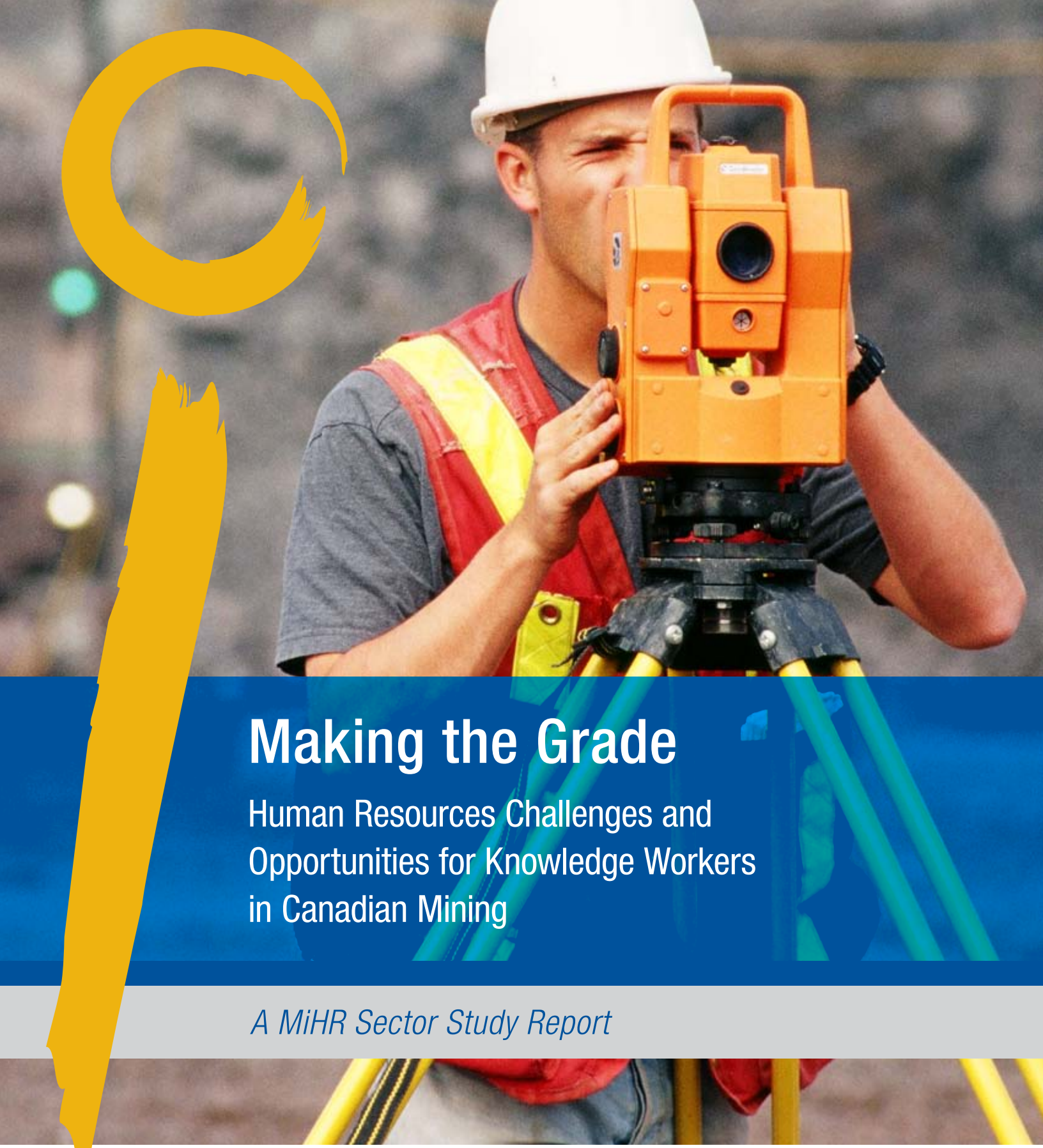

Making the Grade

Human Resources Challenges and Opportunities for Knowledge Workers in Canadian Mining

A MiHR Sector Study Report

MiHR RHiM | MINING INDUSTRY HUMAN RESOURCES COUNCIL

Canada Mining Innovation Council
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Canada

This project is funded in part by the Government of Canada's Sector Council Program.

The opinions and interpretations in this publication are those of the author and do not necessarily reflect those of the Government of Canada.

Research was conducted in partnership with and funded in part by contributions from the Canada Mining Innovation Council.

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Published July 2011

Table of Contents

List of Figures and Tables

Who We Are

The Mining Industry Human Resources (MiHR) Council is Canada's national council for the minerals and metals industry. MiHR contributes to the strength, competitiveness and sustainability of the Canadian minerals and metals sector by bringing all industry stakeholders together to address human resources (HR) challenges and opportunities. MiHR is the recognized industry leader in the identification and analysis of HR issues facing the industry and a catalyst for development and implementation of solutions.

Acknowledgements

MiHR partnered with the Canada Mining Innovation Council (CMIC) to develop this research initiative. Consultants who worked on this project on behalf of MiHR and CMIC, included Roslyn Kunin and Associates (Vancouver), Courtnay Bush (Vancouver), Intergage (Ottawa), Harris Decima (Ottawa), and The Conference Board of Canada (Ottawa).

