners with the increase in automation. While there are positives for miners in terms of efficiency and increased productivity, indirectly, there is likely to be an increased demand for other jobs.

- **Technicians installing control systems and simulation systems** – These include sensors and equipment to control drones. The move to centralised control rooms enables the mining companies to operate multiple mines out of one room, increasing standardization across operations.
- **Information management professionals** – Upskilled employees will assist in managing big data and training in the protocol for the escalation of processes. There will also be a demand for professionals skilled in facilitating the sharing of information that integrates mining pit-to-port.
- **Data analysis (skilled technicians)** – An increased demand for technicians skilled with analysing data. For example, the timely capture of data will allow targeted drilling as per the mine operation. It also enables quality control, increased productivity, data management, and compliance with product and environmental safety standards.

- **Modellers** – Involved in the interpretation of empirical data and capable of adopting predictive modelling to forecast future trends. This will ensure that the mine operations are proactive rather than reactive.
- **Decision makers** – Decision makers take action and management decisions based on the analysed data.
- **Mechatronics trades** – These include the operation of drones and sophisticated machinery.

At site, employees with experience in maintenance will still be needed despite the increase in automated operations. However, given the centrality and interconnectedness of operations, employees will likely be required to upskill and up-train in related aspects of operations. For example, at the laboratory, automation will allow greater accuracy in sampling while taking a smaller number of samples. While live data is transmitted, lab technicians will still need to be at the laboratory and be capable of intervening in the collection process should there be a breakdown or malfunction. A similar example could be had with accurate geological analysis in accordance with mine planning.

Other job categories could also increase in demand. With mining companies engaged in skilling staff in-house, demand will rise for internal training programs and cross skill training to expand 'know-how' and information sharing within the company.

Benefits of automation pertaining to employment include:

- 'At-port' efficiency gains through automation will see ships load and discharge cargo more efficiently;
- Automation could increasingly be used to meet customer requirements, including "just-in-time" blending, the mixing of ores from different pits to meet agreed quality standards; and
- Environmental requirements being met through the use of drones to measure and collect real time data.

Trends in contract mining

Mining contractors are used widely in the mining industry across the world and engage in such tasks as load and haul, drill and blast, grade control and exploration drilling. Contracting companies are also used for maintenance of mines, both at regular intervals and the more extensive shut down operations periodically. Both forms of mining contracting have become highly contested business activities in Australia and overseas as a result of rapid increase in minerals production.

The scope of contracted works vary from individual tasks on the mine site to the entire mining operation. Mining operations can utilise contractors for a variety of reasons, including to:

- Reduce risk;
- Access specialised expertise;
- Reduce capital investment in machinery;
- Achieve greater flexibility; and
- Resource (in terms of labour and equipment) rapidly increasing levels of mine production.

These benefits become increasingly more important during periods of strong commodity price movements. During upswings in commodity prices, contractors tend to fare well as new mines attempt to ramp up quickly. Likewise, in downswings, contractor head-counts decline just as rapidly to reduce costs or suspend operations.

Until relatively recently, the strong commodity prices driven by Asian demand resulted in a once in a generation mining investment boom that has led to a considerable lift in contract mining in Australia over the past decade – doubling in size during the period to an estimated $12.5 billion in 2014/2015[27] (in constant 2012/13 prices). During this period, contracting activity has experienced some volatility, positively impacted by the rise in commodity prices and the large escalation in mining production that, more recently, operations have started to revert to in-house teams as poorer market conditions prevail.

Over the next five years, contract mining is expected to rise approximately 17 percent to $14.6 billion in 2019/20 (in constant prices), driven by expanded output in the oil and gas and iron ore sectors. The biggest increase is likely to come from LNG related contracts as the major LNG projects start production and gas related drilling operations expand. Iron ore contract mining is expected to grow at a moderate to strong pace over the next three years as production levels continue to rise from the major miners ramping up their Pilbara operations to capacity. On the other hand, coal contract mining is expected to grow at a weak to moderate pace over the forecast horizon. Contractors are an important part of the mining industry, helping fill positions for jobs that cannot be completed by in-house workforces. As a result of the increasing cost pressures on producers (where wages can account for more than 50 per cent of mine costs), contract miners see opportunities to renegotiate labour contracts to ensure future competitiveness.

The cost pressures on contractors have also been brought about by the renegotiation of terms mid-contract. The remaining contractors offer attributes such as low cost operations, high level of speciality and having resources within close proximity to the operations. With the ad-hoc or project based nature of contracting, capabilities are increasingly required to be updated and meet industry safety standards. These high standards are basic requirements that need to be met by contractors in order to gain a place on the tendering panels from which the most suitable contractors are appointed. The inclusion of sophisticated technology and the increasing complexity of mining operations, adds to the importance of regular upskilling and training within the contract mining industry.

27 BIS Shrapnel (2015), *Mining in Australia 2015-2030*, North Sydney
28 Safe Work Australia (2016), *Australian Workers Compensation Statistics, 2013-14*, Canberra

Contractors in a global context

Mining contractors have expanded their operations across various regions globally. They provide expert knowledge to various industries including mining. The international scope of the operation allows contractors to shift focus to other mining regions should market conditions become uneconomical in any particular region. The international network of operations also allows global mining contractors to source expertise globally and in turn learn from the unique operational challenges that face mining extraction, which can then be shared across other operations.

Acquisition of local mining contractors is offering opportunities for contractors to bridge project specific knowledge and skills gaps and gain exposure to various mining regions around the world. This arrangement also has the potential to bridge other operational challenges such as engagement with local residents and language barriers, as well as meet skilling regulations for local staff.

