2023

CANADIAN MINING OUTLOOK

MINING INDUSTRY
HUMAN RESOURCES COUNCIL

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HUMAN RESOURCES COUNCIL

For more information, contact:

Mining Industry Human Resources Council
50 Frank Nighbor Place, Unit 105
Kanata, Ontario K2V 1B9
(613) 270-9696
research@mihr.ca

Or visit the website at:
www.mihr.ca

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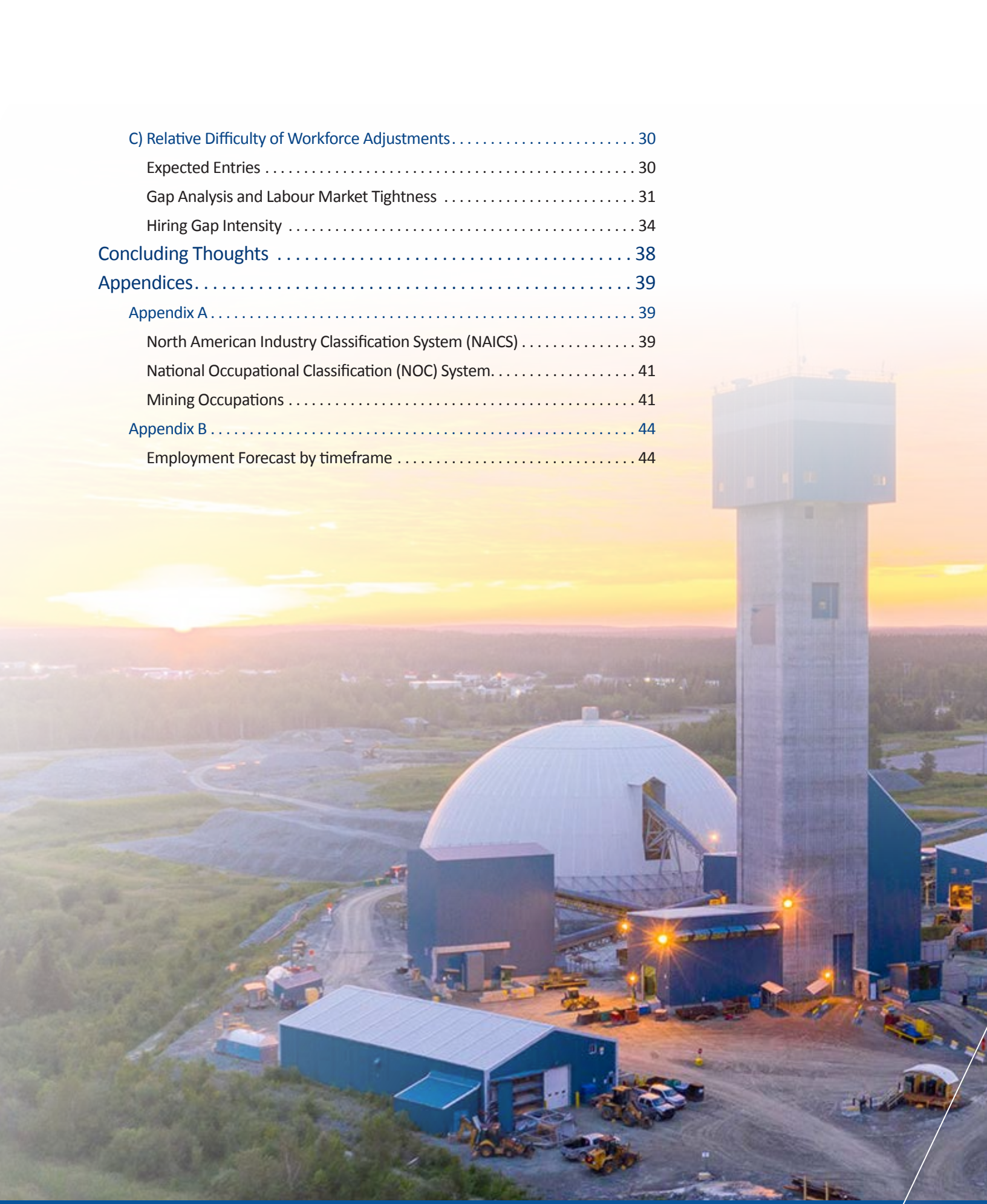


INTRODUCTION

The past few years have been marked by considerable disorder: the COVID-19 pandemic, the abrupt standstill of the global economy and its equally frantic recovery, the Russia-Ukraine War, countless supply-chain challenges, shortages of goods and services, and new fears of high inflation followed by stricter monetary policies from central banks around the world.

Since 2020, the mining industry has experienced rapid growth, driven primarily by higher metals and mineral prices. The upward momentum of mining development, together with the problems caused by the pandemic, has only placed additional pressures on the labour market and the industry's ability to find qualified workers.

This report examines the current labour market conditions of Canada's mining industry and explores key areas where the sector may encounter labour market challenges over the next decade. The report is structured into three main Chapters:

1) Mining has a tight (and tightening) labour market.

2) Reasons for current labour market tightness.

3) Labour market outlook and forecast.

MIHR'S DEFINITION OF CANADA'S MINING INDUSTRY

MiHR defines the mining industry as inclusive of activities that fall within the following three sub-sectors:

1) Extraction and Milling:

Describes the activities at operating mines across Canada, including both surface and underground mining operations; includes on-site processing activities.

2) Support Services:

Includes the activities of organizations providing support services for a wide range of mining activities, usually on a contract or fee basis[1].

3) Primary Metal Manufacturing:

Consists of activities that are directly downstream from extraction and milling, including smelting and refining of ferrous and non-ferrous metals.

Wherever possible, MiHR uses data and information that adhere to MiHR's definition of the mining industry. This includes sector-level data based on the North American Industry Classification System (NAICS). NAICS codes corresponding to each sub-sector are defined within the report in Chapters 1 and 2. Chapter 3, Labour Market Outlook and Forecast, uses a more robust set of NAICS codes for sub-sector definitions (see Appendix A for more information).

1 *Support services* are those required for mine construction, extraction, processing and exploration activities.

CHAPTER ONE:

MINING HAS A TIGHT (AND TIGHTENING) LABOUR MARKET

Labour market tightness simply means that labour supply is not keeping pace with labour demand. A tight labour market is often characterized by labour shortages, which make it more difficult for employers to find the skilled workers they require.

Tighter labour markets drive up costs in recruitment, wages and advertising, and they increase the need for competitors to inefficiently poach talent from each other. On the other hand, a labour market that is more sustainable and competitive would have a labour pool sizeable enough to effectively respond to the short-term acute needs of the industry, such as those observed in 2022.

MIHR'S LABOUR MARKET TIGHTNESS CHECKLIST

There are various signals that can point to labour market tightness. The Mining Industry Human Resources Council (MiHR) continuously monitors a handful of labour market indicators to diagnose labour tightness, analogous to a doctor looking for symptoms to diagnose a patient. This section follows a *labour market tightness checklist* to develop a rounded picture of the state of Canada's mining labour market in the post-COVID era (Table 1).

TABLE 1: LABOUR MARKET TIGHTNESS CHECKLIST

Indicator	Research Question
Industry Sentiment	*Do employers feel there is a tight labour market?*
Unemployment Rate	*Is the pool of job-seekers large enough to accommodate growth in the mining industry?*
Job Vacancy Rate	*What share of job openings is unfilled?*
Unemployed-to-Vacancies Ratio	*Are job seekers difficult or easy to find?*
Employment Growth	*Has employment grown at a sustainable pace?*
Wage Growth	*Are competitive pressures pushing up wages?*

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

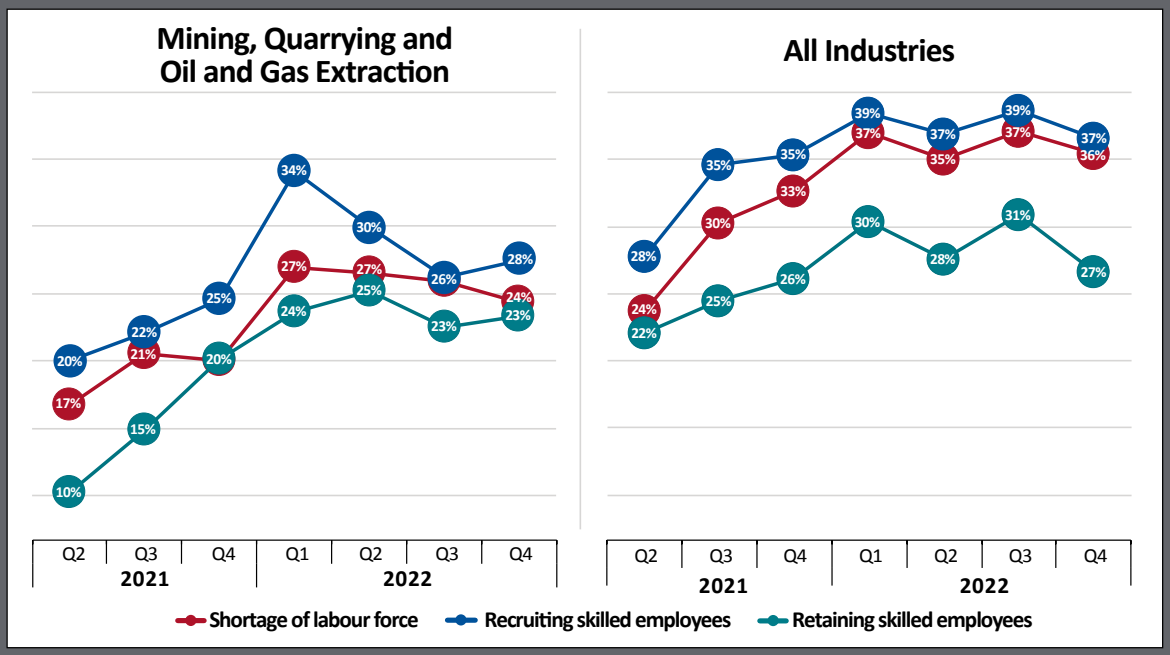
Indicator #1: Industry Sentiment

The first indicator, industry sentiment, follows the perspectives of industry employers to gauge whether their concern over labour tightness is growing or subsiding. The *Canadian Survey on Business Conditions* monitors the economic outlook and expectations among businesses on a quarterly basis. Specifically, respondents were asked if the following factors were expected to be obstacles in the next quarter (Figure 1): (i) *Shortage of labour force*, (ii) *Recruiting skilled employees* and (iii) *Retaining skilled employees.*

Among respondents in *Mining, quarrying and oil and gas extraction (NAICS 21)*, expectations for these factors trended upward in 2021 but have since stabilized in 2022.[2] Thus, while labour tightness has been a growing concern, fewer businesses in this sector anticipate conditions will worsen, at least in the short term. Nonetheless, across all industries in Canada, expectations of labour market tightening have persisted.

2 Note that, for each quarter, data from *Canadian Survey on Business Conditions* was accessed from a separate table product number. This means the design and administration of this survey may have varied from quarter to quarter to accommodate new emerging and topical questions. MiHR has identified those questions that are consistent throughout and has presented them as a time series for the purpose of this analysis.

***FIGURE 1:** PERCEIVED OBSTACLES FOR BUSINESSES OVER THE NEXT THREE MONTHS[3], MINING, QUARRYING AND OIL AND GAS EXTRACTION (NAICS 21) AND ALL INDUSTRIES (2021 – 2022)*



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Canadian Survey on Business Conditions (Table: 33-10-0603-01, Table: 33-10-0534-01, Table: 33-10-0504-01, Table: 33-10-0469-01, Table: 33-10-0400-01, Table: 33-10-0364-01, Table: 33-10-0338-01), 2023.

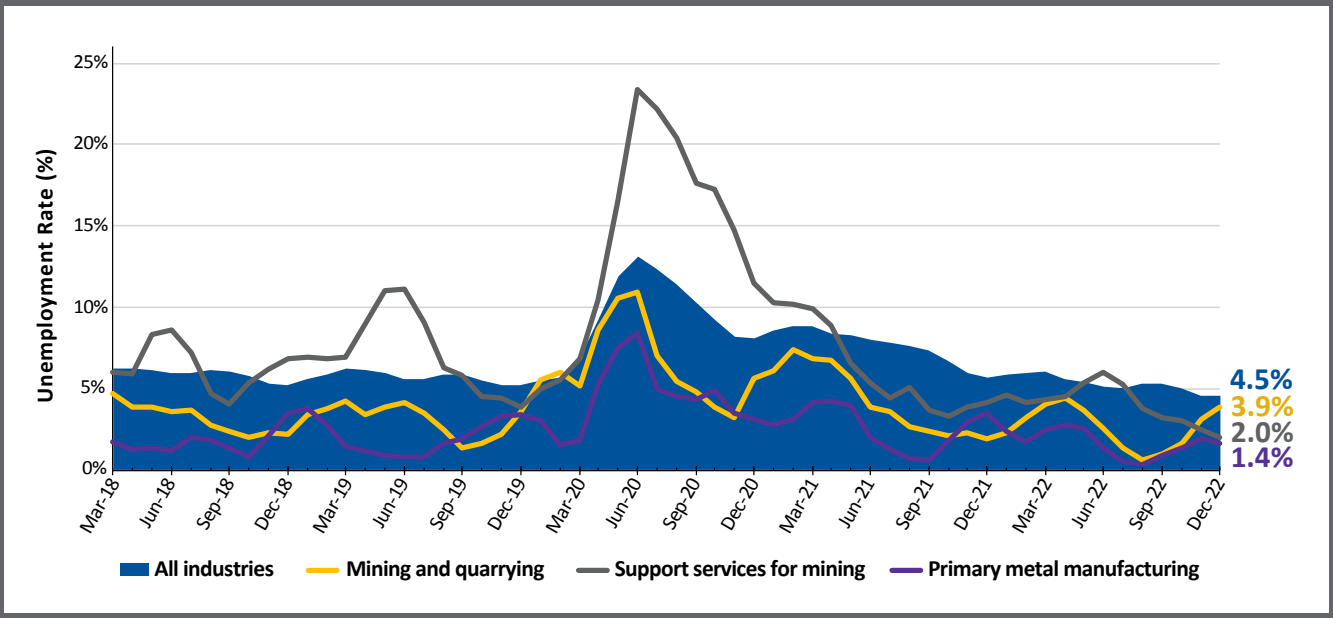
3 Question wording: "Over the next three months, which of the following are expected to be obstacles for this business or organization?"

Indicator #2: Unemployment Rate

A tight labour market will tend to have a lower unemployment rate, as the industry begins to exhaust its available labour pool and there are fewer labour force participants without a job. Consequently, this type of environment is often described as a *job-seeker's market* since those looking for work are in short supply, providing them with additional bargaining power (i.e., the ability to command higher wages, extra benefits/perks, flexible schedules, etc.).

Figure 2 illustrates the rate of unemployment across all industries in Canada, as well as for *Mining and quarrying (NAICS 212), Mining support services (NAICS 213),* and *Primary metal manufacturing (NAICS 331)*. Since peaking at the height of pandemic restrictions in April 2020, unemployment rates for both mining sectors reached historic lows in 2022. Mining unemployment dropped drastically during this interval, falling below 1% in September 2022 – a clear indication of acute labour market tightness in this period.