MiHR and CMIC are grateful to all of the individuals and organizations in the Canadian mining industry who contributed their resources, knowledge and insights to this study and report. MiHR wishes to thank all research participants for their valuable time and input to fill out the survey, engage in interviews, and contribute to focus groups associated with this report. Over 700 students, knowledge workers, employers and other industry volunteers contributed to our research efforts over the past two years.

We are particularly indebted to the project steering committee for their hard work, guidance, and insights.

- Thomas Hynes, Executive Director, CMIC (partner)
- Michel Plouffe, Secretariat, CMIC (partner)
- Malcolm Scoble, University of British Columbia (chair)
- Courtnay Hughes, University of British Columbia
- Georges Beaudoin, Université Laval
- Harold Gibson, Laurentian University
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- John Thompson, Teck
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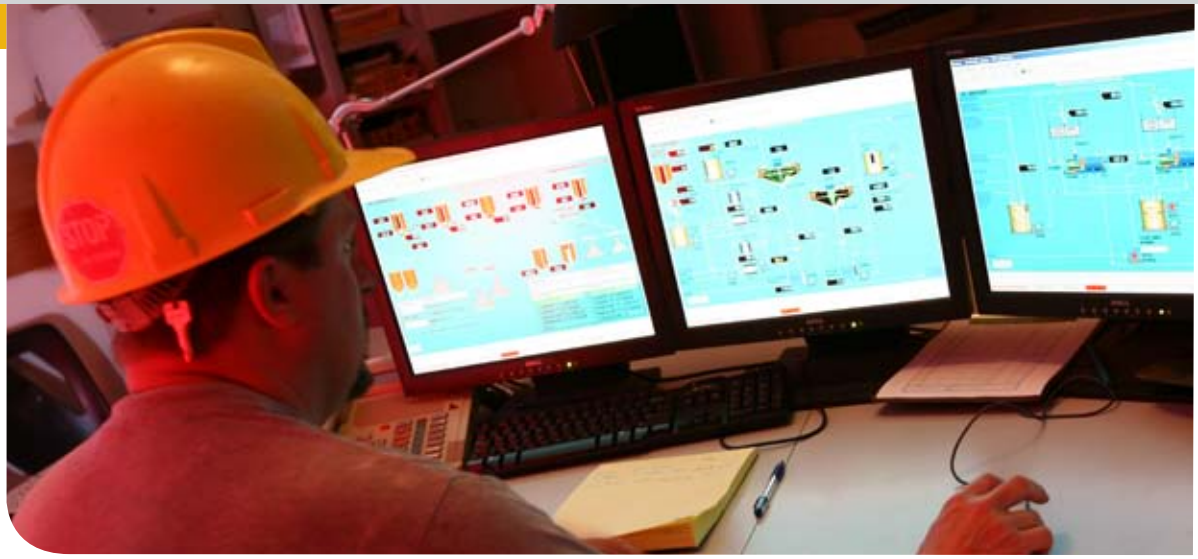
- Alicia Ferdinand, Proven Reserves
- Jim Franklin, Franklin Geosciences
- Oliver Bonham, Geoscientists Canada
- Stephanie Price, Engineers Canada
- Louise Laverdure, Natural Resources Canada

Past committee participation also included individuals from the following organizations:

- Cambrian College, Federated School of Mines
- MIRARCO Mining Innovation



Overview of the Report

Making the Grade provides reliable, relevant and timely labour market information (LMI) to support strategic workforce planning and to stimulate a proactive approach to the human resources (HR) challenges related to knowledge workers in mining. Project work was divided into three phases: a situational analysis; intensive primary and secondary industry research; and stakeholder consultations to develop a strategy and action plan.

High-Level Themes

Increases in technology use and the need to stay ahead in a global, competitive market mean that knowledge workers are crucial to the future prosperity of Canada's minerals and metals sector.

- **Issue:** The move towards a global knowledge economy places increased emphasis on the need for knowledge workers.
- **Actions:** Diligent efforts in recruitment, retention and succession-planning strategies will ensure that organizations have adequate numbers of knowledge workers to meet current and future needs.

Traditional recruitment strategies (e.g., targeted career fairs, reliance on high starting salaries) may not be adequate to engage sufficient numbers of new knowledge workers to the industry.

- **Issue:** Younger employees are not sufficiently aware of the industry, are not as motivated by compensation as previous generations, and are increasingly in demand for their skills.
- **Actions:** Improvements to career awareness outreach, expanding recruitment efforts and targeting key groups (women, skilled immigrants, and students from non-mining programs) will help raise the industry's profile with potential future talent.

Expanded industry efforts to meet the professional development, advancement and lifestyle requirements of its knowledge workers will improve retention, particularly for women and mid-career employees.

- **Issue:** Knowledge workers require challenge and meaning in their work, want clear development paths and opportunities for growth, and need to maintain work-life balance. This is particularly true for mid-career geoscientists and engineers, and highly-skilled women.
- **Actions:** Expanded professional development efforts, creative approaches to career pathing, and flexible solutions to address lifestyle prevent highly-skilled employees from streaming out of their discipline; the needs will help mitigate the outflow of knowledge workers. Partnering with professional associations will ensure special attention is given to understanding mid-career attrition of the industry's knowledge workers.