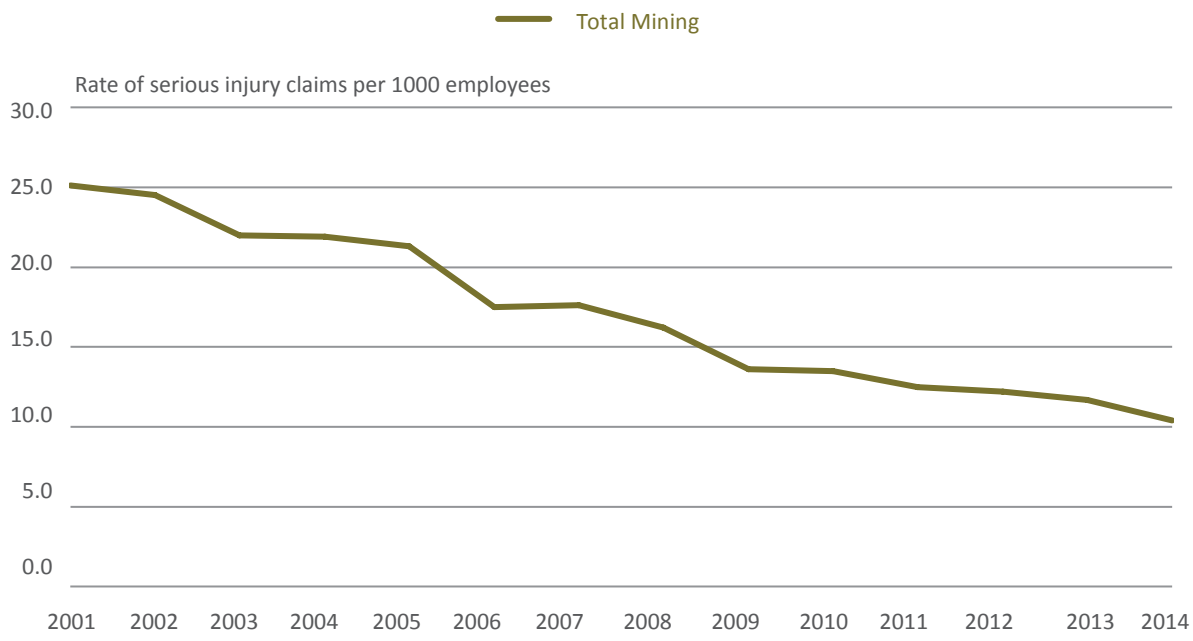
Large contractors could have an advantage in negotiating contracts given their expertise and breadth of resources. However, minor contractors also have opportunities in capturing niche markets concentrating on highly specific aspects of mining operations. However, consolidation is also likely in an increasingly cost competitive environment.

Africa has often been viewed as one of the last frontiers yet to be fully engaged in mining operations. During the height of the mining boom, geologists and exploration companies were fully engaged in exploring the economic possibilities of extracting mineral resources from Africa. However, despite the great wealth of resources, mining in Africa entails several challenges. These include sovereign and country risks, and, poor quality of existing infrastructure. Another challenge includes filling the job requirements within the mine. There is likely to be less expertise and experience in various components of mining operations, and as such, mining contractors are called on to fill this gap in employment.

Mining incidences

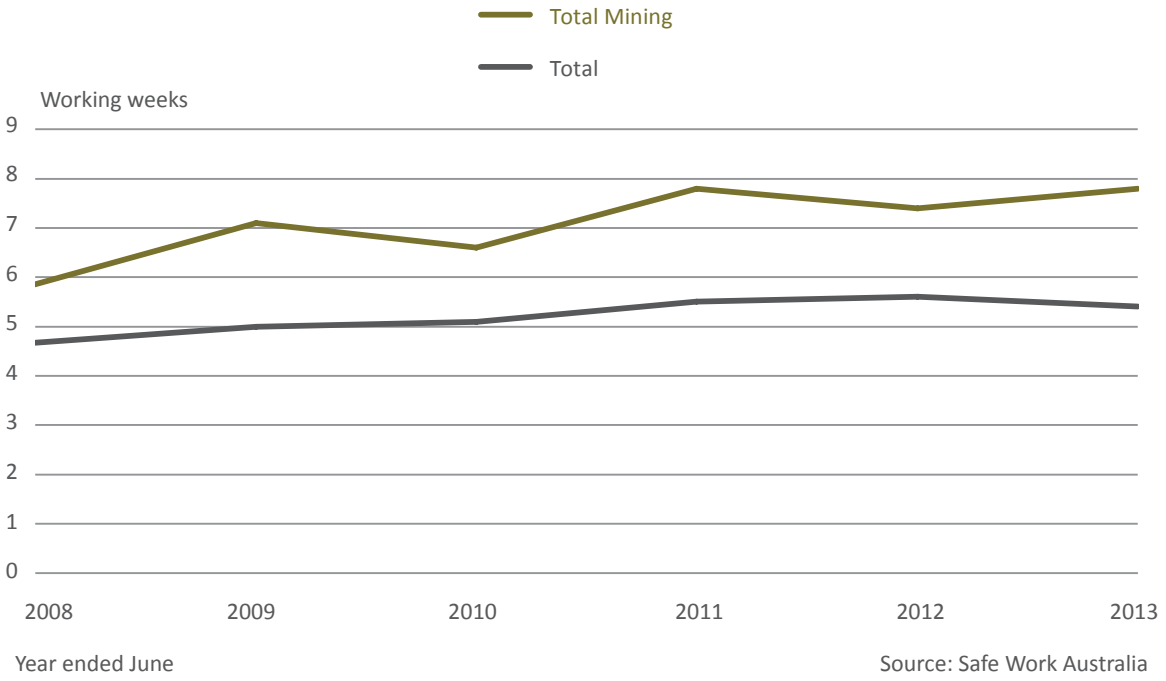
This section investigates the relationship between output and injury rates within the Mining industry. By the nature of its operation, Mining activity has risks of serious injury. In a study conducted by Safe Work Australia (2013/14), the injury incident rates for workers within the Mining industry was 10.4 injuries per 1000 employees. By comparison, the incident rate compares slightly better than the Administrative & Support Services Industry (12.5 incidents per 1000 employees) and well below the industry with the highest incident rates, Agriculture, Forestry & Fishing at 21 incidents per 1000 employees. The incidence rate for Mining has improved since 2001, steadily falling by 55 per cent from 25 serious claims per 1000 employees in 2000/01[28].

Chart 2.7: Total Mining incidence rate, 2014



On the other hand, the median time lost (in working weeks) through injury has gradually increased, rising from 6 weeks to almost 8 weeks between 2007/08 and 2012/13. The lost time rate remained above the "All Industry" average of 5.4 weeks in 2012/13, increasing from approximately 4.7 weeks in 2007/08[29]. An increase in training and upskilling within the Mining Industry may help reduce the number of loss time due to injury and minimise incidence rates.