***FIGURE 2:* UNEMPLOYMENT RATES (THREE-MONTH MOVING AVERAGE), ALL INDUSTRIES AND MINING SUB-SECTORS (2018 – 2022)**



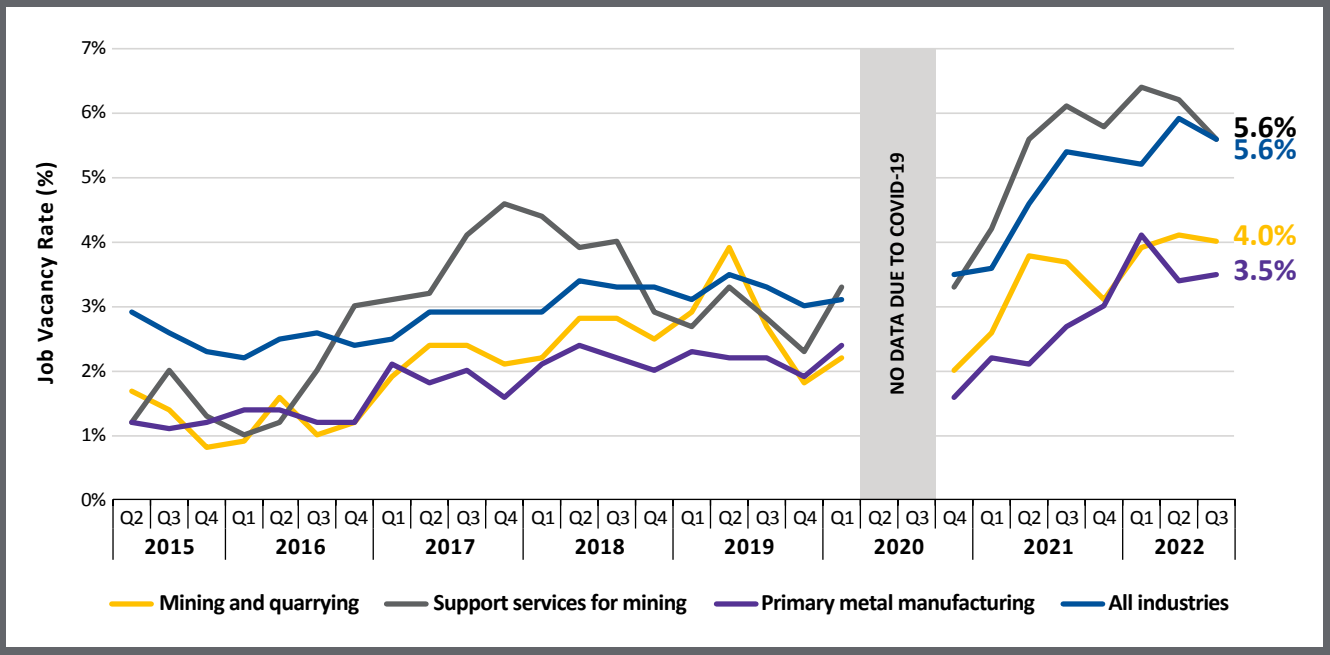
Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Labour Force Survey (Custom Data).

Indicator #3: Job Vacancy Rate

The job vacancy rate measures the percentage of total labour demand that is unfilled job positions. **A tight labour market will display a high job vacancy rate as new openings become more difficult to fill.**

Following a period where data collection was interrupted by the COVID-19 pandemic, job vacancy rates for both *Mining and quarrying (NAICS 212)* and *Mining support services (NAICS 213)* have been on the rise (Figure 3). In both sectors, this indicator has nearly doubled from pre-pandemic levels. The number of unfilled vacancies has also seen unprecedented highs, with 3,415 vacancies in *Mining and quarrying (NAICS 212)* and 4,760 vacancies in *Mining support services (NAICS 213)* as of Q3 2022.

***FIGURE 3:** JOB VACANCY RATES, ALL INDUSTRIES AND MINING SUB-SECTORS (2015 – 2022)*



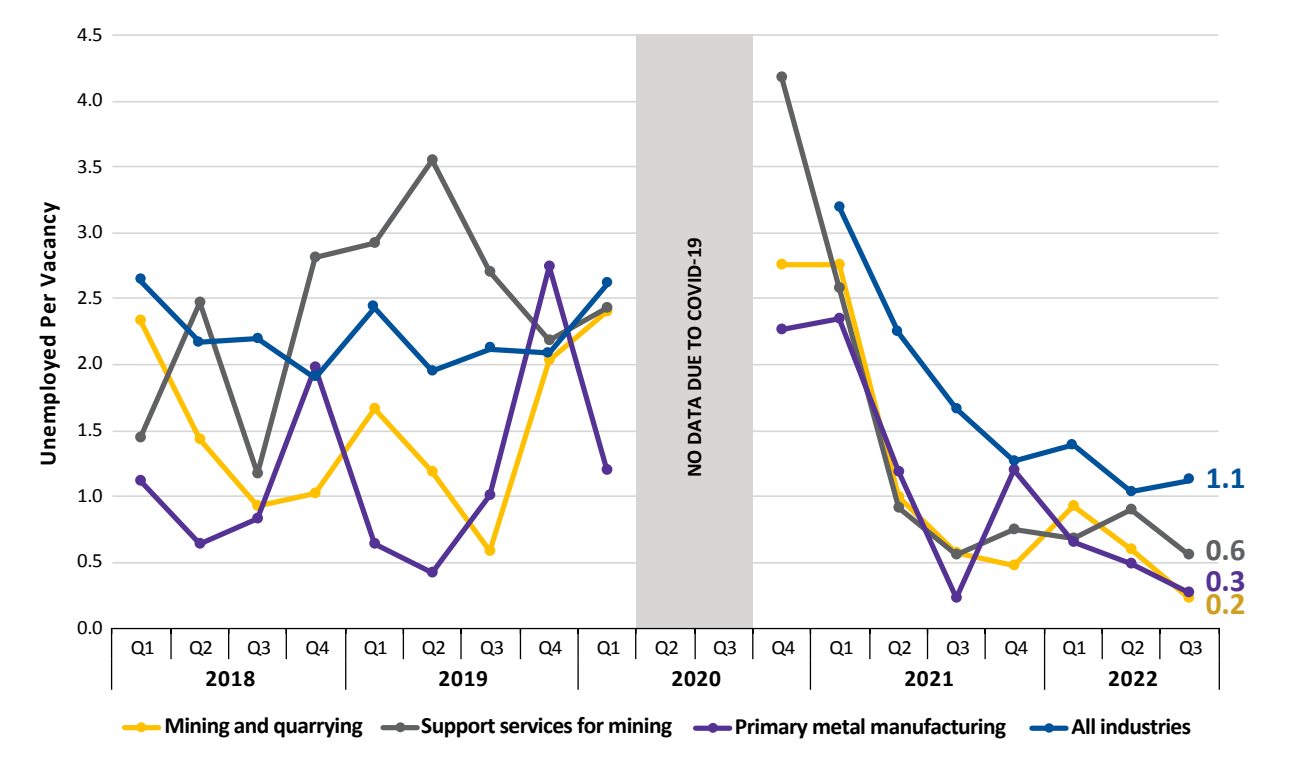
Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Job Vacancy and Wage Survey (Table 14-10-0326-01), 2023..

Indicator #4: Unemployed-to-Vacancies Ratio

The unemployed-to-vacancies ratio compares the number of job seekers with the number of job openings. **A low ratio indicates there are fewer job seekers for every position that is available, pointing to a tight labour market environment where candidates are relatively difficult to find.**

Following the pandemic interruption, this indicator shows a prominent tightening trend in mining related sectors (Figure 4), a combination of having more job openings and fewer people looking for work. Notably, the ratio in *Mining and quarrying (NAICS 212)* has fallen dramatically since the pandemic, from 2.8 to only 0.2 unemployed per job vacancy. This is markedly lower than pre-pandemic levels of roughly 1.5 on average. Other mining-related sectors display a similar trend.

***FIGURE 4:** UNEMPLOYED-TO-VACANCIES RATIO, ALL INDUSTRIES AND MINING SUB-SECTORS (2018 - 2022)*



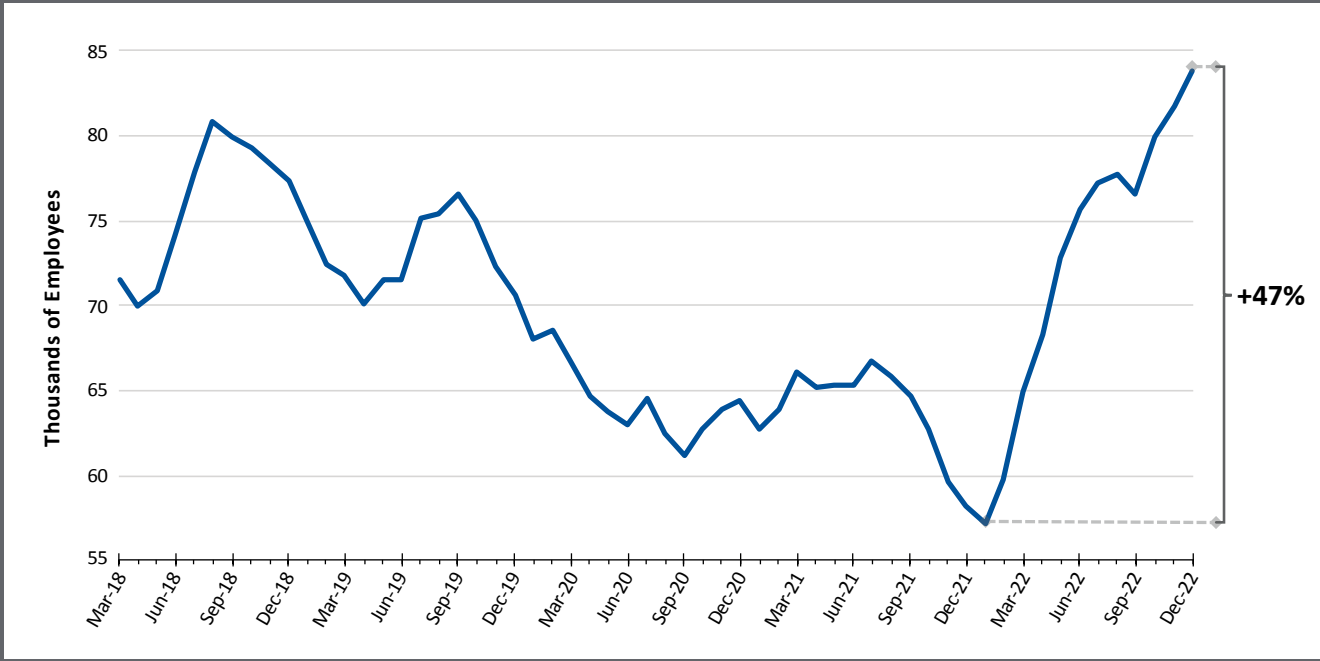
Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Labour Force Survey (Custom Data); Statistics Canada, Job Vacancy and Wage Survey (Table 14-10-0326-01), 2023.

Indicator #5: Employment Growth

Rapid employment growth can be a catalyst for labour market tightness, especially if employment grows at a pace that is unsustainable. Recruitment and workforce training take time and may not respond seamlessly to fast-growing labour demand.

In 2022, employment in *Mining and quarrying (NAICS 212)* expanded aggressively (Figure 5); from January to December, the workforce in this sector increased by about 50%, adding roughly 29,700 workers to its ranks.

***FIGURE 5:** EMPLOYMENT (THREE-MONTH MOVING AVERAGE), MINING & QUARRYING (NAICS 212) (2018 – 2022)*



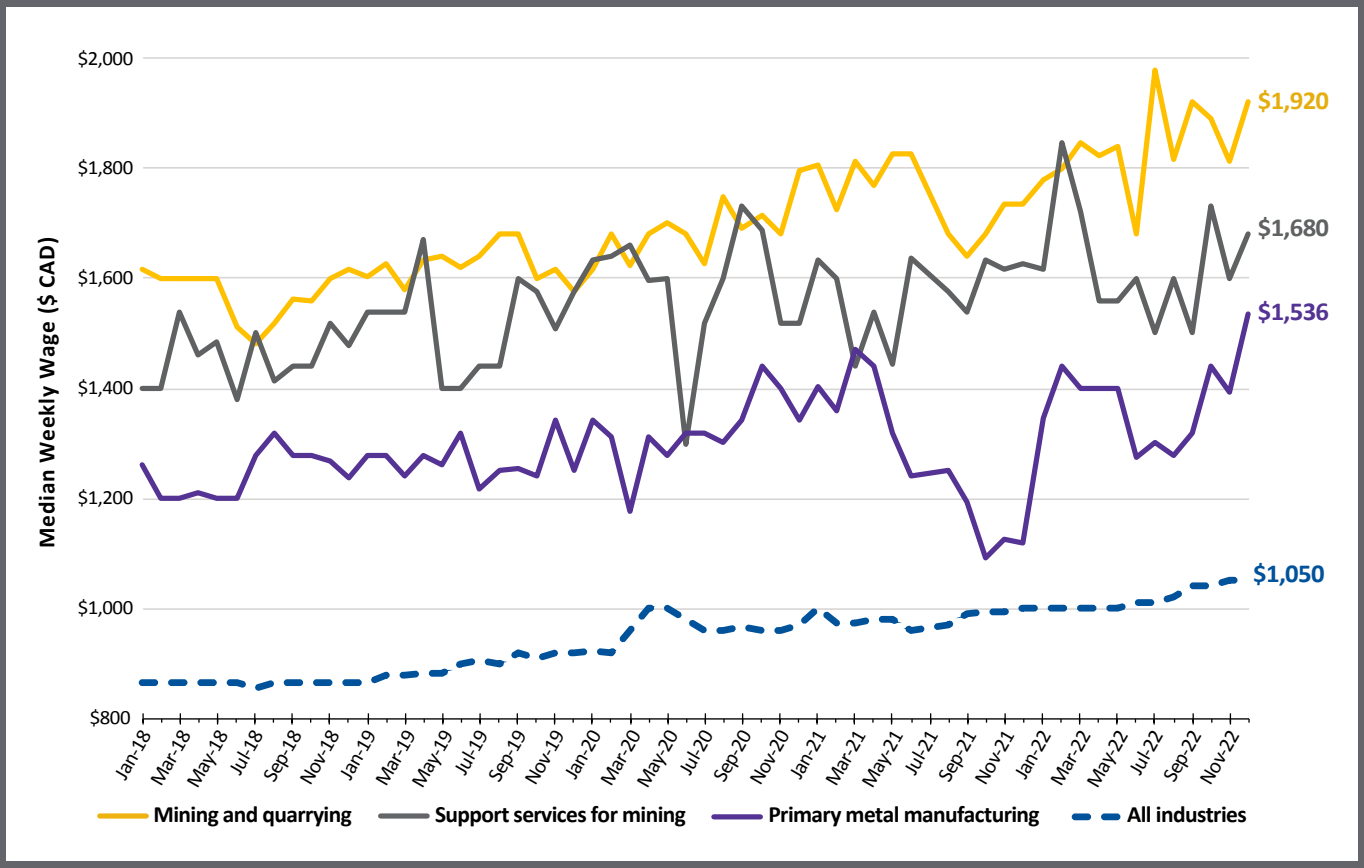
Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Labour Force Survey (Custom Data).