The mining and mineral exploration industry's image is not always aligned with the expectations of youth.

- **Issue:** Students and young people perceive the mining industry as unappealing, dirty and environmentally unfriendly.
- **Actions:** Increased educational and work opportunities for students, continued and enhanced industry-wide messaging and outreach, and cooperating on industry-wide efforts to promote Corporate Social Responsibility (CSR) programs and initiatives will help change these negative perceptions.

About the Report

There are two main sections to this report:

- **Section One** provides a situational analysis of knowledge workers in the global workforce and in the Canadian mining sector — including discussions on definition and scope, and on accessing labour market information using the North American Industrial Classification System (NAICS) and National Occupational Classification (NOC) codes. This section concludes with a demographic profile of the labour force and description of key labour market issues.
- **Section Two** provides discussion and insights on key human resources challenges and opportunities related to knowledge workers in the industry. It concludes with recommendations for an industry strategy to address these issues.

Project Background and Objectives

Background

Knowledge workers (KWs) are a valuable segment of the Canadian mining industry workforce. They often occupy vital roles; provide the sector with organizational leadership; drive innovation, education, and research and development; and ensure the industry's long-term competitiveness and sustainability.

Despite their importance, the industry lacks key information about this segment of the workforce. Standard sources of labour market information (LMI) do not usually report specifically on KWs, and a system for tracking the stocks and flows[1] of KWs through the mining industry has not been firmly established. In addition, the unique HR challenges and opportunities for KWs have not been articulated.

One of the Mining Industry Human Resources (MiHR) Council's strategic objectives is to research, analyze, forecast and disseminate labour market, human resources and other human capital information relevant to the minerals and metals sector. (Such information includes labour market intelligence; sector studies; occupational supply and demand forecasts; and relevant research focused on HR issues.) To meet this objective, MiHR has undertaken several initiatives to improve the quality and availability of LMI to industry stakeholders. *Making the Grade* adds to this work through research, analysis and dissemination of findings on labour market issues and the short- and long-term HR challenges associated with KWs in the mining industry.

1 Stocks and flows are economic variables. "Stocks" generally refers to a quantity available at a fixed point in time. "Flows" generally tracks movement over a period of time.

For this project, MiHR partnered with the Canada Mining Innovation Council (CMIC). CMIC is a network of industry, academic and government leaders created to improve the competitiveness of a responsible mining industry by strengthening mining research excellence across Canada.

One of CMIC's strategic goals is to "enhance sustainable research performance and receptor capacity through highly qualified people." In 2008, a CMIC-led working group identified several action items targeted to KWs in mining, including mapping KWs through education and throughout their careers in the sector. MiHR partnered with CMIC to address the KW group and to lay the foundation for a better understanding of the KW labour market and its HR issues.

Purpose and Objectives

The purpose of *Making the Grade* is to develop a profile of KWs in the sector and understand the stocks and flows of this segment of the workforce throughout all phases of the mining cycle. The project also seeks to increase knowledge of the related HR challenges and opportunities. Ultimately, project findings will contribute to a better understanding of KWs and enable industry partners to become more proactive and strategic in workforce planning.

The primary objectives for this project were to:

- Enhance the labour market information and workforce profile information on KWs that is available to industry stakeholders;
- Assess factors affecting stocks and flows of KWs;
- Develop a strategy to monitor, assess and project the supply and demand of KWs for the minerals and metals industry;
- Identify the short- and long-term HR challenges and opportunities related to KWs in the industry; and
- Serve as the basis for developing an industry strategy and action plan to address key HR issues.

The following long-term impacts are anticipated:

- Improved understanding of stocks and flows of KWs for the Canadian mining industry; and
- Increased understanding among communities of interest about key HR issues related to KWs that the mining industry must address to ensure its long-term competitiveness and innovation potential.

Activities

Project work was divided into three phases: a situational analysis; intensive primary and secondary industry research; and stakeholder consultations to develop a strategy and action plan.

Phase 1: Situational Analysis

The first phase of research assessed the current state of the workforce and available labour market information on KWs. Primary activities in this phase included:

- Analysis of the current state of knowledge and a literature review on known labour market conditions for KWs;
- Determination of the scope of stakeholders' labour market information requirements on KWs;
- An inventory of existing sources of information on labour supply and demand; and
- Identification of labour market information gaps, and determination of probable causes, who is affected, and what has been done to date to address the issues.

Phase 2: Primary and Secondary Research

In this phase, primary and secondary research led to the identification of HR challenges and opportunities related to KWs in the minerals and metals industry. Activities included:

- Use of surveys, questionnaires, interviews and focus groups with industry stakeholders to determine their short- and long-term KW-related HR challenges;
- Review of literature on KW HR issues that were relevant to the sector, as well as Statistics Canada data products and reports; and
- Identification of insights into the short- and long-term HR challenges and opportunities facing the sector.