Chart 2.8: Median time lost due to injury, 2013



29 Safe Work Australia (2016), *Australian Workers Compensation Statistics, 2013-14*, Canberra

Fatalities at work in the Mining industry have gradually declined since 2003, from 12.4 fatalities per 100,000 workers to 4.0 by 2014[30]. The fall can be partially attributable to the increase in focus on safety, and the implementation of proper safeguards and protocols at mine site.

With the increased use of automation and robotics within the mining industry, there is a possibility that the incidence rates will decline further, particularly as high-risk work is shifted to automated and robotic equipment, where operationally feasible. Recent examples of automation used to reduce the chances of injury include the use of drones to replace personnel site inspection of elevated and hard to reach locations requiring the use of scaffolding. Education, 'on-the-job' training and monitoring can help reduce the number of injuries, supplementing the recent technological advances.

When compared to the rapid growth within the Mining Industry (as measured by GDP), fatality rates have gradually fallen, despite an overall increase in employment and a rapid growth in output within the sector. Nonetheless, as the Mining industry shifts towards a more efficient operation, injury prevention and training related to safety protocols will not be compromised for increases in productivity and output.

Mining employment sub-sector

By commodity, the coal industry attracts the largest workforce, employing approximately 54,000 persons in 2014/15, spread mainly within Queensland operations (around 26,000 employees) and New South Wales (employing around 22,000). As a proportion of total workforce, coal accounted for 28 per cent of the total (where total workforce includes quarrying and drilling / exploration industries)[31].

Iron ore follows coal as the second largest employer accounting for 22 per cent (or approximately 43,000 employees) of the total. However, apart from the smaller operations in South Australia and Tasmania, almost all of the mining operations (in excess of 98 per cent) are concentrated in the large iron ore operations in the Pilbara, Western Australia. The Oil and gas industry is the third largest sector with 13 per cent (or around 25,000 employees), spread amongst Western Australia (63 per cent of total oil and gas industry employees), Victoria (17 per cent or almost 4,300 employees) and Northern Territory (12 per cent or just over 3,000 employees). The remaining employment within the Mining sector is spread among the base metals subsector with Western Australia, Queensland and New South Wales employing the majority of the workforce[32].

30 Safe Work Australia (2015), *Work-Related Traumatic Injury Fatalities, Australian - 2014*, Canberra

31 Australian Bureau of Statistics (2015), *Mining Operations, Australia, 2013-14*, ABS catalogue no. 8415.0, http://www.abs.gov.au/AUSSTATS

32 Australian Bureau of Statistics (2015), *Mining Operations, Australia, 2013-14*, ABS catalogue no. 8415.0, http://www.abs.gov.au/AUSSTATS

SECTION THREE: OUTLOOK FOR THE Resources and Infrastructure Industry WORKFORCE

The following analysis of employment considers 'Total Mining', which is the combination of the Coal, Drilling, Metalliferous Mining and Quarrying Sectors, and 'Heavy and Civil Engineering Construction', which includes Heavy Engineering Construction in addition to the Civil Construction Sector. The analysis is conducted in this manner because the Australian Bureau of Statistics does not split employment data into the five Industry Sectors which fall under SkillsDMC's coverage.

Occupations in demand

The Australian Bureau of Statistics Census provides the most comprehensive break down of the employment landscape for the Resources and Infrastructure Industry. The tables presented below identify the top 20 occupations for Heavy and Civil Engineering Construction and Mining as extracted from the August 2011 Australian Bureau of Statistics Census.

Table 3.1: Top 20 Occupations in the Resources and Infrastructure Industry, 2011

Top 20 occupations by industry (as at 2011 Census)
*Occupations at the 4-digit level

Total Mining Sector		
ANZSCO	**Occupation**	**Persons**
7122	Drillers, Miners and Shot Firers	39,283
3232	Metal Fitters and Machinists	14,578
3129	Other Building and Engineering Technicians	8,371
7331	Truck Drivers	7,307
3411	Electricians	5,503
2336	Mining Engineers	5,207
1335	Production Managers	5,149
2344	Geologists and Geophysicists	4,957
8219	Other Construction and Mining Labourers	3,793
3223	Structural Steel and Welding Trades Workers	3,138
7212	Earthmoving Plant Operators	2,925
5311	General Clerks	2,902
7129	Other Stationary Plant Operators	2,821
2211	Accountants	2,777
5111	Contract, Program and Project Administrators	2,515
2513	Occupational and Environmental Health Professionals	2,030
NA	Inadequately described	1,983
5911	Purchasing and Supply Logistics Clerks	1,931
3992	Chemical, Gas, Petroleum and Power Generation Plant Operators	1,511
5511	Accounting Clerks	1,476
	Mining Industry Total	**176,556**

Heavy and Civil Engineering Construction		
ANZSCO	**Occupation**	**Persons**
7212	Earthmoving Plant Operators	5,446
8215	Paving and Surfacing Labourers	3,921
8211	Building and Plumbing Labourers	3,830
7331	Truck Drivers	3,593
2332	Civil Engineering Professionals	3,225
3121	Architectural, Building and Surveying Technicians	3,054
3223	Structural Steel and Welding Trades Workers	2,636
3232	Metal Fitters and Machinists	2,635
1331	Construction Managers	2,537
3411	Electricians	2,232
NA	Mobile Plant Operators nfd	2,027
8999	Other Miscellaneous Labourers	1,896
8217	Structural Steel Construction Workers	1,861
5311	General Clerks	1,541
5111	Contract, Program and Project Administrators	1,512
3341	Plumbers	1,376
3312	Carpenters and Joiners	1,250
5511	Accounting Clerks	1,208
8212	Concreters	1,068
7219	Other Mobile Plant Operators	976
	Heavy and Civil Infrastructure Total	**81,378**

Source: Australian Bureau of Statistics

Of the positions listed, the majority relate to occupations that can broadly be classified as 'Machinery Operators and Drivers' (which includes Drillers, Miners and Shot Firers; Truck Drivers; Earthmoving Plant Operators; and Stationary Plant Operators) and 'Technicians and Trades Workers' (Metal Fitters and Machinists; Other Building and Engineering Technicians; Electricians; and Structural Steel and Welding Trades Workers) for the Mining Industry.