Indicator #6: Wage Growth

A tight labour market will tend to place an upward pressure on wages, as job seekers begin to test their bargaining power with employers who are more desperate to hire workers.

Since January of 2018, median weekly wages across all industries in Canada have grown by 3.9% compounded annually (CAGR) (Figure 6). Though there has been some volatility, wages in *Mining and quarrying (NAICS 212)* grew by 3.5% CAGR over the same period. The pace of this growth accelerated substantially over the last year—from December 2021 to December 2022, wages in this sector had an annualized growth rate of 10.5%. Notwithstanding this aggressive growth, wages in *Mining support services (NAICS 213)* appear to have stagnated (with only 3.3% CAGR), while both sectors exhibit high volatility (and a degree of seasonality). As a result, it is still premature to definitively state whether wage growth in the mining industry is increasing beyond pre-pandemic levels.

***FIGURE 6:** MEDIAN WEEKLY WAGE (THREE-MONTH MOVING AVERAGE), ALL INDUSTRIES AND MINING SUB-SECTORS (2018 - 2022)*



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Labour Force Survey (Custom Data).

Labour Market Checklist Revisited

Collectively, the abovementioned indicators paint a picture of labour market tightness. Table 2 summarizes these findings by evaluating each indicator with a checkmark under three categories: *Tight, Neutral* and *Slack*.

The data are symptomatic of a tightening labour market environment in Canada's mining sector, which began following the pandemic in 2020 and has continued into 2023. While this list is not comprehensive, indicators such as high job vacancies and low unemployment rates provide clear evidence of heightened labour market pressures for mining employers in Canada.

TABLE 2: LABOUR MARKET TIGHTNESS CHECKLIST REVISITED

Indicator	Research Question	Tight	Neutral	Slack
Industry Sentiment	*Do employers feel there is a tight labour market?*		✓	
Unemployment Rate	*Is the pool of job-seekers large enough to accommodate growth in the mining industry?*	✓		
Job Vacancy Rate	*What share of job openings is unfilled?*	✓		
Unemployed-to-Vacancies Ratio	*Are job seekers difficult or easy to find?*	✓		
Employment Growth	*Has employment grown at a sustainable pace?*	✓		
Wage Growth	*Are competitive pressures pushing up wages?*		✓	

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

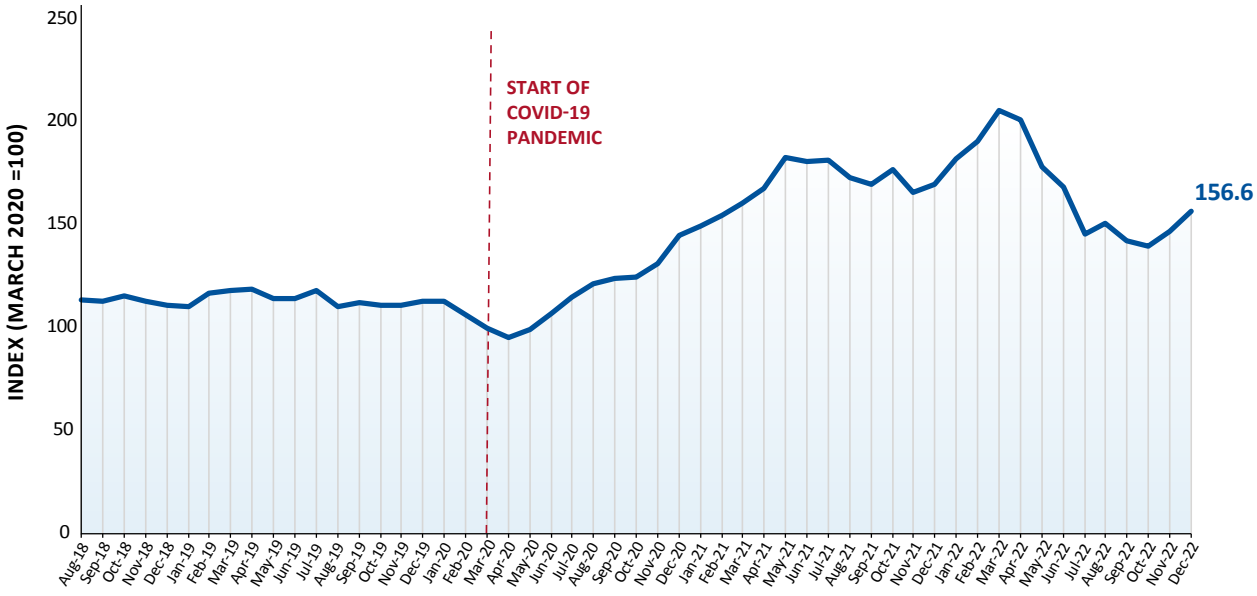
CHAPTER TWO:

REASONS FOR CURRENT LABOUR MARKET TIGHTNESS

The next logical question is "*why is there a tight labour market?*" Undeniably, the past few years have been marked by global economic upheaval, brought about by pandemic lockdowns and restrictions, subsequent re-openings, interruptions to global supply chains, the Russia-Ukraine war, concerns of high inflation and a looming economic recession. Each of these events has contributed to the current acute labour tightness which has been growing since the beginning of the pandemic. Their effects can be observed in mineral prices and industry spending.

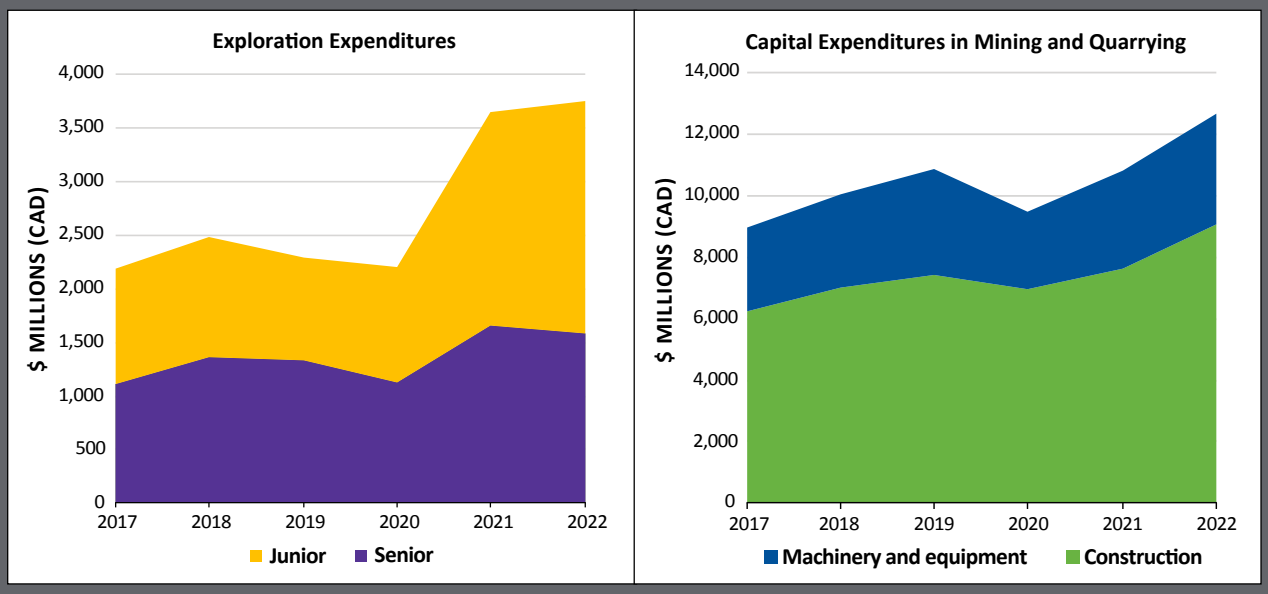
From April 2020 to March 2022, metals and mineral prices soared by 105% (Figure 7). Since then, prices have stabilized to a level 57% higher than April 2020. This near-term spike in prices has fuelled an increase in exploration spending and capital expenditures (Figure 8) as well as a surge in employment in *Mining and quarrying (NAICS 212)* (Figure 5).

FIGURE 7: METALS AND MINERALS PRICE INDEX (2018 – 2022)



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; World Bank, Metals & Minerals Price Index (accessed via Ycharts), 2023.

FIGURE 8: EXPLORATION EXPENDITURES AND CAPITAL EXPENDITURES, MINING AND QUARRYING (NAICS 212) (2017 – 2022)



Source: Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Natural Resources Canada, Exploration Plus Deposit Appraisal Expenditures, by Mineral Commodity Sought 2017 - 2020 Annual, 2021 Preliminary Estimates and 2022 Spending Intentions; Statistics Canada, Annual Capital Expenditures Survey: Actual, Preliminary Estimate and Intentions (CAPEX) (Table: 34-10-0035-01), 2023.

SHIFTING FOCUS TO LONG-TERM LABOUR SUPPLY CHALLENGES

The events of the past three years can be characterized as shorter-term disruptions, which may lead to many trends correcting or reverting to their normal state. Eventually, global supply chains will resolve their issues, inflationary concerns will subside and global conflicts like the Russia-Ukraine war will end, though the timing of these developments is highly uncertain.

Of greater concern are longer-term forces that continue to undermine the mining labour supply's ability to effectively respond to periods of growth. These are factors that are comparatively persistent and are unlikely to be resolved without intervention. For example, unfavourable demographics in the mining industry (including the rising percentage of workers who are nearing retirement age, and the lack of young workers entering the industry), dwindling post-secondary enrolment in important mining-related programs, the continued underperformance in attracting key underrepresented groups, among other related issues. These challenges are discussed in depth in MiHR's *Canadian Mining Workplace Profile (2023).*

The next section aims to diagnose longer term labour market tightness by developing a forecast for Canada's mining labour market.

CHAPTER THREE:

LABOUR MARKET OUTLOOK AND FORECAST

MiHR's labour market projections aim to identify key areas where the mining industry will face labour challenges, particularly in ensuring there is a sustainable labour source that can meet the competitive demands of the industry.

MiHR's forecasting is centered on three main research questions:

A) What will be the mining industry's labour demand in the future?

MiHR's industry employment forecast provides an estimate of the demand for labour in the mining industry (i.e., the optimal employment level) over the next decade (2023–2033).

B) What workforce adjustments will be required to achieve the optimal level of industry employment?

The industry's employment level, at any given time, is sustained by ongoing recruitment efforts. MiHR's forecast of hiring requirements estimates the cumulative workforce adjustments that will be necessary to maintain the optimal level of employment over the next decade.

C) How difficult will it be to meet the required workforce adjustments?

The industry's ability to satisfy its hiring requirements will depend on whether there is a sufficient number of new workers (i.e., graduates, migrants, etc.) entering mining-related occupations. A healthy labour market will draw enough entrants to offset future hiring needs.

A) FUTURE LABOUR DEMAND

Central to MiHR's analysis of the mining labour market is a forecast of industry employment over a 10-year horizon. MiHR uses a time-series econometric model, which considers historic patterns and various leading explanatory factors to predict future employment levels in three mining sub-sectors. For each sub-sector, the best fitted model with the lowest prediction error was selected.

MiHR developed the following three economic scenarios for employment projections to capture the industry's underlying volatility relative to changes in economic conditions:

1) Baseline scenario:

The mean forecasted values serve as the baseline benchmark for MiHR's labour market forecast. The forecast considers the employment trend in each sub-sector since 1999[4] and the impact on employment of key predictive variables such as World Bank commodity prices of metals and minerals, which is a strong indicator of the industry's vitality[5]. Future values of indicators were based on consensus estimates from reliable sources. For instance, World Bank's latest projected commodity prices were used which anticipates a price correction over the next few years from the pandemic price hike before stabilizing[6]. MiHR's baseline employment projection reflects this conservative commodity price outlook.

2) Expansionary scenario:

MiHR's expansionary scenario is estimated from the *upper bound 20% prediction interval*, relative to the baseline benchmark forecasted values. A prediction interval is the estimated interval within which the forecasted value is expected to fall, given a margin of error. This scenario captures the possibility of an alternative environment where future employment levels trend upward (relative to the baseline benchmark) due to, for instance, commodity prices following a new high price regime, or interest rates remaining low.

3) Contractionary scenario:

MiHR's contractionary scenario is estimated from the *lower bound 20% prediction interval*, relative to the baseline benchmark forecasted values. This scenario poses a contrarian scenario to the expansionary whereby future employment levels trend downwards (relative to the baseline benchmark) due to, for example, commodity prices being lower than World Bank's projected estimates.

MiHR's forecast implicitly assumes that the future will somewhat resemble the past. While the different scenarios capture some inherent uncertainties, there are still limitations to projections. The model does not account for unexpected or unpredictable events that may occur during the time horizon analyzed. The effects of potential exogenous shocks on mining employment, such as the faster adoption of innovative technology or transition to a greener economy are explored qualitatively in this section.

How This Year's Forecast Differs from Previous Years

Forecasting in MiHR's *Canadian Mining Outlook (2023)* may differ from previous versions due to adjustments in underlying methodology, industry definition and data sources. One substantial change is industry transfers: after a review of previous forecasts, the estimate for workers transferring to-and-from the mining industry has been adjusted upward to reflect new information regarding this ongoing occurrence. The result is a greater hiring requirement forecast compared to previous years, but not necessarily after accounting for new entries into the mining sector (see the gap analysis).

Moreover, this version of the forecast does not include the exploration sub-sector due to data limitations in defining the sector. MiHR will investigate this sub-sector in more detail in an upcoming study to be released in late 2023.

4 Historic employment data is from Statistics Canada's System of National Accounts (SNA) (Table: 36-10-0489-01). Employment levels cited in Chapter 3 differ from those in Chapter 1 due to use of different data sources (i.e., labour force survey versus SNA), and the use of a robust set of NAICS codes in Chapter 3 (see Appendix A for details).

5 Other predictive indicators include Federal Reserve Economic Data (FRED) database inflation-adjusted interest rates, Statistics Canada import and export of metal ores and non-metallic minerals. Both one year lag and coincident values were considered for all indicators.