Phase 3: Strategy and Action Plan

In the third phase, industry stakeholders were consulted in an online forum to review project findings and begin to develop an industry strategy for addressing the issues raised. Activities included:

- Consulting with industry stakeholders about Phase 1 and Phase 2 findings through roundtable or focus group discussions, and determining the overall implications for the industry;
- Providing insights and suggesting practical solutions; and
- Initiating development of an industry strategy to address identified issues.

SECTION ONE

Situational Analysis

1

The Changing Nature of Work

In today's knowledge economy, an organization's knowledge workers (KWs) have become its most valuable asset.[2] Globalization, the move toward a knowledge economy and shifting workforce demographics have all led to a "heightened performance imperative" for organizations.[3] To meet the demands of this performance imperative, organizational leaders must recognize the value of their KWs, and ensure that organizations build, develop and retain this talent.

Today's organizations face global competition for revenues, which accelerates the need for innovation and rapid development of both processes and products. This increased competition, coupled with rapid advances in technology, have led to the current "age of the knowledge economy." Unlike their industrial predecessors, organizations in this new age must rely heavily on a highly-skilled, highly educated workforce to generate the knowledge and advancements necessary for continuous development and improvement of products and services.

To remain competitive in a knowledge economy, organizations must also compete for the top talent that will drive performance and innovation. Highly educated people with critical skills (commonly known as "knowledge workers" or "KWs") will play an increasingly important role within organizations — at the very time that KWs' availability is declining. Organizations that fail to meet the needs and expectations of this critical segment of their workforce will fall behind their competitors.

The Rise of the Knowledge Worker

Knowledge workers are typically defined as people who are highly educated, technologically savvy, and engaged in work that leads to the creation of knowledge and innovation. They can apply theory

2 The Conference Board, Inc. (2011). Innovation and Intangible Assets. *Executive Action Series*, New York: The Conference Board, Inc.

3 The Conference Board of Canada. (2010). *Human Resources Trends and Metrics: Valuing Your Talent.* Ottawa: The Conference Board of Canada.

and factual knowledge quickly and creatively to solve complex problems with shifting parameters. Knowledge workers contribute to organizations through one of three types of knowledge:[4]

- New or created knowledge
- Portable knowledge
- Specialty knowledge

Those involved in the creation of knowledge work typically hold research and development positions. Their skills lead to the generation of novel products and processes for organizations, and commonly, they will stay with one organization for a long period during the development of the new knowledge. Those engaged in portable knowledge work have broad knowledge that is applicable to a wide variety of situations, across many different job categories and sectors (e.g., engineers and geologists). Specialty knowledge work involves application of specialized knowledge on aspects of work specific to the unique context of an organization (e.g., a mine manager).

For all industries, KWs (and the advances they create) represent an organization's intangible assets.[5] Attracting, retaining and developing these assets are the keys to organizational performance and competitiveness in a global, knowledge-based economy. Shifts in demographic trends mean that many of the employees with critical skills will leave the workforce by 2020,[6] thus increasing the demand for KWs still in the labour force. Knowledge workers (other than those engaged in highly specialized knowledge work) are typically highly mobile because their skills are portable and in high demand across a number of industries.

As global skills shortages and skills competition increase, it will be more difficult to recruit and retain many KWs. As a result, organizations will have to work harder to attract, engage and keep these key people. Many organizations will find that their talent-management practices and programs must adapt to meet the needs of their knowledge workforce. To make the changes necessary to optimally manage and develop their talents, organizations must assess KWs' motivations and expectations.

Understanding Knowledge Workers

Highly Qualified Personnel (HQP) — for the purposes of this report, referred to as "knowledge workers" or "KWs"[7] — are essential for the development and diffusion of knowledge. According to the OECD,[8] they also provide the critical links between technological progress and economic growth, social development and environmental welfare. Furthermore, KWs are an integral part of the development and preservation of competitive and sustainable industries. In mining, both the global focus on leveraging technologies to gain competitive advantage and the magnitude of the social responsibility and environmental sustainability issues are making innovation all the more crucial.

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4 Dove, Rick. (1998). The Knowledge Worker. *Automotive Manufacturing & Production* 110, no. 6: 26–27.

5 The Conference Board, Inc. (2011). Innovation and Intangible Assets. *Executive Action Series.*

6 Meister, Jeanne C, and Karie Willyerd. (2010). *The 2020 Workplace: How Innovative Companies Attract, Develop, and Keep Tomorrow's Employees Today.* New York: Harper Collins.

7 Highly Qualified Personnel (HQP), are referred to as "Knowledge Workers", for the purposes of this report.

8 OECD is the Organisation for Economic Co-operation and Development. The organization's views on HQP or KWs appear in several publications – see for example, www.oecd.org/dataoecd/18/61/35221568.pdf

In 2007, the federal, provincial and territorial Mines Ministers asked the Canada Mining Innovation Council (CMIC) to develop a Pan-Canadian Mining Research and Innovation Strategy. Through a series of workshops with mining stakeholders, CMIC developed a strategy that included the attraction, development and retention of KWs in mining research and innovation as a key strategic pillar.[9]

There is growing awareness of the role that KWs occupy in education and training; research and development and innovation; and organizational leadership. Knowledge workers are important drivers of innovation; moreover, their role within the mining industry extends beyond innovation and is becoming progressively more varied. Today's mining industry requires increasing levels of knowledge and competency to mitigate evolving industry challenges. Knowledge workers are expanding their role, as the industry engages with new technologies and faces not only complex regulatory environments, but new social and organizational expectations. These factors are not exclusive to the mining industry and are affecting industries around the globe — driving up the global demand for KWs.