The Civil Construction Industry contains a spread of 'Labourers' (Paving and Surfacing Labourers; Building and Plumbing Labourers; Other Miscellaneous Labourers; Structural Steel Construction Workers; and Concreters), 'Technicians and Trades Workers' (Architectural, Building and Surveying Technicians; Structural Steel and Welding Trades Workers; Metal Fitters and Machinists; Electricians; Plumbers; and Carpenters and Joiners) and 'Machinery Operators and Drivers' (Earthmoving Plant Operators; Truck Drivers; and Other Mobile Plant Operators).

Skills shortages

Research by the Department of Employment tracks the extent of skills shortages across the Australian labour market. Skills Shortages Australia 2014-15 shows that the qualifications, skills and experience of those prospective employees is sufficient for almost all occupations (see Table 3.2).

At the national level, there are only shortages identified with the Metal Machinist (First Class) occupation – which was last assessed in November 2014. Otherwise no significant shortages remain in the Mining Sector, although the shortages of workers in the 'Technicians and Trade Workers' category may have some limited impacts. Most notably, skill shortages related to automotive maintenance (including motor mechanics and automotive electricians) could have a negative impact on the mining support industry depending on the regions the shortages occur in. However, this is not immediately concerning as the Department of Employment notes that many of these shortages exist largely outside of the Resources sector.

Unfortunately, the Department of Employment has not assessed the technician and trade occupations for recruiting difficulties over the past year. However, given the declines in resources and infrastructure industry employment levels in the past year, it would be expected there would be no new major shortages emerging.

Table 3.2: Identified skills shortages

ANZSCO Code	Occupation
	Managers
1341-11	Child Care Centre Manager
	Professionals
2322-12	Surveyor
2332-13	Quantity Surveyor
2512-11	Medical Diagnostic Radiographer
2512-14	Sonographer
2514-11	Optometrist
2525-11	Physiotherapist
2527-11	Audiologist
2541-11	Midwife
	Technicians and trade workers
312114	Construction Estimator
3211-11	Automotive Electrician
3212-11,12,13	Motor Mechanic
3222-11	Sheetmetal Trades Worker
3232-14	Metal Machinist (First Class)
3241-11	Panelbeater
3311-11	Bricklayer
3311-12	Stonemason
3331-11	Glazier
3332-12	Solid Plasterer
3333-11	Roof Tiler
3334-11	Wall and Floor Tiler
3341	Plumber
3511-11	Baker
3511-12	Pastrycook
3512-11	Butcher or Smallgoods Maker
3622-12	Arborist
3911-11	Hairdresser
3941-11	Cabinetmaker

Source: Department of Employment

Identifying future labour requirements

Defining the current specialist skills and occupations for the Resources and Infrastructure Industry sectors

In order to quantify a skills capability shortfall or surplus, we need to define at the outset the skills being considered and the size of the defined workforce.

For this study, the top occupations requiring vocational education and training services from the Heavy and Civil Engineering Construction and Mining sectors (representing the Resources and Infrastructure Industry workforce) were considered. This eliminates from the analysis occupations requiring a university Bachelor degree such as Mining Engineers, Geologists and Geophysicists and Civil Engineering Professionals.

To define the size of occupation workforce, Census data from the Australian Bureau of Statistics is used. This data set provides the most comprehensive coverage of occupation data by industry but unfortunately is last available for 2011. This data is augmented with other industry indicators to help produce 'base year' estimates for the occupations selected in the table below.

This report makes use of 2014/15 as the 'base year' demand for the occupations studied. The 'base year' occupation estimates are for a historical period and as such defines the total labour demanded by the Resources and Infrastructure Industry as well as the total labour supplied to industry.

Table 3.3: Occupations modelled

Top 20 occupations by industry (as at 2011 Census)

*Occupations at the 4-digit level

Total Mining Sector	
ANZSCO	**Occupation**
7122	Drillers, Miners and Shot Firers
3232	Metal Fitters and Machinists
3129	Other Building and Engineering Technicians
7331	Truck Drivers
3411	Electricians
2336	Mining Engineers
1335	Production Managers
2344	Geologists and Geophysicists
8219	Other Construction and Mining Labourers
3223	Structural Steel and Welding Trades Workers

Heavy and Civil Engineering Construction	
ANZSCO	**Occupation**
7212	Earthmoving Plant Operators
8215	Paving and Surfacing Labourers
8211	Building and Plumbing Labourers
7331	Truck Drivers
2332	Civil Engineering Professionals
3121	Architectural, Building and Surveying Technicians
3223	Structural Steel and Welding Trades Workers
3232	Metal Fitters and Machinists
1331	Construction Managers
3411	Electricians

Source: Australian Bureau of Statistics

Forecasting the future specialist skills and occupations required for the Resources and Infrastructure Industry

The demand for skilled workers is a function of the overall outlook for activity in the key end-use markets. In the case of the Civil Infrastructure sector, this sector is defined by total engineering construction activity — including the construction of Mining and Heavy Industry Infrastructure.

For the Resources Industry, a range of activities are identified as driving the demand for skilled workers including in Mining Production, Mine Infrastructure Maintenance, Construction and the exploration for minerals.

Table 3.4 provides a summary of the outlooks for the key end-use sectors.

Table 3.4: Summary outlook for key end-use sectors

Infrastructure	
Civil Infrastructure*	Construction of infrastructure has fallen 23 percent since the peak in 2012/13 to $54.5 billion in 2014/15. The decline in construction has been almost uniform across the transport and utilities sectors, with the only notable exception the telecommunications sector. It is expected 2015/16 will be the trough in the construction cycle with improved prospects for the roads, rail, telecommunications and electricity leading the upturn in activity later this decade.
Mining and Heavy Industry Infrastructure*	Mining and heavy industry construction fell 12 percent to $53 billion in 2014/15. The declines were initially led by strong declines in the coal and iron ore industries. Construction activity is expected to continue to fall a further 65 percent in the period to 2018/19 as construction activity wraps up on the major LNG projects and a weak commodity price climate deters major investment in new capacity.
Resources	
Mine Production+	A decade long investment boom has allowed the mining industry to expand output by roughly 40 percent over the last five years to $139 billion in 2014/15. The completion of several LNG projects and the ramp up of operations in iron ore and coal are expected to push total economic output from the mining industry to $182 billion in 2019/20.
Mine Construction*	See Mining and Heavy Industry Infrastructure Investment
Civil Infrastructure*	Construction of infrastructure has fallen 23 percent since the peak in 2012/13 to $54.5 billion in 2014/15. The decline in construction has been almost uniform across the transport and utilities sectors, with the only notable exception the telecommunications sector. It is expected 2015/16 will be the trough in the construction cycle with improved prospects for the roads, rail, telecommunications and electricity leading the upturn in activity later this decade.
Mining and Heavy Industry Infrastructure*	Mining and heavy industry construction fell 12 percent to $53 billion in 2014/15. The declines were initially led by strong declines in the coal and iron ore industries. Construction activity is expected to continue to fall a further 65 percent in the period to 2018/19 as construction activity wraps up on the major LNG projects and a weak commodity price climate deters major investment in new capacity.