6 World Bank. (2023). Pink Sheet Data Commodity Prices. https://www.worldbank.org/en/research/commodity-markets#1

Mining Employment Outlook

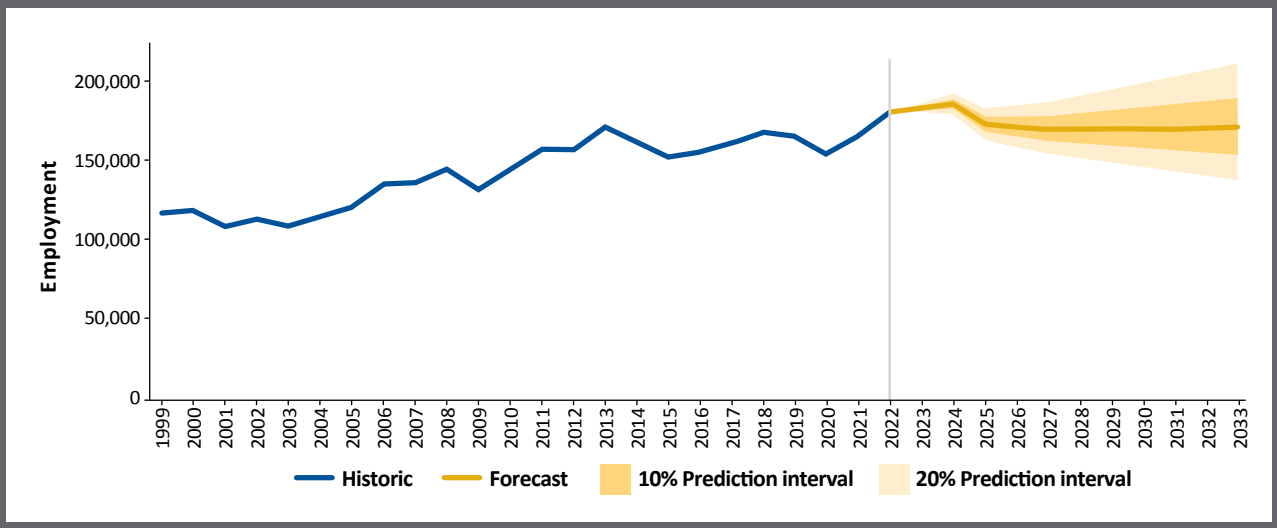
Figure 9 illustrates the overall mining industry employment outlook (historical and forecasted). In 2020, the COVID-19 pandemic led to a 7% fall in employment levels from the previous year. This disruption proved to be temporary, as the mining industry saw a steadfast recovery back to its pre-pandemic employment levels in 2021, followed by a further growth of 9% in 2022 to reach 180,438 employed[7].

Under the baseline scenario, MiHR projects the mining industry employment will decrease by about 5% to 170,796 employed in 2033. Under the expansionary scenario, employment is projected to increase to 211,806 workers (or a 17% increase), whereas under the contractionary scenario, employment is projected to decrease to 137,501 workers (or a 24% decrease).

MiHR's baseline projection suggests the pace of employment growth experienced over the past year is not sustainable in the long run. This rapid growth is attributed to the post-pandemic environment driven by the reopening of the economy, a surge in commodity prices, and low real interest rates. As commodity prices dwindle per the World Bank's projections, and a higher interest rate scheme is implemented to tackle inflation per Federal Reserve Economic Data (FRED) database projections, the rate of growth in employment will slow down in the short run (a moderate 3% growth between 2023 and 2024), followed by a sharp decline in the medium run (a 9% decline between 2025 and 2027). Stabilization of commodity prices and other indicators is anticipated in the long run leading to a modest employment growth (a 1% growth between 2028 and 2033). Under the expansionary scenario, the long run growth is estimated to be 13% over the same period.

7 Note that 2022 employment levels were estimated using Statistic Canada's monthly Labour Force Survey and anchored to SNA employment levels to account for survey inconsistencies.

FIGURE 9: HISTORICAL AND FORECASTED EMPLOYMENT IN THE MINING INDUSTRY (1999 – 2033)



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Employment Outlook by Mining Sub-Sector

Figure 10 illustrates the employment outlook for the mining industry broken down by its three main sub-sectors– *Extraction and Milling, Support Services* and *Primary Metal Manufacturing. Extraction and Milling* workers make up the majority of the mining industry (about 64% in 2022), followed by *Primary Metal Manufacturing* workers (about 22% in 2022) and *Support Services* workers (about 14% in 2022). Historically, employment in *Extraction and Milling* and *Support Services* has been gradually trending upwards while *Primary Metal Manufacturing* employment has trended downwards. In recent years, a pattern of temporary decline in employment (due to the pandemic) and subsequent recovery can be observed across all three sub-sectors.[8]

Employment projections for the sub-sectors are as follows under the baseline scenario:

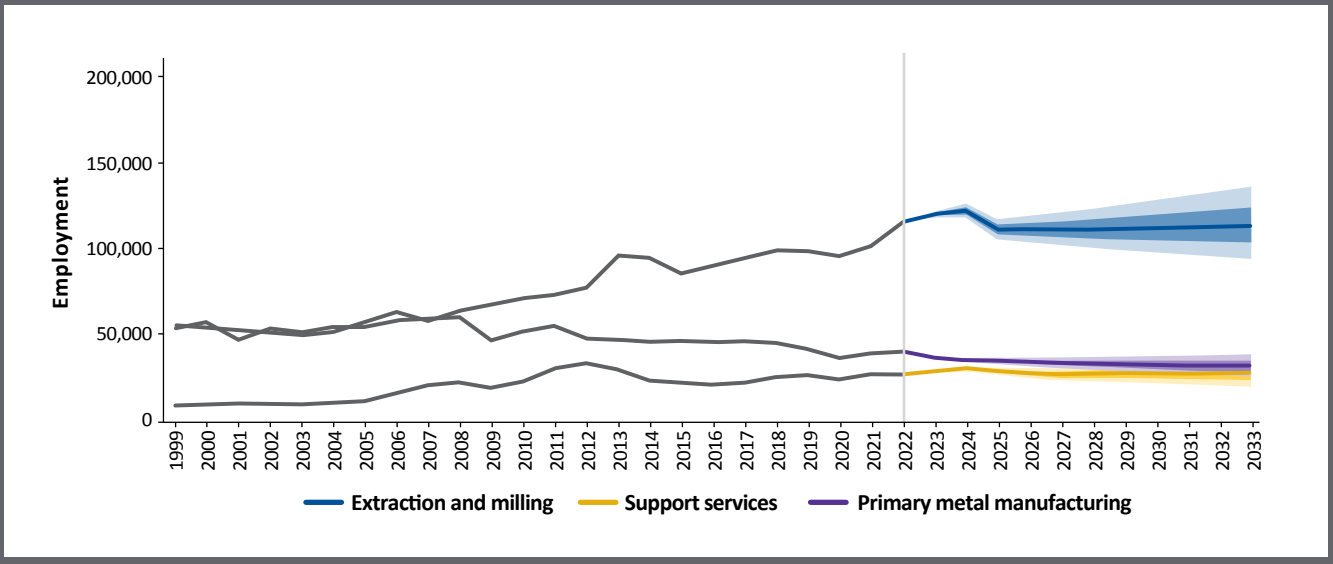
1) *Extraction and Milling* is estimated to decrease by about 2% from 114,935 workers in 2022 to 112,912 workers in 2033.

2) *Support Services* is estimated to have a moderate increase of roughly 4% from 26,107 workers in 2022 to 27,024 workers in 2033.

3) *Primary Metal Manufacturing* is estimated to decrease substantially by 22% from 39,396 workers in 2022 to 30,860 workers in 2033.

8 The share of sub-sector employment in 2033 is expected to remain roughly the same as 2022 (*Extraction and Milling at 66%, Support Services at 16%, and Primary Metal Manufacturing at 18%*).

***FIGURE 10:* HISTORICAL AND FORECASTED EMPLOYMENT IN MINING SUB-SECTORS (1999 – 2033)**



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

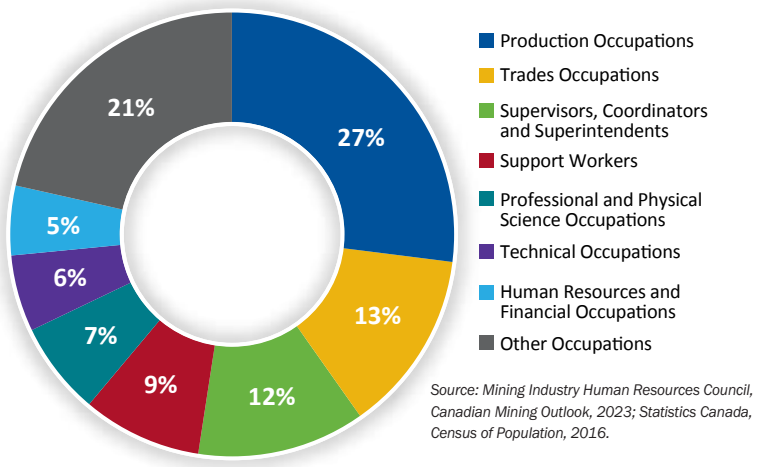
Occupational Mix

Forecasting for specific occupations depends on the mining industry's 'occupational mix', which describes the combination of critical jobs that are expected to comprise future labour demand.

MiHR has identified 120 mining-relevant occupations aligned with the National Occupational Classification (NOC) System for defining occupations (see Appendix A for more information). These range from occupations in production and operations (e.g., heavy equipment operators) to tradespeople, (e.g., mechanics) to professional and physical sciences (e.g., geologists).

Occupations are grouped into one of eight broad occupational categories (Figure 11). As reported by the 2016 Census, the largest segment is *Production Occupations,* which comprises about 27% of all mining labour demand, followed by *Trades Occupations* (13%) and *Supervisors, Coordinators, and Foremen* (12%). Table 3 reports the top ten occupations in each mining-sub sector by share of employment. For the purposes of this analysis, MiHR assumes the occupational mix will reflect the historical data and remain consistent over the forecasting period.[9]

FIGURE 11: SHARE OF EMPLOYMENT BY BROAD OCCUPATIONAL CATEGORY (2016)



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Census of Population, 2016.

TABLE 3: TOP 10 OCCUPATIONS BY SHARE OF EMPLOYMENT IN MINING SUB-SECTORS (2016)

	EXTRACTION AND MILLING		SUPPORT SERVICES		PRIMARY METAL MANUFACTURING	
Rank	**Position**	**Share of Total**	**Position**	**Share of Total**	**Position**	**Share of Total**
1	Underground production and development miners	14.5%	Transport truck drivers	5.2%	Machine operators, mineral and metal processing	9.6%
2	Heavy equipment operators (except crane)	8.8%	Managers in natural resources production and fishing	3.1%	Construction millwrights and industrial mechanics	6.9%
3	Supervisors, mining and quarrying	6.4%	Underground production and development miners	2.9%	Labourers in mineral and metal processing	5.0%
4	Construction millwrights and industrial mechanics	6.3%	Construction millwrights and industrial mechanics	2.7%	Supervisors, mineral and metal processing	4.5%
5	Transport truck drivers	4.4%	Heavy equipment operators (except crane)	2.6%	Welders and related machine operators	4.1%
6	Industrial electricians	3.0%	Welders and related machine operators	2.3%	Metalworking and forging machine operators	3.6%
7	Heavy-duty equipment mechanics	3.0%	Senior managers - construction, transportation, production and utilities	2.3%	Manufacturing managers	3.5%
8	Mine labourers	2.9%	Administrative officers	1.9%	Crane operators	3.3%
9	Managers in natural resources production and fishing	2.4%	Supervisors, mining and quarrying	1.7%	Labourers in metal fabrication	2.8%
10	Underground mine service and support workers	2.2%	Financial auditors and accountants	1.6%	Industrial electricians	2.7%

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Statistics Canada, Census of Population, 2016.

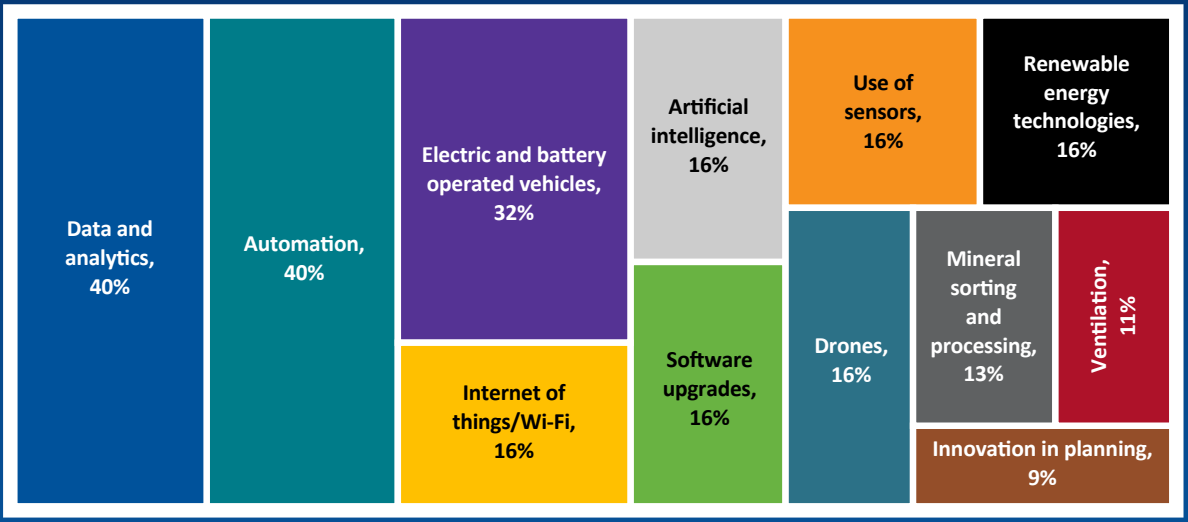
9 Note that the occupational mix is constantly in flux as demand for different occupations will rise and fall depending on where mining projects are in the mining life cycle and macroeconomic conditions. In addition, this could change radically with new technology and increased demand for critical minerals. The baseline forecast assumes that operations are more likely to adhere to the status quo.

BOX 1

ADOPTION OF INNOVATIVE TECHNOLOGIES

The use of new and innovative technologies has been rapidly expanding in mining companies worldwide to create safer workplaces, improve productivity, and access deeper, narrower and more complex deposits at lower costs. In recent years, Canadian mining sites have increasingly adopted innovative technologies such as autonomous trucks with pre-defined GPS courses, remote collection of real-time data from mining locations and the use of predictive algorithms to enhance the precision and speed of gold recovery. A qualitative study done by MiHR in 2019[10] asked mining stakeholders to identify innovations in Canadian mining operations that have already been implemented or will be implemented in the near future. The most frequently cited innovations were data and analytics (40%) and automation (40%), followed by electric and battery-operated vehicles (32%) (Figure 12).

FIGURE 12: INNOVATIONS IN CANADIAN MINING OPERATIONS BY SHARE OF RESPONDENT CITATIONS (2019)



Source: Mining Industry Human Resources Council, The Changing Nature of Work, 2020.

The new generation of equipment and processes leveraging data analytics and automation is changing the nature of mining work, placing increasing pressure on the workforce to adjust to new skillset requirements, different workplace roles and a different personnel structure.

While it is difficult to gauge the scale and timing of technological change, it is clear that automation will fundamentally alter the occupational mix of the industry. Disruption from automation is predicted to be disproportionately higher for low-skilled workers who perform manual labour or repetitive jobs, such as drilling and blasting, as well as transportation and hauling jobs, which will largely be supported by autonomous equipment. Demand will shift toward workers with specialized skills and knowledge, such as those with expertise in operating and maintaining advanced technology and machinery. Technologies such as artificial intelligence, machine learning and Internet of Things (IoT) will create demand for new jobs for workers with skills in data analysis, computer programming, and other technology-related fields, as mining companies increasingly rely on advanced analytics and data management systems to optimize their operations. Table 4 provides a list of occupations most likely to be in demand in the immediate term and over the next five to 10 years, as perceived by Canadian mining stakeholders based on the 2019 MiHR qualitative study.