The Canadian mining industry's concern about the supply of talent is not new. Over 30 years ago, the Mining Association of Canada (MAC) called on industry members to collaborate in their efforts to retain mining employees, using a series of best practices including sharing recruitment information, candidates and resources.[10] Although practices in HR recruitment and retention may have changed, the industry still — 30 years later — faces extreme challenges in its efforts to sustain its most valuable resource, its people.

The following section contains a brief discussion of the terminology and definition of KWs, the role they play in mining and their impacts on the workplace. This information is followed by discussion of labour market supply and demand challenges related to KWs, both globally and in the Canadian mining sector. Several illustrations of global practices for attracting and retaining KWs to mining are contained in Appendix A.

Definition and Scope: Who are Knowledge Workers?

Despite the significance of this labour segment, there is inconsistency in how KWs are defined. Worldwide, all sectors use a variety of definitions when describing KWs. This lack of uniformity is further complicated by the various terms used in the literature to represent this segment of the workforce. When taking a broad perspective, KWs have been referred to by the following terms:

- Highly Qualified Personnel[11]
- Knowledge Worker (KW)[12]
- Skilled Worker[13]

9 See the CMIC website: www.cmic-ccim.org/en/about/mission_vision_values.asp

10 Gam. (1980). Mining firms urged to collaborate in solving problems with recruitment. *The Globe and Mail*, September 19.

11 McKenzie, M. (2009). Innovation Analysis Bulletin: A profile of Canada's highly qualified personnel. *SIEID, Statistics Canada*, 1–4; Canadian Federation of Earth Scientists (2008). *Human Resources Needs in Earth Sciences in Canada A Preliminary Survey*.

12 Hall, P. (2005). Brain drains and brain gains: Causes, consequences, policy. *International Journal of Social Economics*, 32(11), 939–950; Smith, K. C. (2005). Existing Knowledge, Knowledge Creation Capability, and the rate of new product introduction in the High-Technology Firms. *Academy of Management Journal*, Vol.48, No.2, 346–357.

13 Wylie, J. &. (2008). Shortage of skilled workers poses hard-hitting challenge. *Canadian Mining Journal*, 129(6), 27.

- Qualified Worker[14]
- Highly-Skilled Worker[15]

The above terms have distinct meanings for some stakeholder groups but are used interchangeably by others, which can lead to confusion when examining research results. For example, one group might view "qualified" and "skilled" to mean the same thing, while others might understand them as two distinct concepts. The term "Highly Qualified Personnel (HQP)" has been defined in a variety of ways, with particular differences noted in the level of education required and the inclusion or exclusion of industry experience, as key aspects of the definition. For the purposes of this work, use of the term "highly qualified" (which has been used in previous MiHR project work) presented challenges; different stakeholders in the mining sector have different meanings for the term "qualified." As a result, the term "knowledge worker" replaced "highly qualified people", to remove as much confusion as possible for a broad audience of stakeholders.

Level of Education

Statistics Canada defines Highly Qualified Personnel, called KWs here, as "individuals with university degrees at the Bachelor's level and above". This definition includes a minimum educational standard but does not include industry experience. Consistent with the Statistics Canada definition, the Canadian Federation of Earth Sciences defines KWs as geoscientists that have obtained a minimum Bachelor's education. This group also highlights the specific need for graduate-level education to fulfill research and academic roles in the earth sciences.

In comparison, Industry Canada's *Innovation Strategy* defines KWs "as people having completed a post-secondary degree or diploma or its equivalent". This definition widens the scope of KWs' educational attainment to include degrees and diplomas outside of the Bachelor's context, implying the inclusion of college or technical and vocational education.

In a recent study of the stocks and flows of highly qualified workers in England, varying levels of education of KWs were defined through the *National Qualification Framework*. This framework defines "qualifications" as a series of knowledge levels based on the years of education obtained — defining Bachelor's-level education, and college and technical diplomas as separate levels from graduate-level education.[16]

14 Barta, P. (2005). Lack of qualified workers strains mining companies. *Wall Street Journal*—Eastern Edition, 246(34), A1–A7.

15 Ednie, H. (2004). Human resources—innovative solutions for mining's human resource challenges. *CIM Bulletin*, 97(1076), 9–15.

16 Bosworth, D., Jones, P., & Wilson, R. (2008). The transition to a highly qualified workforce. *Education Economics*, 16(2), 127–147.

Occupation and Industry Experience

In addition to level of education, many groups acknowledge occupation and industry experience as important criteria in defining KWs. For example, a study supported by Industry Canada on the mobility of KWs defined them as:

> *"…individuals who are engaged in knowledge-intensive professions such as physicians, nurses, science and technology (S&T) workers, engineers, information technology (IT) specialists, graduate and post-doctoral students, scholars and researchers, and high-level administrators and managers".*[17]

The emphasis here is placed on the role the person plays in the workforce, and in some cases also their sphere of influence, rather than their level of education.