Source: BIS Shrapnel

* The values quoted in the table above for Civil Infrastructure, Mining and Heavy Industry Infrastructure and Mining Exploration refer to the value of investment undertaken (in constant dollar figures) for each activity

+ The measure of output for mine production is represented in constant dollar figures. This standardised measure allows the aggregation of output from different commodities which typically report in different units of measurement (eg: coal, oil, gas, gold etc)

^ Mine Infrastructure Maintenance is measured in constant dollar values representing the value of operating expenditure attributed to the activity

As commodity prices have slipped, productivity is a major factor shaping the demand for labour. Through the boom years, labour productivity deteriorated as the resources and construction industries attempted to scale up operations quickly, which pushed up costs for both industries. However, the large oversupply in commodity markets and depressed commodity prices have forced the industry to cut costs and seek measures to boost productivity. This analysis assumes large increases in mining productivity over the next decade as the industry embraces greater use of technology to drive improvements in productivity.

The modelling aligns the 'base year' occupation demand with the key 'base year' activity indicators to derive a 'usage coefficient' – the number of people employed in each occupation per unit (or dollar of expenditure) of the end use sector activity. This usage coefficient is applied to forecasts of the end-use activity indicators to derive forecasts of future occupation demand.

The model therefore assumes that future changes in demand for skilled labour in the Resources and Infrastructure Industry are driven by changes in the identified industry activity indicators.

As an example, for Civil Infrastructure occupations, the relevant "end-use" activity indicator used to determine future demand is total engineering construction activity. Similarly, for other occupations, the "end-use" activity indicator will tend to be Industry output. Hence, the model will assume that future changes in demand for skilled labour will be driven by changes in the underlying activity or Industry output.

Modelling existing skilled workforce attrition from an ageing workforce

As mentioned previously, the 'base year' occupation estimates also define the total labour supplied to industry. If unaddressed, the total pool of skilled workers will naturally decline over time due to the attrition of the existing workforce through ageing effects. This will increase the requirement for future quality outcomes from the vocational education and training arrangements within the National Training System to equip the labour force in order to meet future levels of activity in the Resources and Infrastructure Industry.

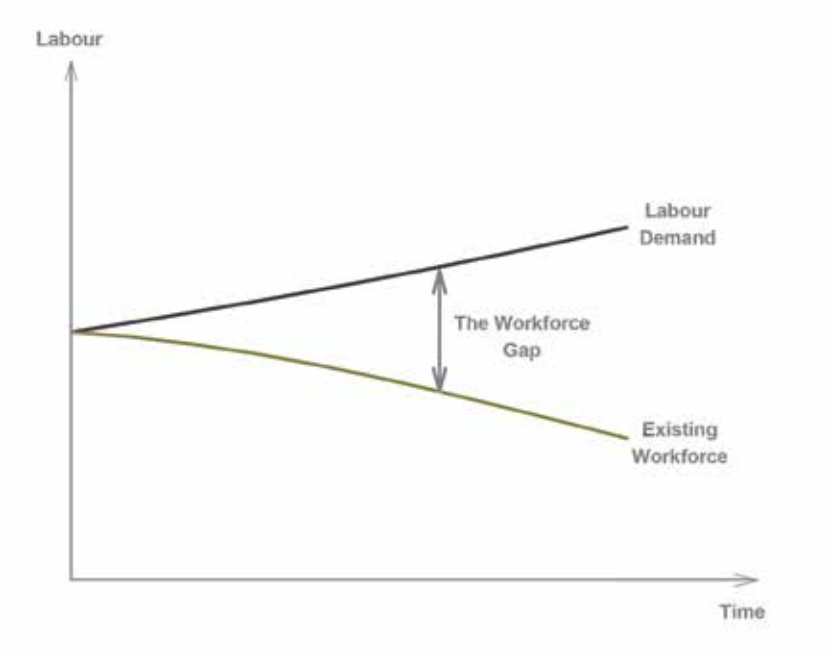
This study utilises modelling published by the Australian Workforce and Productivity Agency (2012), which produces retirement rate projections for all occupations at the four digit ANZSIC level.

Calculating the capability shortfall or surplus

The difference between the changing demand for selected skills and the need to replace personnel lost through workforce attrition, when positive, will lead to an additional labour requirement or the opening up of a 'workforce gap'. A positive workforce gap implies that the existing workforce will not be sufficient to cover for expected future demand. Similarly, a negative implies a situation of 'capability excess/surplus'. This is shown conceptually in Figure 3.1.

However, it is important to note, a capability surplus does not necessarily mean those skills will be available in future years. **The lack of utilisation of skilled resources is likely to lead to the migration of those skills into other industries.** What is not known is whether those skills will be available when activity in the sector recovers.

Figure 3.1: Workforce gap



Results of labour demand and workforce gaps modelling

Due to the impact of global influences, the Resources and Infrastructure Industry is expected to face some challenges over the next decade. The challenges of oversupplied commodity markets, weak prices, cost constraints, technological change, an ageing workforce and the poor state of public finances are all factors which are likely to reduce the demand for labour during the outlook period.

Miners are in consolidation mode, cutting back costs on operations and delaying investment in new projects given the low returns on offer at the prevailing commodity prices. Similarly, the public sector is taking a cautious approach to investment in new infrastructure construction, funding new projects with proceeds from asset sales – capital recycling – rather than extending balance sheets by taking on additional debt.

These spending cuts have translated into job losses. During 2014/15, the mining industry shed 40,000 jobs, and is expected to lose a further 21,000 in the two years to 2016/17[33]. As the tail end of the mining investment boom reaches a conclusion with the commissioning of LNG facilities in Queensland, Western Australia and the Northern Territory, the heavy and civil construction industry is also expected to suffer significant job losses.