10 The qualitative study involved the participation of about 125 Canadian mining stakeholders who have direct, relevant knowledge of the Canadian mining context. MiHR conducted interviews, an online survey, a focus group, case studies, and validation sessions to capture a broad spectrum of views and expertise.

TABLE 4: OCCUPATIONS IN DEMAND OVER THE NEXT FIVE YEARS, PERCEIVED BY CANADIAN MINING STAKEHOLDERS (2019)

Over the immediate term	Over the next five years		Over the next decade
• Electrical Engineers • Automation Engineers • Instrumentation Technologists • Instrumentation Technicians • Network Analysts • Network Programmers	• Strategic Planners • Programmers • Data Scientists • Geologists • IT Specialists in Fibre Optic & Wireless Technologies • Engineers	• Systems Engineers • Systems Integrators • Software Experts • Data Analysts • Generalists • Facilitators • HR Experts • Instrumentation Tech, Engineers, Geologists	• Data Scientists • Data Analysts • Mechatronics Engineers • Engineers with Background in Data Science / Optimization

Source: Mining Industry Human Resources Council, The Changing Nature of Work, 2020.

Overall, innovation will have significant implications for the workforce and for the education and training needed for future mining industry employees. It is important for mining companies to plan accordingly to mitigate the negative effects of job displacement and to provide training and upskilling opportunities for employees to adapt to the new occupational mix. The increased demand for higher skills and knowledge will raise the threshold for basic education and training as workers will continue to expand their knowledge and expertise into other areas of mining.

B) WORKFORCE ADJUSTMENTS

MiHR considers two main factors that contribute to workforce adjustments in the mining industry: *net change in employment and expected exits*. Net change in employment describes changes in labour demand due to industry expansion or contraction. Expected exits refer to individuals leaving Canada's mining industry, either through retirement, industry-migration, or other avenues.

Adjustments from Net Change in Employment

Using MiHR's employment forecast, the cumulative net change in employment is calculated for mining sub-sectors and broad occupational categories across the three economic scenarios – contractionary, baseline, and expansionary.

Net Change in Employment by Sub-sector

Table 5 shows the cumulative net change in employment for each mining sub-sector over the forecasted 10-year horizon (2023 – 2033). Under the baseline scenario (i.e., using a conservative outlook for commodity prices), the mining industry is expected to employ 9,642 fewer workers (about a 5% decline from 2022) over the forecast period.[11]

Among the three sub-sectors, only *Support Services* is expected to grow over the next decade with an addition of 917 workers (about a 4% growth from 2022), under the baseline scenario. *Primary Metal Manufacturing* is expected to face the largest contraction with 8,536 fewer workers (about a 22% fall from 2022).

11 Appendix B further explore the adjustments from cumulative net change in employment across three time periods – short run, medium run and long run. This makes it possible to parse out the volatility of the employment levels across the 10-year time horizon.

TABLE 5: FORECAST SCENARIOS OF CUMULATIVE NET CHANGE IN EMPLOYMENT BY SUB-SECTOR (2023 – 2033)

	Contractionary	Baseline	Expansionary
Extraction and Milling	-21,474	-2,023	21,041
Support Services	-6,928	917	11,575
Primary Metal Manufacturing	-14,536	-8,536	-1,248
All Sub-sectors	**-42,937**	**-9,642**	**31,368**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Net Change in Employment by Occupation

Table 6 shows the cumulative net change in employment for each broad occupational category over the forecasted 10-year horizon (2023 – 2033). *Production occupations* is expected to experience the largest contraction under the baseline and contractionary scenarios, but also the most growth under the expansionary scenario, mainly because this category is the largest segment of the mining workforce. Under the baseline scenario, the industry is anticipated to reduce 2,603 workers in this occupational category.

TABLE 6: FORECAST SCENARIOS OF CUMULATIVE NET CHANGE IN EMPLOYMENT BY MINING OCCUPATION (2023 – 2033)

	Contractionary	Baseline	Expansionary
Human Resources and Financial Occupations	-2,174	-488	1,588
Production Occupations	-11,592	-2,603	8,468
Professional and Physical Science Occupations	-2,908	-653	2,125
Supervisors, Coordinators and Superintendents	-5,242	-1,177	3,830
Support Workers	-3,728	-837	2,724
Technical Occupations	-2,394	-538	1,749
Trades Occupations	-5,677	-1,275	4,148
Other Occupations[12]	-9,221	-2,071	6,736
All Occupations	**-42,937**	**-9,642**	**31,368**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

12 *Other Occupations* refers to a large group of four-digit NOC occupations not necessarily exclusive to mining operations, and outside the critical occupations targeted in this analysis, but employed by the industry nonetheless (e.g., registered nurses, light duty cleaners, security guards, etc.)

Adjustments from Exits

Employee exits are a common and ongoing occurrence for all industries and the mining industry is no exception. Workers exit the mining labour force for various reasons. MiHR's forecasting captures two main categories of exits: (1) Mining labour force exits (retirements) and (2) Mining industry exits.

Mining labour force exits (retirements) estimates the number of individuals exiting the labour force altogether. The vast majority of labour force exits are primarily due to retirement, but may also include other reasons such as going back to school, starting maternity/paternity leave, etc. Labour force exits describe former mining industry participants who are no longer in the labour force.

MiHR's model of labour force exits takes into account demographic characteristics (such as age and educational attainment) to estimate the share of workers anticipated to withdraw from the mining labour force over time. Labour force exits in mining sub-sectors have risen as the demographics of the mining industry have continued to follow an aging trend. From 2023 to 2033, the average labour force exit rate is expected to be 2.3% per year in the mining industry (Figure 13). Among mining sub-sectors, *Primary Metal Manufacturing* exhibits the highest exit rate, followed by *Support Services* and *Extraction and Milling*.

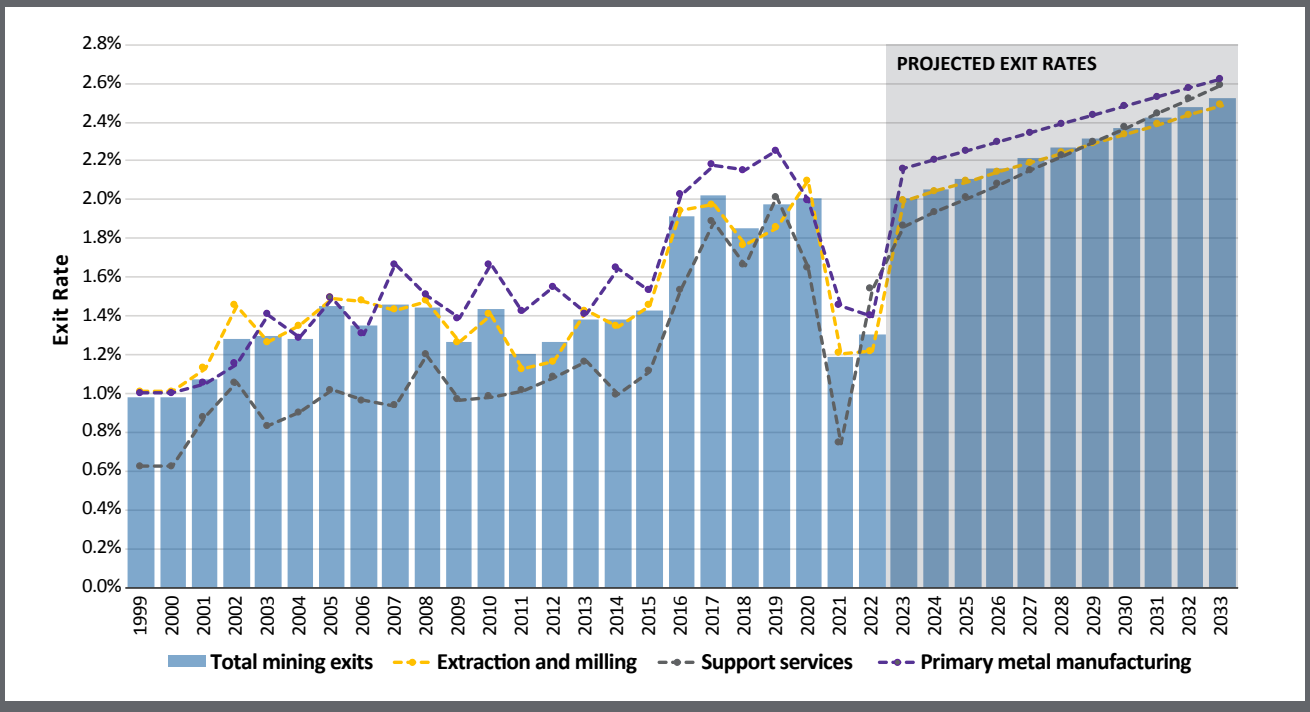
Mining industry exits estimates the number of individuals leaving the mining industry to work in another industry. Although cross-industry mobility is a normal and ongoing reality, every exit generates hiring pressures for employers.

Given that information related to industry exits is rather sparse, MiHR has relied on limited available literature to estimate a reasonable industry exit rate over the forecast period. Notable information includes historical turnover data previously collected by MiHR, the US Bureau of Labour Statistics and historical data from the Survey of Labour and Income Dynamics (SLID).[13]

MiHR's forecast assumes the annual industry exit rate will range between 6%-7% in the three mining sub-sectors. For occupational categories, the forecast assumes a couple of deviations: 8% for *Production occupations* and 5% for *Human Resources and Financial Occupations*, *Professional and Physical Science Occupations and Supervisors*, *Coordinators and Superintendents*.

13 Notable resources consulted include: Xuyang Chen and Maxime Fougère (2009) *Inter-provincial and Inter-industry Labour Mobility in Canada, 1994-2005*, the Survey of Labour and Income Dynamics (SLID). (Note that SLID has since been discontinued in 2011) and the US Bureau of Labour Statistics forecast of "occupational separations (2021-2031)" (https://www.bls.gov/emp/documentation/separations.htm).

FIGURE 13: ***HISTORIC AND FORECASTED LABOUR FORCE EXIT RATES BY MINING SUB-SECTOR (1999 - 2033)***



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Hiring Requirements

MiHR's forecast of hiring requirements gauges the human resources efforts (i.e., hiring effort) required to ensure that, over time, the forecasted mining industry employment (Figure 9) is attained. The hiring requirement is estimated as the sum of net change in employment, mining labour force exits and mining industry exits – each of which create hiring pressures for the industry.

Table 7 presents industry-wide cumulative hiring requirements for the forecast period, under the three economic scenarios. The projected 10-year cumulative hiring requirements are as follows: 158,220 workers for the baseline scenario; 220,193 workers for the expansionary scenario; and 106,678 workers for the contractionary scenario. The majority of hiring requirements are expected to come from replacing exiting workers.

TABLE 7: FORECAST SCENARIOS OF CUMULATIVE HIRING REQUIREMENTS IN MINING (2023 – 2033)

		Contractionary	Baseline	Expansionary
Cumulative Net Change in Employment		-42,937	-9,642	31,368
Replacement Requirements	Cumulative Labour Force Exits	38,298	43,118	48,669
	Cumulative Industry Exits	111,317	124,744	140,156
Cumulative Hiring Requirements		**106,678**	**158,220**	**220,193**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Hiring Requirements by Sub-Sector

Table 8 provides the cumulative hiring requirements for the forecast period for each sub-sectors, under the three economic scenarios. *Extraction and Milling* is expected to make up the vast majority of the hiring requirements with of 108,481 additional workers needed under the baseline scenario.

TABLE 8: FORECAST SCENARIOS OF CUMULATIVE HIRING REQUIREMENTS BY MINING SUB-SECTOR (2023 – 2033)

	Contractionary	Baseline	Expansionary
Extraction and Milling	78,338	108,481	143,530
Support Services	14,050	25,921	41,524
Primary Metal Manufacturing	14,365	23,818	35,033
All mining sub-sectors	**106,678**	**158,220**	**220,193**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Hiring Requirements by Occupation

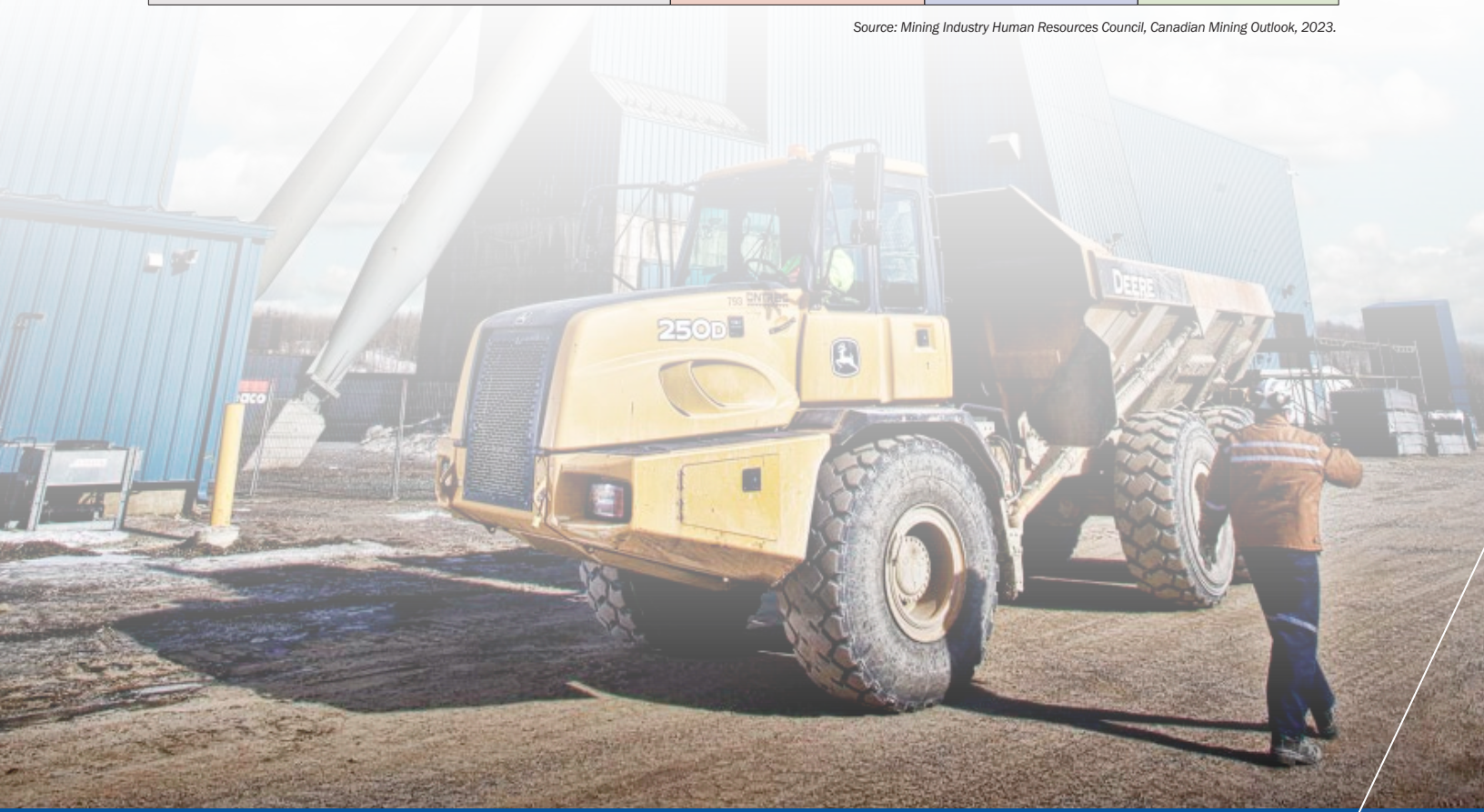
Table 9 provides the cumulative hiring requirements for the forecast period for each broad occupational category, under the three economic scenarios.