A Combination of Education and Occupation Experience

Similar to England's *National Qualification Framework*, the Australian *Canberra Manual* defines Human Resources in Science and Technology (HRST) as a specialized and highly-skilled workforce. The categorization of KWs within this framework incorporates a tiered educational qualification, and recognizes specific occupational roles and professional designations as equivalent to educational qualifications. The *Canberra Manual*[18] defines two levels of KWs in the following manner:

- **University-level HRST** are people who fulfill one of the two following conditions:
  - Successfully completed education at the third level of the type that leads to a first or post-graduate university degree or equivalent, in an S&T field of study; or
  - Not formally qualified as above, but employed in an S&T occupation where the above qualifications are normally required.
- **Technician-level HRST** are people who fulfill one of the two following conditions:
  - Successfully completed education at the third level of the type that leads to an award not equivalent to a first or higher university degree, in an S&T field of study (other than those employed in occupations normally requiring a higher qualification); or
  - Not formally qualified as above, but employed in an S&T occupation where the above qualifications are normally required.

Graduate-level KWs are recognized as having specific labour force characteristics and policy priorities. The *Canberra Manual* is intended for international comparison, as such a category for KWs with graduate-level education was carefully considered in the document. It is challenging to reconcile countries' different education systems and to identify corresponding occupations; therefore, for this report a graduate KW definition was not included.

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17 Gera, S. &. (2004). International Mobility of Highly-Qualified People in APEC. *Realizing Innovation and Human Capital Potential APEC, November Economic Committee Publication*, 8–73.

18 www.oecd.org/LongAbstract/0,3425,en_2825_500777_2096007_119669_1_1_1,00.html

With specific reference to the mining industry in Canada, the term "Qualified Person" is defined in *National Instrument 43–101* (for public disclosure of mineral resources and mining projects) as an individual who:

a) is an engineer or geoscientist with at least five years of experience in mineral exploration, mine development or operation, or mineral project assessment, or any combination of these;

b) has experience relevant to the subject matter of the mineral project and the technical report; and

c) is a member in good standing of a professional association.[19]

Although the *Canadian National Instrument* does not include the word "highly" in the term, it is worth noting that the definition refers to work experience, professional designation and specific occupations that require a minimum Bachelor's level of education.

Other Considerations

Other factors can also play into a definition of KWs. One important factor is the accumulation of skill sets. The Scientific Affairs Committee of the Canadian Psychological Association specifically outlines a skills list that is acquired through social science education. This list presents a framework for categorizing KWs that can address both education and work experience through the demonstration of competencies. In other words, KWs can be defined by their ability to demonstrate predetermined skill sets or competencies gained through education or work experience.

Although beyond the scope of the current research, such a definition of KWs for Canadian mining could be explored in future research. A competency-based definition of KWs would incorporate job competencies and perhaps job performance — two factors not considered further in the definition of KWs used for the purposes of this study, thereby creating a platform that would link educational attainment and work experience through high performance.

Limitations with Current Definitions

Each of the definitions for KWs discussed above contain inherent limitations for use in building a KW profile for the Canadian mining sector. A broad definition that includes a range of educational attainment levels and work experience may be appealing because of its comprehensiveness; however, when trying to attract and retain KWs, recommendations around a broad definition may yield less-targeted findings and ultimately, generic recommendations. For example, attraction and retention strategies for mining engineers within mining organizations would differ from strategies to attract and retain mining engineering professors for post-secondary education programs.

19 www.apgo.net/ni43-101.htm

Another approach for defining KWs could be to use criteria based on educational attainment data, which is easier to validate and measure than information focused on work experience. However, limiting the definition to educational attainment presents risks; the result could be to disregard the expertise and technical knowledge KWs gain through work experience. In an industry facing a significant knowledge-transfer crisis as the aging workforce retires, a large portion of the workforce may not have obtained educational credentials — but can still demonstrate advanced competencies. For those workers who have obtained educational credentials and work experience, such profiling would put them in the same category as a recent graduate.

Recommended Definition

Education is consistently used across industry sectors as the key defining variable for KWs. It also provides a clear boundary for defining the segment in terms of access to statistical data.

The tiered system utilized in the U.K. is a strong example: it acknowledges the differences between graduate and undergraduate studies, and the varied roles within the industry that are typically met by individuals with specific educational credentials. Creating a tiered classification for KWs in Canada may be worthwhile in future research. Such a system would allow for a more accurate profile that more finely segments KWs and creates more specific HR recommendations for each post-secondary tier.

Example Tiered System

Tier 1	College and Vocational Certificate
Tier 2	Bachelor-Level Degree
Tier 3	Graduate-Level Degree

The Rise of the Knowledge Worker in Mining

With an established labour force and strong labour laws, Canada's mining industry employs a large portion of highly-skilled and independent workers. By contrast, in developing countries, colonial domination and the absence of free labour allowed companies to profit in spite of labour-intensive mining, thus removing the incentive to modernize. Production was organized around the use of poorly paid workers, the majority of whom were grouped into unskilled or semi-skilled job categories.[20]

The evolving nature of work in the mining industry is reflected in a decreasing reliance on labour and an increasing reliance on technology, which has begun to eliminate some aspects of the so-called semi-skilled or low-skilled positions within the industry. As a result, mining jobs today require more skill and training than they did a decade or more ago — in part because mines are more technologically advanced. Instead of relying on low-skilled workers, most mines now require employees who can operate highly technical machinery.