The poor short term employment outlook for the Resources and Infrastructure Industry has led to a significant surplus of skilled labour in the short term which is carried through for most of the modelled period for all the mining occupations (with the exception of the drillers, miners and shot firers category), while the heavy and civil infrastructure industry is expected to see some skills gaps emerge early next decade.

33 Australian Bureau of Statistics (2015), *Labour Force, Australia, Detailed, Quarterly, November 2015*, ABS catalogue no. 6291.0.55.003, http://www.abs.gov.au/AUSSTATS

However, it is important to consider the impact of the large skills surpluses that emerge early in the projection period. The participants in these labour markets will make adjustments. The risk is the industry could lose a large portion of the skills in the workforce with some workers retiring, others with transferrable skills finding employment in another industry and others will re-train and seek employment in other industries. Without continuous employment, some workers may not keep up with technological change. Although this model identifies a skills surplus, these projections are based on the existing workforce staying in the Resources and Infrastructure industries, with this population naturally reducing over time only through ageing effects.

In reality, labour and skills will begin to exit the Resources and Infrastructure industries until the market rebalances. That is, just as a skills *deficit* identifies the quantum of skills required from other industries (or from overseas) in times of excess demand, a skills *surplus* identifies the quantum of skills which are at risk of moving into other industries (or overseas) in times of excess supply, perhaps permanently. In practice, no skills deficit or surplus is actually observed, with the industry balancing demand and supply each year, either constraining growth below a theoretical maximum (in times of excess demand) or experiencing higher unemployment or loss of skills to other industries (in times of excess supply). This is a key area where more research is required to determine and understand what happens to these qualified and skilled workers in times of skills surpluses, which industries they move into and, importantly, how easily they can be re-integrated into the Resources and Infrastructure industries when demand increases.

The subsequent challenge then is to ensure the industry is fully prepared for the next upturn in activity. It is expected there will be a lift in mining investment late this decade and early next decade to offset mine depletions from investments that were undertaken in the early stages of the recent mining investment boom - particularly in the case of the iron ore. In the current highly competitive setting of the resources industry, it will be even more critical for the local mining industry to be ready for the next upturn in the cycle. Whilst in 2015/16 there may be a pool of underutilised resources available, the reality is there could be some critical skills shortages emerging from 2019/20 when demand from the Resources and Infrastructure Industry begins to pick up.

These issues and concerns highlight areas that need to be addressed constantly in the Resources and Infrastructure Industry. The industry is highly cyclical. Although the industry is currently going through a tough period, prospects are expected to improve in the medium term. To be prepared for the next industry upswing, the need for investment in skills is required throughout the cycle.

The innovative changes that are being adopted across the resources industry is another key factor requiring the continued investment in skills. Technological change is leading to increased levels of automation in processes and should create safer workplace practices. Even as automation replaces the needs for some traditional roles, technological innovation in the Industry will also produce new and varied roles required to oversee and maintain equipment operating efficiently. These changes will drive a need for workers to continually update their training and skills to meet changing Industry demands.

Opportunities to improve industry capacity are available. Given the industry operates in remote regions, greater inclusion and participation of the under-represented female and Indigenous populations can have a positive impact on securing long term labour supply.

Table 3.5: Projected workforce gaps – total Mining

Projected Workforce Gaps - Mining

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Summary charts
	Estimate	Forecast										
Drillers, Miners and Shot Firers												
Labour Demand	48,644	46,360	43,431	42,332	43,286	44,267	44,192	42,615	39,785	38,204	36,161	
Existing Workforce	48,644	47,671	46,718	45,783	44,868	43,970	43,091	42,229	41,385	40,557	39,746	
Workforce Gap		***-1,311***	***-3,287***	***-3,451***	***-1,582***	***297***	***1,101***	***386***	***-1,600***	***-2,353***	***-3,585***	
Metal Fitters and Machinists												
Labour Demand	24,397	22,290	20,015	19,416	20,494	20,975	21,413	20,657	19,297	18,544	17,549	
Existing Workforce	24,397	23,933	23,478	23,032	22,595	22,165	21,744	21,331	20,926	20,528	20,138	
Workforce Gap		***-1,643***	***-3,463***	***-3,616***	***-2,101***	***-1,190***	***-331***	***-674***	***-1,629***	***-1,984***	***-2,589***	
Truck Drivers												
Labour Demand	13,688	13,173	11,661	11,132	11,334	11,539	11,575	11,171	10,469	10,154	9,614	
Existing Workforce	13,688	13,387	13,093	12,805	12,523	12,248	11,978	11,715	11,457	11,205	10,958	
Workforce Gap		***-214***	***-1,432***	***-1,673***	***-1,189***	***-709***	***-403***	***-544***	***-988***	***-1,051***	***-1,344***	
Other Building and Engineering Technicians												
Labour Demand	13,092	12,417	11,027	10,581	10,868	11,202	11,225	10,819	10,120	9,790	9,268	
Existing Workforce	13,092	12,817	12,548	12,285	12,027	11,774	11,527	11,285	11,048	10,816	10,589	
Workforce Gap		***-400***	***-1,521***	***-1,704***	***-1,159***	***-572***	***-302***	***-466***	***-928***	***-1,026***	***-1,321***	
Electricians												
Labour Demand	7,521	6,871	6,170	5,985	6,318	6,466	6,459	6,230	5,821	5,598	5,298	
Existing Workforce	7,521	7,408	7,297	7,187	7,080	6,973	6,869	6,766	6,664	6,564	6,466	
Workforce Gap		***-537***	***-1,127***	***-1,202***	***-762***	***-507***	***-410***	***-536***	***-843***	***-966***	***-1,168***	
Production Managers												
Labour Demand	6,608	6,359	5,630	5,374	5,471	5,570	5,588	5,393	5,054	4,902	4,641	
Existing Workforce	6,608	6,469	6,334	6,201	6,070	5,943	5,818	5,696	5,576	5,459	5,345	
Workforce Gap		***-110***	***-704***	***-827***	***-599***	***-373***	***-230***	***-303***	***-522***	***-557***	***-704***	
Earthmoving Plant Operators												
Labour Demand	6,237	5,698	5,117	4,964	5,239	5,362	5,356	5,166	4,827	4,642	4,394	
Existing Workforce	6,237	6,118	6,002	5,888	5,776	5,666	5,559	5,453	5,349	5,248	5,148	
Workforce Gap		***-420***	***-885***	***-924***	***-537***	***-304***	***-203***	***-287***	***-522***	***-606***	***-754***	
Structural Steel and Welding Trades Workers												
Labour Demand	6,079	5,765	5,120	4,913	5,046	5,201	5,212	5,023	4,699	4,545	4,303	
Existing Workforce	6,079	5,972	5,868	5,765	5,664	5,565	5,468	5,372	5,278	5,186	5,095	
Workforce Gap		***-207***	***-748***	***-852***	***-618***	***-364***	***-256***	***-349***	***-579***	***-641***	***-792***	
Other Construction and Mining Labourers												
Labour Demand	3,611	3,451	3,057	2,922	2,983	3,038	3,046	2,938	2,751	2,665	2,523	
Existing Workforce	3,611	3,557	3,503	3,451	3,399	3,348	3,298	3,248	3,200	3,152	3,104	
Workforce Gap		***-106***	***-446***	***-529***	***-416***	***-310***	***-252***	***-310***	***-449***	***-487***	***-581***	
Other Stationary Plant Operators												
Labour Demand	3,587	3,452	3,056	2,917	2,970	3,024	3,033	2,928	2,744	2,661	2,519	
Existing Workforce	3,587	3,516	3,445	3,376	3,309	3,243	3,178	3,114	3,052	2,991	2,931	
Workforce Gap		***-64***	***-389***	***-459***	***-339***	***-219***	***-145***	***-186***	***-308***	***-330***	***-412***	