Production occupations is expected to constitute the bulk of hiring requirements with a requirement of 51,497 additional workers under the baseline scenario.

TABLE 9: FORECAST SCENARIOS OF CUMULATIVE HIRING REQUIREMENTS BY MINING OCCUPATION (2023 – 2033)

	Contractionary	Baseline	Expansionary
Human Resources and Financial Occupations	4,188	6,653	9,624
Production Occupations	36,642	51,497	69,307
Professional and Physical Science Occupations	5,608	8,905	12,879
Supervisors, Coordinators and Superintendents	10,130	16,074	23,239
Support Workers	8,717	13,127	18,434
Technical Occupations	6,578	9,528	13,070
Trades Occupations	13,315	20,033	28,116
Other Occupations	21,499	32,404	45,524
All Occupations	**106,678**	**158,220**	**220,193**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.



C) RELATIVE DIFFICULTY OF WORKFORCE ADJUSTMENTS

MiHR's gap analysis investigates whether new entrants to mining-related occupations can adequately offset future hiring requirements. A shortfall of new entrants points to potential risks for mining operations; a thin labour supply can derail projects, drive up the cost of finding workers and ultimately undermine an operation's ability to continue to run competitively.

Expected Entries

Entries represent the opportunity to neutralize the pressures and costs associated with hiring; that is, the burden of replacing a worker lessens if there is an abundant availability of qualified candidates. MiHR's model of expected entrants provides a forecast of new entrants to the mining labour market. Counter to the expected exits, MiHR considers two parallel categories of entries: (1) Mining labour force entries and (2) Mining industry entries.

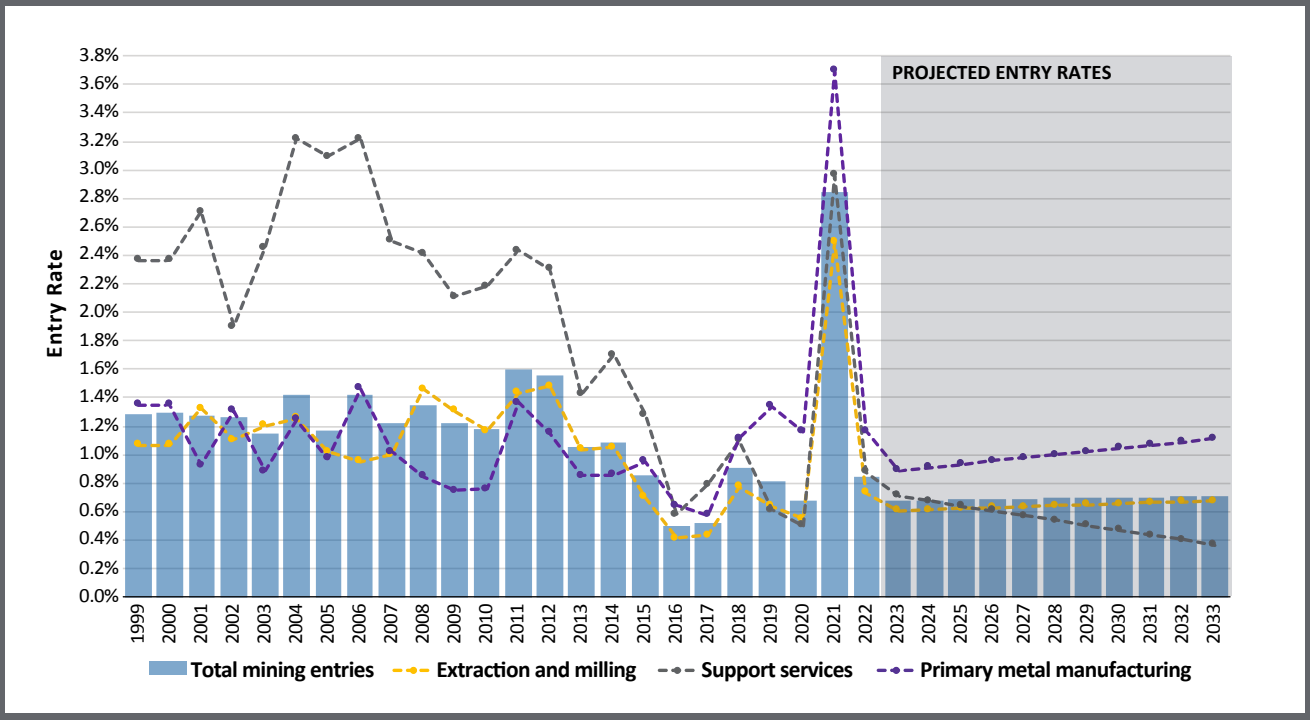
Mining Labour Force Entries

A model of labour force entries covers a variety of entry points. Firstly, students transitioning from school into the labour force comprise the lion's share of new entrants, but labour force entries are inclusive of all cases of people joining the labour force (i.e., non-students who were previously not in the labour force for any reason).

The method for estimating labour force entries is the same as labour force exits (See "Adjustments from Exits"), except the focus is on individuals' likelihood of entering the mining labour force, based on historical trends and their key demographic characteristics.

From 2023 to 2033, the average labour force entry rate is expected to be 0.7% per year in the mining industry (Figure 14). Among mining sub-sectors, *Extraction and Milling* shows the lowest expected entry rates, suggesting that this group will face the greatest pressure to obtain new entrants for its workforce.

***FIGURE 14:** HISTORIC AND FORECASTED LABOUR FORCE ENTRY RATES BY MINING SUB-SECTOR (1999 - 2033)*



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Mining Industry Entries

Mining industry entries are parallel to the previously derived mining industry exits. As workers continually switch roles throughout their working life, one industry's entry also represents another's exit. The key question is whether transfers between industries are in balance. If exits to other industries consistently surpass entries, the mining workforce will experience attrition over time.

This balance of industry exits and entries will depend on the economic push and pull of different industries through their cycles over time. Therefore, MiHR considers three scenarios of mining industry entries based on their degree of balance with mining industry exits. To cover the range of possibilities in the forecast, three scenarios describe industry entries as follows:

1) Balanced scenario: Industry entries equal industry exits.

2) Inflow Scenario: Industry entries exceed industry exits (+2%).

3) Outflow Scenario: Industry entries fall behind industry exits (-2%).

Gap Analysis and Labour Market Tightness

MiHR's gap analysis combines hiring requirements with forecasts of entries into one comparative analysis of sub-sector and broad occupational categories. A hiring gap occurs when expected entries are unable to cover the forecasted hiring needs. Hires that stretch beyond the obtainable labour supply represent an additional burden to employers to increase their effort to meet their labour demand.

A hiring gap further provides a signal of labour market tightness in the long-term view. Unlike short term tightness, where certain economic factors are cyclical and likely to resolve over time, long-term tightness anticipates an un-reversing trend led by long-term demographic and economic factors.

Gap Analysis for the Mining Industry

A gap-sensitivity analysis for the mining industry is presented in Table 10. The table highlights a range of outcomes for the projected gap (i.e., expected entrants minus hiring requirements) depending on three scenarios for mining employment (baseline, contractionary and expansionary) and three scenarios of balance between industry exits and entrants (balanced, industry inflow and industry outflow). The scenario with the largest gap is shown to be the *expansionary employment scenario* and *industry outflow scenario*, meaning industry employment is projected to grow at the same time industry exits will surpass industry entries by 2%.

TABLE 10: FORECAST SCENARIOS OF HIRING GAP IN MINING (2023–2033)

	Contractionary	Baseline	Expansionary
Industry Inflow	50,405	17,821	-22,389
Balanced	16,399	-20,287	-65,205
Industry Outflow	-17,608	-58,395	-108,022

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Gap Analysis by Mining Sub-Sector

Table 11 shows the gap analysis for mining sub-sectors. Selected scenarios provide a range of possible hiring gaps/surpluses over the forecast period. The gap is especially prevalent in Extraction and Milling under the scenario where industry exits exceed entrants (Industry outflow) and labour demand follows the expansionary path. Under the baseline-balanced scenario, gaps in *Extraction and Milling* (-17,871) and *Support Services* (-5,944) are reversed by the projected surplus in *Primary Metal Manufacturing* (3,529).

TABLE 11: SELECTED FORECAST SCENARIOS OF HIRING GAP ANALYSIS BY MINING SUB-SECTOR (2023–2033)

	Contractionary - Industry Inflow	Baseline - Balanced	Expansionary - Industry Outflow
Extraction and Milling	26,091	-17,871	-70,757
Support Services	7,820	-5,944	-24,848
Primary Metal Manufacturing	16,522	3,529	-12,460
All Sub-sectors	**50,405**	**-20,287**	**-108,022**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Table 12 further highlights how each gap is derived under the baseline-balanced scenario:

Net change in employment + expected exits – expected entries = projected hiring gaps. The gap is coming primarily from *Extraction and Milling* exits; 110,503 workers are projected to exit the mining workforce, causing a significant hiring pressure over the forecast period.

TABLE 12: BREAKDOWN OF BASELINE-BALANCED HIRING GAP ANALYSIS BY MINING SUB-SECTOR (2023–2033)

	Net Change in Employment	Exits	Total Hiring Requirements	Expected Entries	Gap Analysis
Extraction and Milling	-2,023	110,503	108,481	90,610	-17,871
Support Services	917	25,004	25,921	19,977	-5,944
Primary Metal Manufacturing	-8,536	32,354	23,818	27,347	3,529
All Sub-sectors	**-9,642**	**167,862**	**158,220**	**137,934**	**-20,287**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Gap Analysis by Occupations

Table 13 shows the gap analysis for broad occupational category. Selected scenarios provide a range of possible hiring gaps/surpluses over the forecast period. The gap is especially prevalent in *Production Occupations* under the scenario where industry exits exceed entrants (Industry outflow) and labour demand follows the expansionary path. Given its relative size, the gap in this category becomes a surplus under the baseline and contractionary scenarios, highlighting the high sensitivity of the gaps (and surpluses) projected in this forecast.

Table 14 further highlights how each gap is derived under the baseline-balanced scenario:

Net change in employment + expected exits – expected entries = projected hiring gaps. The gap is coming primarily from *Production Occupations exits*; 54,100 workers are projected to exit the mining workforce, causing a significant hiring pressure over the forecast.

TABLE 13: SELECTED FORECAST SCENARIOS OF HIRING GAP ANALYSIS BY OCCUPATION (2023–2033)

	Contractionary - Industry Inflow	Baseline - Balanced	Expansionary - Industry Outflow
Human Resources and Financial Occupations	2,539	-1,054	-5,523
Production Occupations	13,687	-5,311	-28,826
Professional and Physical Science Occupations	3,411	-1,390	-7,363
Supervisors, Coordinators and Superintendents	6,183	-2,466	-13,224
Support Workers	4,367	-1,778	-9,410
Technical Occupations	2,806	-1,131	-6,012
Trades Occupations	6,729	-2,612	-14,212
Other Occupations	10,682	-4,545	-23,452
All Occupations	**50,405**	**-20,287**	**-108,022**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

TABLE 14: BREAKDOWN OF BASELINE-BALANCED HIRING GAP ANALYSIS BY MINING OCCUPATION (2023–2033)

	Net Change in Employment	Exits	Total Hiring Requirements	Expected Entries	Gap Analysis
Human Resources and Financial Occupations	-488	7,141	6,653	5,599	-1,054
Production Occupations	-2,603	54,100	51,497	46,187	-5,311
Professional and Physical Science Occupations	-653	9,558	8,905	7,514	-1,390
Supervisors, Coordinators and Superintendents	-1,177	17,251	16,074	13,608	-2,466
Support Workers	-837	13,965	13,127	11,349	-1,778
Technical Occupations	-538	10,065	9,528	8,397	-1,131
Trades Occupations	-1,275	21,308	20,033	17,422	-2,612
Other Occupations	-2,071	34,474	32,404	27,858	-4,545
All Occupations	**-9,642**	**167,862**	**158,220**	**137,934**	**-20,287**

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

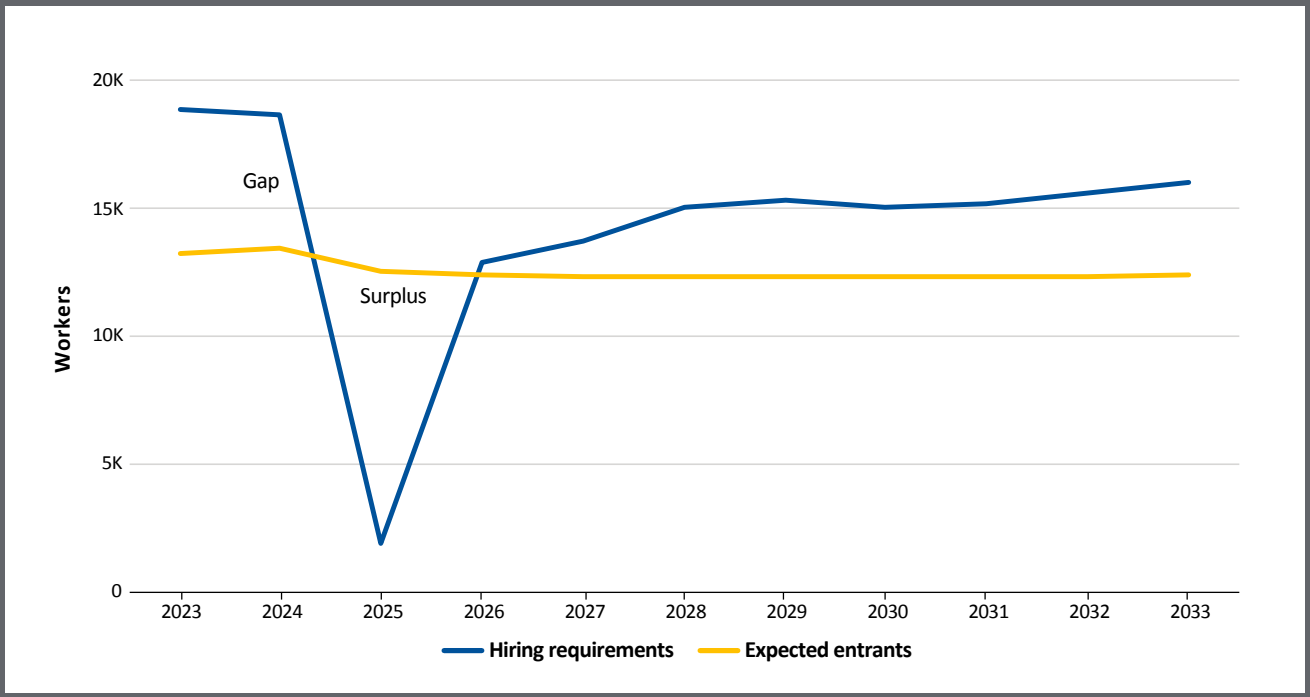
Hiring Gap Intensity

Figure 15 overlays hiring requirements with expected entries over the forecast period. In the first two years of the forecast, hiring requirements exceed expected entrants creating a gap. However, as per the labour demand forecast, employment levels are anticipated to fall and then recover shortly thereafter, creating a surplus of entrants in the medium term. This reflects the volatility of hiring requirements as compared to the relative stability of expected entrants. Lastly, hiring requirements are projected to surpass the level of entries indicating a growing hiring gap in the long-term.