20 Dansereau, S. (2006). Globalization and Mining Labour: Wages, Skills and Mobility. *Minerals and Energy*, 21(2) 8–22.

Evidence of this shift in organizational design is illustrated in the development and industry-wide application of automation technologies, such as the widespread use of continuous miners, and the emerging optical communications systems that allow people to operate robotic mining equipment from extreme distances. These technologies have changed the nature of work in mining and will continue to transform current operations.

Globally, the social, technological and organizational environments facing all industries are changing rapidly, which is increasing the number and variety of the roles of KWs. Despite the myriad of terminology used to describe KWs, there is a general consensus among experts about the roles that KWs play. Common themes include:

- An important role in the application and dissemination of knowledge;
- A significant role in generating innovation; and
- An important role within organizational leadership.

Knowledge Workers as Educators

Knowledge workers who have completed graduate-level studies and are pursuing careers as researchers and educators play an important role in the application and dissemination of knowledge. Knowledge created at universities and technical colleges is shared for public benefit in a variety of ways, including publications, consulting, public policy development, socio-economic influence and commercialization of research.[21] Of all the forms of knowledge mobilization that result from universities' research activities, the training of graduates in a research-rich environment has the most pronounced impact and importance.

However, the number of KWs taking on the role of educators is declining, despite recent hiring to replace retiring faculty and accommodate department growth. In 2005, one-third of faculty in Canadian universities were age 55 or older, while about 20 per cent were 40 or younger. In addition, on average, every five years, two new professors join each mining engineering faculty in Canada.[22] Coupled with the declining number of KWs acting as educators, mining schools around the globe have traditionally seen declines in the recruitment of new students — and threats to the survival of the departments — during industry downturns. This uncertainty was clearly illustrated in 2000, when many North American, as well as Australian faculties were close to extinction.[23] These challenges present significant risks to ensuring that an adequate number of KWs continue to work as educators in the industry and also present risks to the future supply of KWs for industry jobs.

21 Association of Universities and Colleges of Canada. (2007). *Trends in higher education.*

22 Meech, J. (2002). University Graduates in Mining and Process Engineering in a Global Context — How Many Mining Engineering Programs does the Canadian Mining Industry Need? *Centre for Environmental Research in Minerals, Metals, and Materials*, http://www.mining.ubc.ca/cerm3/human%20resources.html

23 Scoble, M. (2003). The crisis in mining education. *Annual Conference, Prospectors and Developers Association of Canada*, Toronto.

Educators will be called upon to play an increasing role in connecting students with industry to assist in the transition from school to the world of work, and to prepare new graduates for employment in the sector. The Bachelor's degree is increasingly seen as the foundational qualification required to enter the industry, with an emphasis placed on lifelong learning.[24] While a re-engineering of the mining education process is occurring in some schools, ensuring adequate numbers of KW educators is a challenge that needs to be tackled jointly by industry and academia.

Knowledge Workers as Innovators

Canada's Innovation Strategy[25] recognizes that innovation and knowledge will play a significant role in the sustainability of the Canadian economy. According to Industry Canada, as Canada's human capital shrinks and ages, the sustainability of the Canadian economy will be partially dependent on its ability to shift towards a leaner knowledge-based economy.

Innovation has been repeatedly linked to economic progress, and there is a direct relationship between innovation and skilled and talented human resources.[26] There are many ways to innovate, and resource-based industries (e.g., mining and logging) tend to focus on extraction-process innovation ahead of product innovation. A recent study of Canadian innovation performance found that Canada has a reasonably good rate of innovation for products but is relatively weak in process innovation; this is a possible area of growth for KWs working in mining innovation.

Canadian mining industry stakeholders generally believe that Canada has lost ground in recent years as other countries have poured more money and resources into research and development. The KW's role as "Innovator" is therefore defined in the overarching national innovation strategy, and is further supported in the Canadian mining industry context.

> *" We have seen a decline in Canadian R&D and innovation over a couple of decades. We've said in mining that doesn't work for us. If we've lost ground, that's unacceptable."*
>
> – John Vavrek, Executive Director, The Canadian Institute of Mining, Metallurgy and Petroleum[27]

Industry investments in education are essential in developing KWs. The Canadian mining industry's commitment to the development of KWs through financial donations to academic institutions is well-documented. For example, in 2006, Teck's significant contribution enabled the development of the Norman B. Keevil Institute of Mining at the University of British Columbia (UBC). The value of this contribution was noted by the university's president: "The enhancement to the education and research will help UBC prepare the global citizens of tomorrow, and will help meet the demand for skilled professionals in the industry".[28]

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24 Scoble, M. & Laurence, D. (2008). Future Mining Engineers: Educational Development Strategy, www.infomine.com/publications/docs/Scoble2008.pdf

25 See Industry Canada at, http://dsp-psd.pwgsc.gc.ca/Collection/Iu4-5-2002E.pdf

26 OECD. (2006). Innovation and economic performance. *OECD Economic Surveys*, 10, 73.

27 Koven, P. (2009). Mining the moon, they hope — Canadian miners aim to regain lost ground as resourceful innovators. *Financial Post*, May 11.