Table 3.6: Projected workforce gaps – Heavy and Civil Engineering Construction

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Summary charts
	Estimate	Forecast										
Earthmoving Plant Operators												
Labour Demand	9,223	7,781	7,251	6,744	6,525	6,543	6,355	6,690	7,040	7,406	7,081	
Existing Workforce	9,223	9,048	8,876	8,707	8,542	8,380	8,220	8,064	7,911	7,761	7,613	
Workforce Gap		***-1,267***	***-1,625***	***-1,963***	***-2,017***	***-1,836***	***-1,865***	***-1,374***	***-871***	***-355***	***-532***	
Paving and Surfacing Labourers												
Labour Demand	4,757	4,166	3,989	3,810	3,741	3,750	3,672	3,841	4,031	4,203	4,064	
Existing Workforce	4,757	4,686	4,616	4,546	4,478	4,411	4,345	4,280	4,215	4,152	4,090	
Workforce Gap		***-520***	***-626***	***-737***	***-738***	***-661***	***-673***	***-439***	***-185***	***51***	***-26***	
Truck Drivers												
Labour Demand	4,612	3,891	3,625	3,372	3,340	3,350	3,253	3,425	3,604	3,791	3,625	
Existing Workforce	4,612	4,510	4,411	4,314	4,219	4,126	4,035	3,947	3,860	3,775	3,692	
Workforce Gap		***-620***	***-786***	***-942***	***-879***	***-777***	***-782***	***-522***	***-256***	***16***	***-67***	
Building and Plumbing Labourers												
Labour Demand	4,543	3,979	3,810	3,638	3,572	3,581	3,506	3,668	3,850	4,014	3,882	
Existing Workforce	4,543	4,475	4,408	4,342	4,277	4,213	4,149	4,087	4,026	3,966	3,906	
Workforce Gap		***-496***	***-598***	***-704***	***-704***	***-632***	***-643***	***-419***	***-176***	***49***	***-24***	
Architectural, Building and Surveying Technicians												
Labour Demand	3,650	3,079	2,869	2,669	2,582	2,589	2,515	2,647	2,786	2,931	2,802	
Existing Workforce	3,650	3,573	3,498	3,425	3,353	3,283	3,214	3,146	3,080	3,015	2,952	
Workforce Gap		***-494***	***-629***	***-756***	***-771***	***-693***	***-699***	***-499***	***-294***	***-85***	***-150***	
Construction Managers												
Labour Demand	3,032	2,558	2,384	2,217	2,145	2,151	2,089	2,199	2,315	2,435	2,328	
Existing Workforce	3,032	2,969	2,906	2,845	2,785	2,727	2,670	2,614	2,559	2,505	2,452	
Workforce Gap		***-410***	***-522***	***-628***	***-640***	***-576***	***-580***	***-414***	***-244***	***-70***	***-124***	
Structural Steel and Welding Trades Workers												
Labour Demand	3,082	2,699	2,584	2,468	2,528	2,535	2,482	2,596	2,725	2,841	2,747	
Existing Workforce	3,082	3,028	2,975	2,923	2,872	2,822	2,772	2,724	2,676	2,629	2,583	
Workforce Gap		***-329***	***-391***	***-455***	***-343***	***-287***	***-290***	***-127***	***49***	***212***	***164***	
Metal Fitters and Machinists												
Labour Demand	3,081	2,698	2,583	2,467	2,528	2,534	2,481	2,595	2,724	2,840	2,746	
Existing Workforce	3,081	3,022	2,965	2,908	2,853	2,799	2,746	2,694	2,642	2,592	2,543	
Workforce Gap		***-324***	***-381***	***-441***	***-326***	***-265***	***-265***	***-98***	***81***	***248***	***203***	
Electricians												
Labour Demand	2,610	2,285	2,188	2,090	2,052	2,057	2,014	2,107	2,211	2,306	2,230	
Existing Workforce	2,610	2,570	2,532	2,494	2,456	2,420	2,383	2,348	2,312	2,278	2,244	
Workforce Gap		***-285***	***-344***	***-404***	***-405***	***-363***	***-369***	***-241***	***-101***	***28***	***-14***	
Other Miscellaneous Labourers												
Labour Demand	2,217	1,941	1,859	1,775	1,743	1,747	1,711	1,790	1,878	1,959	1,894	
Existing Workforce	2,217	2,177	2,138	2,099	2,061	2,024	1,988	1,952	1,917	1,882	1,849	
Workforce Gap		***-236***	***-279***	***-324***	***-318***	***-277***	***-277***	***-162***	***-39***	***76***	***45***	

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APPENDIX B: METHODOLOGY

Workforce Gap Modelling

The 2016 Resources and Infrastructure Industry Workforce Analysis and Forecast contains analysis conducted by BIS Shrapnel, which considers the impact of future demand and supply for skills in the workforce.