MiHR reports the "hiring gap intensity" – the share of hiring needs that is projected to remain unsatisfied under the status quo state. Hiring requirements become more gap-intensive as the proportion of unmet hiring needs increases. In other words, the higher the gap intensity, the greater the number of vacancies that are expected to remain unfilled (or relatively difficult to fill) given the forecast of new entrants. Therefore, a high gap intensity is a sign of labour market tightness.

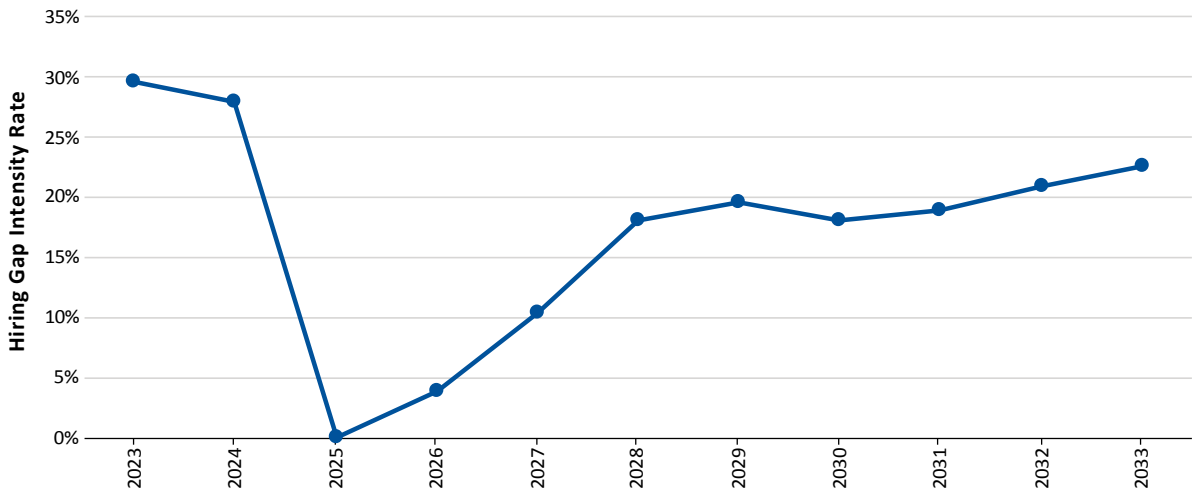
Hiring gap intensity, expressed as the hiring gap divided by the hiring requirements, is shown for overall mining for the forecast period (Figure 16). This predicts that by 2033, close to a quarter of hires will be difficult to acquire as they are unaccounted for by the entries under the baseline-balanced scenario. This also provides a measure of the additional effort and expense to compensate for the lack of expected entries.

FIGURE 15: BASELINE-BALANCED SCENARIO HIRING GAP/SURPLUS IN MINING (2023–2033)



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

***FIGURE 16:* BASELINE-BALANCED SCENARIO HIRING GAP INTENSITY IN MINING (2023–2033)**



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

BOX 2
GREEN ECONOMY

The past decade has seen a heightened awareness of and responsiveness to the local environmental impacts of mining. Global concerns about Greenhouse Gas (GHG) emissions and climate change have influenced mining operations and demand for minerals being mined[14]. Yet one of the most critical problems for the mining industry continues to be minimizing the environmental footprint of mining and related activities.

Not only does automation technology change the nature of work, but it also plays a significant role in reducing the carbon footprint of the mining industry and transitioning towards a greener economy. The use of automation such as automated trucks means lower carbon emissions, optimized usage of inputs and continuous around the clock operations[15]. Table 15 summarizes some examples of the positive impacts of innovative technologies on sustainability and the environment.

TABLE 15: IMPACT OF INNOVATIVE MINING TECHNOLOGIES ON THE ENVIRONMENT

Innovative Technology	Environmental impact
Autonomous trucks	Reduced fuel, input efficiency and prolonged machine lifespan.
Automated drilling and tunnel-boring systems	More efficient drilling that reduces waste and maximizes output.
Automated site monitoring	Preventative measures such as alert weakening of separation barriers for tailings areas, tracking levels of emissions, water and air quality.
Automated ventilation systems at underground mining sites	More energy efficient (saves up to 40% energy) by using sensors to move air as needed at a given time instead of running continuously.
Drones	Remote monitoring of toxicity levels and environmental conditions after closing of mining sites.
Electrification (Electric vehicles; electrified underground mining sites)	Reduced GHG emissions, input efficiency, improve reliability.
Renewable energy technologies	Reduced diesel fuel use and GHG emissions.
Use of sensors (unmanned aerial vehicles and satellites)	Avoid invasive exploration approaches and reduce ecological footprint.

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023; Organization for Economic Co-operation and Development (OECD), Mining and Green Growth in the EECCA Region Report, 2019.

The transition towards a greener global economy will continue to demand significant quantities of metals and minerals. Canada's 2030 emission reduction plan[16] outlines a sectorial plan to reach carbon emission levels 40% below 2005 levels by 2030 and a net zero emission by 2050. Reducing carbon footprint goes hand in hand with increased mineral use as clean energy technologies are significantly more mineral intensive than fossil-fuel energy technologies. For instance, a wind plant needs nine times the mineral resources than a gas-fired power plant and an electric vehicle needs six times more minerals than a traditional vehicle[17].

14 Odell, S. D., Bebbington, A., & Frey, K. E. (2018). Mining and climate change: A review and framework for analysis. *The Extractive Industries and Society, 5(1).* 201–214. **https://doi.org/10.1016/j.exis.2017.12.004**.

15 OECD. (2019). Mining and Green Growth in the EECCA Region. **https://www.oecd-ilibrary.org/environment/mining-and-green-growth-in-the-eecca-region_1926a45a-en**.

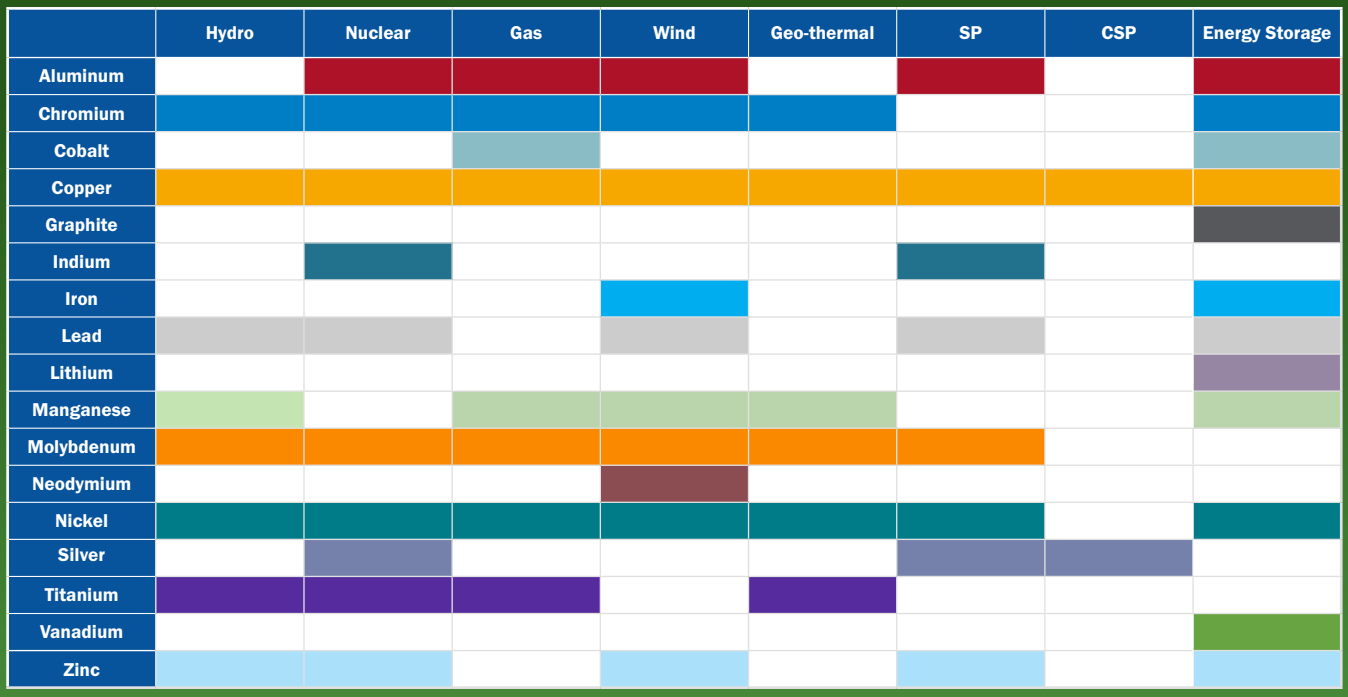
16 Environment and Climate Change Canada. (2022). Canada's 2030 Emissions Reduction Plan. **https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030/plan.html**.

17 International Energy Agency (IEA). (2021). The Role of Critical Minerals in Clean Energy Transitions. **https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions**

The volume and specific mineral needs do vary widely across different clean energy technologies. As such, change in future metals and minerals demand will depend heavily on energy technologies. As shown in Figure 17, critical minerals such as copper, nickel, and chromium are used across a wide variety of clean energy technologies and energy storage and therefore, expected to hold a steady demand schedule.

A shift in demand is more uncertain for concentrated minerals such as cobalt, lithium and graphite since they are required only for a few specific clean energy technologies. Demand for these minerals will primarily be driven by technology and infrastructure development to support these types of energy generation. A recent minerals demand forecast by World Bank[18] finds that, under a scenario where there is at least a 50% chance of limiting global temperature increase to 2°C by 2100, production of battery technology minerals such as graphite, lithium, and cobalt could increase by nearly 500% by 2050 (compared to 2018 levels) to meet growing demand for clean energy technologies.

FIGURE 17: MINERALS USED IN LOW CARBON ENERGY TECHNOLOGIES (2020)



Note: SP = Solar photovoltaic; CSP = Concentrated solar power. This is not an exhaustive list of all clean energy technologies or the range of materials needed for each technology.
Source: World Bank, Climate-smart Mining: Minerals for Climate Action Report, 2020; Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

The key takeaway is that, as the global economy transitions toward a greener future, the energy sector will become a leading consumer of metals and minerals. Until recently, the energy sector only represented a small part of the total demand for most minerals, and other factors such as commodity prices, imports and exports of metals and minerals were the primary drivers of employment demand in the mining industry. The shift to cleaner energy generation will increase the requirements for mineral resources and subsequent employment demand.

The mining industry is closely intertwined with other areas of the economy. A sustainable mining ecosystem can have tangible socio-economic benefits for mining companies and spill-over effects into other parts of the economy. This means that if the mining industry continues to act as a conduit for innovative technologies such as automation and digitization and becomes a driver for renewable energy and green infrastructure, it can improve Canada's environmental performance within existing and new linkages.

18 World Bank. (2020). Climate-smart mining: Minerals for climate action. **https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf**.

CONCLUDING THOUGHTS

The objective of this outlook report is to detect and measure labour market tightness in Canada's mining labour market. A tight labour market can result from a shortfall of available workers or from a robust demand for workers (or a combination of both factors). In either case, employers' demand for workers outpaces supply, likely causing wages to rise and unemployment to fall as employers become more willing to pay for labour inputs.

In the short-term view, several indicators point to emerging labour market tightness in the aftermath of the COVID-19 pandemic. MiHR's labour market tightness checklist finds four out six indicators showing signals of tightness in 2022/2023.

In the long-term view, labour tightness issues have the potential to persist based on MiHR's labour forecasts for hiring gaps in mining sub-sectors and broad occupational categories. However, the outcomes produced in this analysis are highly sensitive to certain assumptions and are mostly evident under the expansionary scenario. *Extraction and Milling* and *Production Occupations* are particularly susceptible to labour tightness under certain scenarios. In these cases, forecasted entries are not expected to be sufficient to completely alleviate the hiring pressures generated by new labour demand and exiting workers.

Overall, hiring gaps are indicative of the potential costs associated with hiring new workers and replacing exiting workers. This commonly involves a combination of advertising, interviewing, selecting, onboarding and training an individual to meet both company standards and regulatory requirements. The process can be time-consuming, especially in tight labour supply situations. Compounding this challenge is the limited ability of employers to recruit workers to remote locations that are far from the amenities regularly found in larger population centres.

APPENDICES

APPENDIX A

North American Industry Classification System (NAICS)

MiHR has aligned its definition of the industry to a set of NAICS codes.[19] NAICS codes are used by statistical agencies throughout North America to describe economic and business activity at the industry level.

MiHR uses the following NAICS codes to define the mining industry in Section 3: Labour market outlook and forecast:

Extraction & Milling

NAICS 2121 (Coal mining): This industry group comprises establishments primarily engaged in mining bituminous coal, anthracite and lignite by underground mining, and auger mining, strip mining, culm bank mining and other surface mining.

NAICS 2122 (Metal ore mining): This industry group comprises establishments primarily engaged in mining metallic minerals (ores). Also included are establishments engaged in ore dressing and beneficiating operations, whether performed at mills operated in conjunction with the mines served, or at mills, such as custom mills, operated separately.

NAICS 2123 (Non-metallic mineral mining and quarrying): This industry group comprises establishments primarily engaged in mining or quarrying non-metallic minerals, except coal. Primary preparation plants, such as those engaged in crushing, grinding and washing, are included.

NAICS 211114 (Non-conventional oil extraction): This industry group comprises establishments primarily engaged in producing crude oil from surface shales or oil sands or from reservoirs in which the hydrocarbons are semisolids and conventional production methods are not possible.[20]

19 For more information on NAICS codes, see the Statistics Canada website: https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553

20 Currently, MiHR considers non-conventional oil extraction (NAICS 211114) to account for oil sands mining activities. This NAICS code likely includes other activities that are not relevant to mining (e.g., offshore drilling and shale oil production).