This analysis narrowed down a list of top occupations for the Resources and Infrastructure Industry to the 10 most important (in terms of numbers), which require some form of vocational education and training.

The purpose was to develop a demand forecasting model for these occupations, which will project demand over the coming decade (to June 2025). Coupled with an analysis of the labour supply (considering depletion of the existing workforce through ageing), it was possible to identify potential workforce capability gaps, where training will be most required in the future.

The stages of the workforce analysis are explained in the four steps below:

1. Defining the current specialist skills and occupations for the Industry sectors;
2. Forecasting the future specialist skills and occupations required;
3. Modelling existing skilled workforce attrition; and
4. Calculating the capability shortfall or surplus.

Defining the current specialist skills and occupations for the Industry sectors

For this study, the top 10 occupations for the Resources and Infrastructure Industry requiring vocational education and training were chosen. It is assumed the current demand for skills in the chosen occupations is equal to the size of the existing workforce. The population size for each occupation is derived from the Australian Bureau of Statistics 2011 Census data released in

September 2012. In order to make the data timelier, BIS Shrapnel estimated the size of the 2014/15 skilled workforce by extrapolating from the 2006 and 2011 Censuses, guided by known changes in Industry sector activity since 2011.

Forecasting the future specialist skills and occupations required for the industries of interest

The approach to forecasting future skilled labour demand uses an estimate of 'base year' demand and ties it to an appropriate 'base year' indicator to derive a 'usage coefficient' per unit of end use sector activity. This usage coefficient is then applied to the Industry forecasts to derive projections of future demand by occupation.

For this particular project, base year demand in the 2014/15 financial year was estimated as the size of skilled employment by occupation using the populations obtained from the August 2011 Census. This was assessed at the four digit level as defined in the Australian and New Zealand Standard Classification of Occupations (2006, Revision 1.0). The forecasts of the drivers of activity and employment by sector (i.e. the indicator) are based on BIS Shrapnel's macroeconomic and Industry forecasts for Australia.

As an example, for Coal Mining occupations, the relevant "end-use" activity indicator used to determine future demand is total coal production. Similarly, for other occupations, the "end-use" activity indicator will tend to be Industry output. Hence, the model will assume that future changes in demand for skilled labour will be driven by changes in the underlying activity or Industry output.

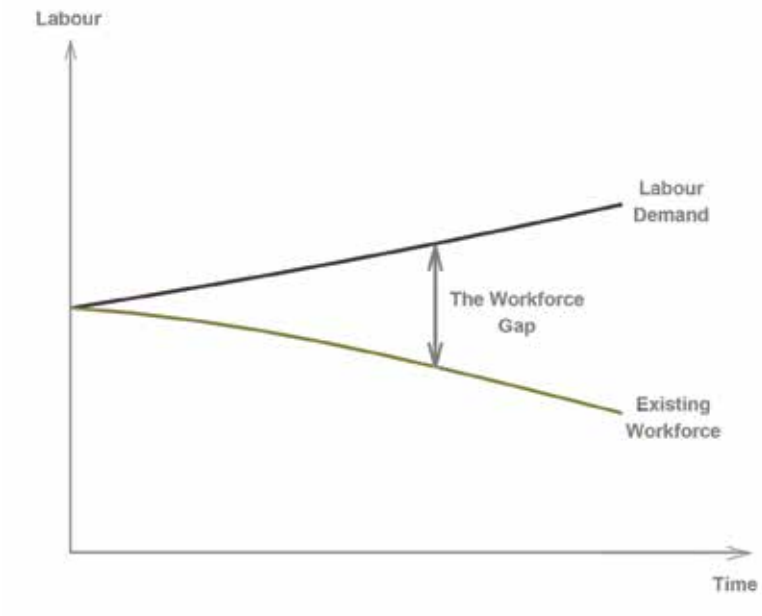
The model incorporates "dynamic" usage coefficients — i.e. coefficients, which change over time. Effectively, this means that the model incorporates labour productivity growth assumptions.

Modelling existing skilled workforce attrition

In an expanding Industry, the total future skilled workforce requirement will inevitably be higher due to the attrition of the existing workforce through ageing effects, particularly through retirement. This study utilises modelling published by the Australian Workforce and Productivity Agency, which produces retirement rate projections for all occupations at the four digit Australian and New Zealand Standard Industrial Classification level.

The difference between the changing demand for selected skills (driven by changes in its underlying demand drivers) and the need to replace personnel lost through workforce attrition — when positive — will lead to an additional labour requirement or the opening up of a "workforce gap". A positive workforce gap implies that the existing workforce will not be sufficient to cover for expected future demand. This is shown conceptually in Figure A2.1 below (for simplicity, an increasing demand for labour is assumed).

Figure A2.1: The Workforce Gap



Calculating the capability shortfall or surplus

The difference between the changing demand for selected skills and the need to replace personnel lost through workforce attrition — when positive — will lead to an additional labour requirement or the opening up of a "workforce gap". A positive workforce gap implies that the existing workforce will not be sufficient to cover for expected future demand. Similarly, a negative implies a situation of 'capability excess/surplus'.

It is important to note that the capability shortfall (or surplus) is a theoretical construct. In practice there will be no observable capability shortfall. Either labour demand (and output) will fall back to meet the constrained level of labour supply — implying that some future investment will need to be cut back or foregone — or measures will need to be put in place that will boost labour supply to meet projected levels of output.

However, the quantification of the capability shortfall, although theoretical, will provide important insights. First and foremost, it will provide a simple measure of how much more labour is required to meet current expectations of future output. Alternatively, a capability shortfall could be used to measure the "cost" of the labour constraint in terms of the value of the investment or output foregone if supply were not augmented.

Limitations of the model and areas for future study

The aim of this workforce gap study is to quantify a skills capacity shortfall or surplus based on some reasonable assumptions regarding future demand for skills in the industries of interest. While great care has been taken in the specification of the model and the assumptions used, there are still some limitations that need to be noted:

- Competition for employees from other industries;
- Job matching issues (e.g. experience, location);
- Under-employment of labour is not considered;
- Employment market is considered balanced in starting period; and
- No measure to account for re-skilling of employees.

Improving upon the specification of the model or the choice of assumptions based on feedback to this report or via new sources of information would be a useful avenue for future research. Ideally, the model used here could be improved upon and run again periodically to assess whether the capability outlook has changed.

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