Support Services

NAICS 21311B (Support activities for mining): This industry group comprises establishments primarily engaged in providing support services, on a contract or fee basis, required for the mining and quarrying of minerals. Establishments engaged in the exploration for minerals are included. Exploration includes traditional prospecting methods, such as taking ore samples and making geological observations at prospective sites. Note that this NAICS code combines NAICS codes 213117 (Contract drilling (except oil and gas)) and 213119 (Other support activities for mining).

Primary Metal Manufacturing

NAICS 3311 (Iron and steel mills and ferro-alloy manufacturing): This industry group comprises establishments primarily engaged in smelting iron ore and steel scrap to produce pig iron in molten or solid form.

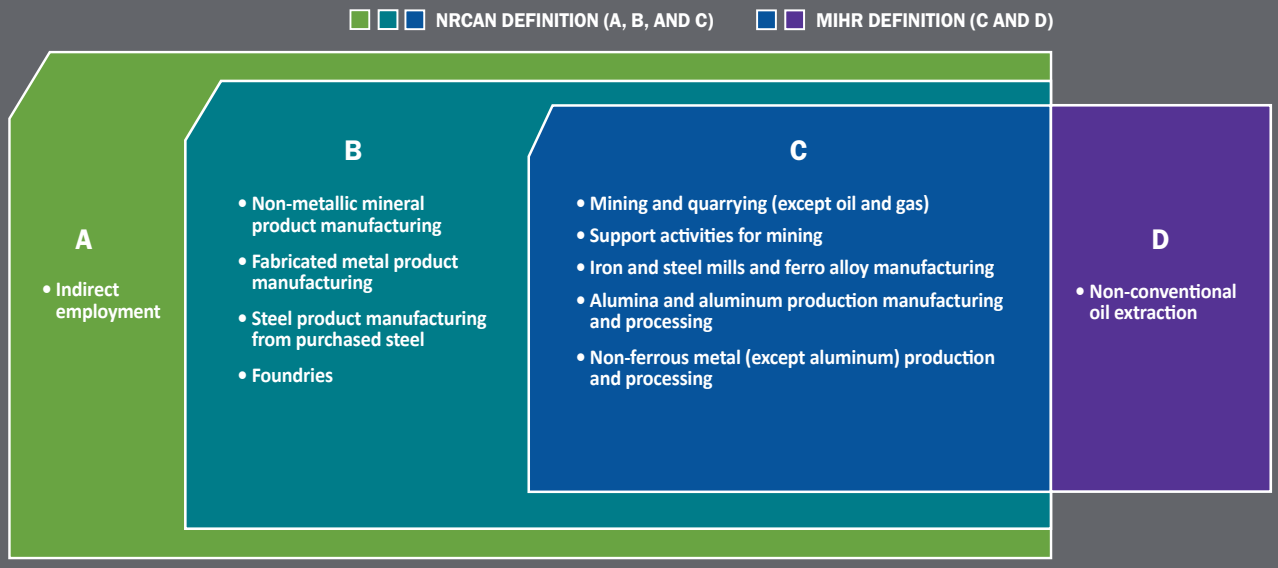
NAICS 3313 (Alumina and aluminum production and processing): This industry group comprises establishments primarily engaged in extracting alumina.

NAICS 3314 (Non-ferrous metal (except aluminum) production and processing): This industry group comprises establishments primarily engaged in smelting, refining, rolling, drawing, extruding and alloying non-ferrous metal (except aluminum).

How MiHR's Industry Definition is Different

MiHR's definition of the mining industry does not perfectly align with definitions used by Natural Resources Canada (NRCan), the Mining Association of Canada (MAC), or other organizations that produce labour market and employment information related to mining. In contrast to NRCan, MiHR excludes certain aspects of downstream manufacturing and indirect employment from its definition (Figure A - 1). Consequently, MiHR's employment estimates tend to be lower compared to NRCan's estimate.

FIGURE A - 1: COMPARISON OF MIHR AND NRCAN DEFINITIONS OF THE MINING INDUSTRY



Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

National Occupational Classification (NOC) System

Occupational analysis in this report follows the NOC system to report on labour market activity. The NOC system is the nationally accepted taxonomy and organizational framework of occupations in the Canadian labour market.[21]

From the hundreds of occupations under the NOC system, MiHR has identified and tracked 120 "selected occupations" considered the most relevant to the mining industry (Table A - 1). These range from occupations in production and operations, such as heavy equipment operators, to occupations in professional and physical sciences, such as geologists.

Mining Occupations

Table A - 1 shows 120 NOC codes for occupations MiHR considers important to mining in Canada. Note that the occupation titles listed below are those used in the Statistics Canada system.

21 For more information on NOC codes, see the Government of Canada website: https://noc.esdc.gc.ca/.

TABLE A - 1: LIST OF NATIONAL OCCUPATIONAL CLASSIFICATION (NOC) CODES

NOC	Categories	Title
0013	Human Resources and Financial	Senior managers- financial, communications and other business services
0111		Financial managers
0112		Human resources managers
1111		Financial auditors and accountants
1112		Financial and investment analysts
1121		Human resource professionals
1223		Human resources and recruitment officers
1311		Accounting technicians and bookkeepers
1431		Accounting and related clerks
7372	Production	Drillers and blasters- surface mining, quarrying and construction
7452		Material handlers
7511		Transport truck drivers
7521		Heavy equipment operators (except crane)
8231		Underground production and development miners
8614		Mine labourers
9411		Machine operators, mineral and metal processing
7371		Crane operators
7611		Construction trades helpers and labourers
7612		Other trades helpers and labourers
8411		Underground mine service and support workers
9231		Central control and process operators, mineral and metal processing
9241		Power engineers and power systems operators
9243		Water and waste treatment plant operators
9412		Foundry workers
9416		Metalworking and forging machine operators
9417		Machining tool operators
9418		Other metal products machine operators
9423		Rubber processing machine operators and related workers
9611		Labourers in mineral and metal processing
9612		Labourers in metal fabrication
9619		Other labourers in processing, manufacturing and utilities

NOC	Categories	Title
2112	Professional and Physical Science	Chemists
2132		Mechanical engineers
2113		Geoscientists and oceanographers
2115		Other professional occupations in physical sciences
2121		Biologist and related scientists
2131		Civil engineers
2133		Electrical and electronics engineers
2134		Chemical engineers
2141		Industrial and manufacturing engineers
2142		Metallurgical and materials engineers
2143		Mining engineers
2144		Geological engineers
2145		Petroleum engineers
2147		Computer engineers (except software engineers and designers)
2148		Other professional engineers, n.e.c.
2152		Landscape architects
2153		Urban and land use planners
2173		Software engineers and designers
2174		Computer programmers and interactive media developers
2271		Air pilots, flight engineers and flying instructors
2274		Engineer officers, water transport
4161		Natural and applied science policy researchers, consultants and program officers
1215	Supervisors, Coordinators, and Foremen	Supervisors, supply chain, tracking and scheduling coordination
16		Senior managers - construction, transportation, production and utilities
113		Purchasing managers
211		Engineering managers
711		Construction managers
714		Facility operation and maintenance managers
811		Managers in natural resources production and fishing
911		Manufacturing managers
912		Utilities managers
2264		Construction inspectors
7201		Contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations
7203		Contractors and supervisors, pipefitting trades
7204		Contractors and supervisors, carpentry trades
7205		Contractors and supervisors, other construction trades, installers, repairers and servicers
7301		Contractors and supervisors, mechanic trades
7302		Contractors and supervisors, heavy equipment operator crews
8221		Supervisors, mining and quarrying
9211		Supervisors, mineral and metal processing
9212		Supervisors, petroleum, gas and chemical processing and utilities

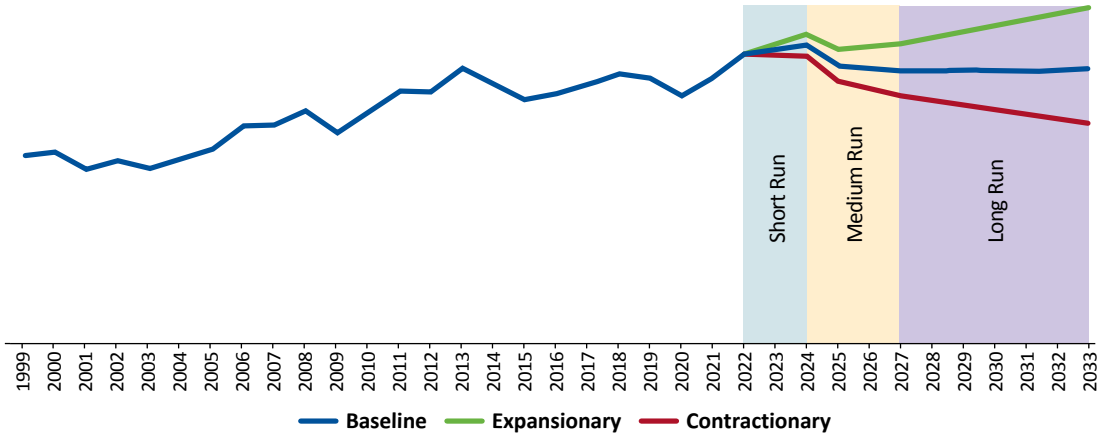
NOC	Categories	Title
1411	Support workers	General office support workers
1526		Transportation route and crew schedulers
4212		Social and community service workers
6541		Security guards and related security service occupations
1221		Administrative officers
1225		Purchasing agents and officers
1241		Administrative assistants
1452		Correspondence, publication and regulatory clerks
1521		Shippers and receivers
1523		Production logistics coordinators
1524		Purchasing and inventory control workers
1525		Dispatchers
2234		Construction estimators
2261		Non-destructive testers and inspection technicians
2262		Engineering inspectors and regulatory officers
2263		Inspectors in public and environmental health and occupational health and safety
6322		Cooks
6521		Travel counsellors
6733		Janitors, caretakers and building superintendents
9415		Inspectors and testers, mineral and metal processing
2171	Technical	Information systems analysts and consultants
2212		Geological and mineral technologists and technicians
2232		Mechanical engineering technologists and technicians
2154		Land surveyors
2211		Chemical technologists and technicians
2221		Biological technologists and technicians
2223		Forestry technologists and technicians
2231		Civil engineering technologists and technicians
2233		Industrial engineering and manufacturing technologists and technicians
2241		Electrical and electronics engineering technologists and technicians
2243		Industrial instrument technicians and mechanics
2253		Drafting technologists and technicians
2254		Land survey technologists and technicians
2255		Technical occupations in geomatics and meteorology
2281		Computer network technicians
6221		Technical sales specialists- wholesale trade
7241	Trades	Electricians
7251		Plumbers
7312		Heavy-duty equipment mechanics
7231		Machinists and machining and tool inspectors
7235		Structural metal and platework fabricators and fitters
7236		Ironworkers
7237		Welders and related machine operators
7242		Industrial electricians
7252		Steamfitter, pipefitter and sprinkler system installer
7271		Carpenters
7311		Construction millwrights and industrial mechanics
7321		Automotive service technicians, truck and bus mechanics and mechanical repairers

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

APPENDIX B

Employment Forecast by timeframe

FIGURE A - 2: ***SHORT RUN (2023 – 2024), MEDIUM RUN (2025 – 2027), AND LONG RUN (2028 – 2033) FORECASTED EMPLOYMENT IN MINING (1999 – 2033)***



Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Net Change in Employment by Sub-sectors

Table A - 2 shows that in the short run, *Extraction and Milling* and *Support Services* employment is expected to see a modest growth while *Primary Metal Manufacturing* declines considerably. Significant contraction in employment is expected across all sub-sectors in the medium run. In the long run, *Extraction and Milling* and *Support Services* employment is expected to see a slight growth while *Primary Metal Manufacturing* declines.

TABLE A - 2: FORECAST SCENARIOS OF CUMULATIVE NET CHANGE IN EMPLOYMENT BY MINING SUB-SECTOR, ACROSS SHORT RUN (2023 – 2024), MEDIUM RUN (2025 – 2027), AND LONG RUN (2028 – 2033)

Short Run

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
					Contractionary		Baseline		Expansionary	
Extraction and Milling					2,841		6,831		10,888	
Support Services					2,279		3,733		5,222	
Primary Metal Manufacturing					-6,063		-4,802		-3,518	
All Sub-sectors					**-943**		**5,761**		**12,592**	

Medium Run

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
					Contractionary		Baseline		Expansionary	
Extraction and Milling					-16,074		-10,878		-5,098	
Support Services					-5,812		-3,684		-1,154	
Primary Metal Manufacturing					-3,467		-1,694		297	
All Sub-sectors					**-25,353**		**-16,256**		**-5,954**	

Long Run

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
					Contractionary		Baseline		Expansionary	
Extraction and Milling					-8,241		2,025		15,251	
Support Services					-3,395		869		7,507	
Primary Metal Manufacturing					-5,006		-2,040		1,973	
All Sub-sectors					**-16,642**		**853**		**24,730**	

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.

Net Change in Employment by Occupation

Table A - 3 shows that in the short run, all occupations are expected to grow modestly under the baseline scenario. Significant contraction in employment is expected across all occupations in the medium run. In the long run, slight growth is expected across all occupations.

TABLE A - 3: FORECAST SCENARIOS OF CUMULATIVE NET CHANGE IN EMPLOYMENT BY MINING OCCUPATION, ACROSS SHORT RUN (2023 – 2024), MEDIUM RUN (2025 – 2027) AND LONG RUN (2028 – 2033)

Short Run

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
					Contractionary		Baseline		Expansionary	
Human Resources and Financial Occupations					-48		292		638	
Production Occupations					-255		1,555		3,399	
Professional and Physical Science Occupations					-64		390		853	
Supervisors, Coordinators and Superintendents					-115		703		1,537	
Support Workers					-82		500		1,093	
Technical Occupations					-53		321		702	
Trades Occupations					-125		762		1,665	
Other Occupations					-202		1,237		2,704	
All Occupations					**-943**		**5,761**		**12,592**	

Medium Run

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
					Contractionary		Baseline		Expansionary	
Human Resources and Financial Occupations					-1,284		-823		-302	
Production Occupations					-6,844		-4,389		-1,607	
Professional and Physical Science Occupations					-1,717		-1,101		-403	
Supervisors, Coordinators and Superintendents					-3,095		-1,985		-727	
Support Workers					-2,201		-1,412		-517	
Technical Occupations					-1,414		-906		-332	
Trades Occupations					-3,352		-2,150		-787	
Other Occupations					-5,445		-3,491		-1,279	
All Occupations					**-25,353**		**-16,256**		**-5,954**	

Long Run

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
					Contractionary		Baseline		Expansionary	
Human Resources and Financial Occupations					-843		43		1,252	
Production Occupations					-4,493		230		6,676	
Professional and Physical Science Occupations					-1,127		58		1,675	
Supervisors, Coordinators and Superintendents					-2,032		104		3,019	
Support Workers					-1,445		74		2,147	
Technical Occupations					-928		48		1,379	
Trades Occupations					-2,200		113		3,270	
Other Occupations					-3,574		183		5,311	
All Occupations					**-16,642**		**853**		**24,730**	

Source: Mining Industry Human Resources Council, Canadian Mining Outlook, 2023.