28 Martha Piper — President of the University of British Columbia 1997–2006.

These partnerships are not exclusive to large organizations and large universities. Canada's technical colleges and polytechnic institutions also make important contributions to innovation. Polytechnic graduates often provide research support for small- and medium-sized businesses, whereas larger organizations with in-house R&D capacity tend to forge larger-scale partnerships. The applied research conducted at polytechnic institutions is often directly linked to solving industry problems.[29]

Importance of Knowledge Workers for Innovation and R&D

In a competitive global economy, innovation is essential to the success of producers of goods and services. The mining and exploration industry is no exception; the constant need for new, innovative and efficient processes and technologies is one reason for the increased requirement for KWs in the sector.

In 2006, the mining and exploration industry in Canada invested $615 million in R&D, highlighting the importance of innovation in this sector.[30] As shown in Table 1, this R&D investment exceeded that of similar sectors in Canada, including oil and gas extraction, the motor-vehicle industry, wood and paper products, and machinery.

Table 1
Research and Development Expenditures by the Mining and Exploration Sector, and Selected Industries, 2004–2009
($ millions)

	2004	2005	2006	2007	2008	2009
MINING AND METALS SECTOR						
Mining — extraction	58	41	63	71	73	74
Primary metals — nonferrous	225	257	261	n/a	195	201
Fabricated metal products	202	211	222	218	n/a	n/a
Non-metallic mineral products	44	73	69	65	64	62
TOTAL: MINING AND METALS	**529**	**582**	**615**	**n/a**	**n/a**	**n/a**
OTHER SECTORS						
Oil and gas extraction	314	440	525	476	376	385
Motor vehicles and parts	657	631	612	495	447	432
Wood products and paper		449	n/a	361	n/a	n/a
Machinery		561	544	530	605	618
TOTAL: MANUFACTURING	**8,343**	**8,367**	**8,504**	**8,211**	**8,496**	**8,437**
TOTAL: ALL INDUSTRIES	**15,299**	**15,774**	**16,021**	**15,882**	**15,980**	**16,146**

Source: The Mining Association of Canada, 2010.

29 Maloney, S. (2008). Canada's applied advantage: Polytechnics. *Canadian Business*, 81(18), 96.

30 The Mining Association of Canada. (2010). *A report on the state of the Canadian mining industry: facts and figures 2010.*

As a result of its R&D efforts, the Canadian mining and exploration industry is a world leader in environmental stewardship, geological mapping and technological advances.[31] Some of these important innovations include:

- Exploration-technology innovations (e.g., airborne geophysics and low-impact seismic methods) that help increase productivity while minimizing impact on the environment;
- Underground mining technologies (e.g., telemining automated load-haul-dump fleets) that lead to higher ore recovery and profitability, and improvements in workplace quality;
- Internet technology (e.g., improved information exchange with remote sites and global online business-to-business exchange) that help reduce maintenance and procurement costs; and
- Mining environmental management (e.g., recycling processes and landfill disposal of hazardous materials) that help address environmental concerns.[32]

Additionally, several technologies developed for the mining and exploration sector have also been adapted for use in other industries. Such "reverse technology-transfers" include the Geological and Environmental Mapping (GEM) system for surface oil detection and the zero-gravity drill that can be used in space.[33]

Knowledge workers play an essential role in the research, development and implementation of new mining and exploration technologies and systems for next-generation mines. Yet, a significant proportion of this group is nearing retirement age.[34] This could lead to a devastating loss of both specialist knowledge and leadership in the sector. To address this issue, in 2008, the Canada Mining Innovation Council assembled industry working groups to discuss KWs. They identified the following action items for the sector:

- Focus on the attraction, development and retention of KWs;
- Improve the research capacity of Canadian mining schools and strengthen links to industry;
- Increase involvement in training and offer more opportunities for students in co-operative programs; and
- Increase the profile of mining research within educational institutions, and strengthen the industry's research base.[35]

31 Prospectors and Developers Association of Canada and Canadian Mining Industry Research Organization – Exploration Division (2002). *Innovation in Canada's Mineral Exploration and Development Sector*. Submission to Industry Canada.

32 Global Economics Limited (2001). *Mining Innovation: An overview of Canada's dynamic, technologically advanced mining industry*. Submission to the Mining Association of Canada.

33 *Ibid.*

34 Canada Mining Innovation Council. (2008). *The Pan-Canadian Mining Research and Innovation Strategy: Strengthening the Competitiveness of a Responsible Canadian Mining Industry Through Excellence in Research, Innovation and Commercialization.*

35 *Ibid.*

However, a challenge facing the global supply of KWs is the relative sensitivity of R&D investment to the economic climate. Even during times of economic instability, industry leaders recognize the importance of investment in R&D to drive innovation, help decrease costs and improve efficiencies. Despite industry leaders' agreement about the importance of investment in R&D, they acknowledged that during an economic downturn, other realities come into play.

Dropping commodity prices and economic downturn negatively affect industry's R&D resource allocation. Historically, R&D expenditure slowed markedly during the economic downturns of the 1990s and the early 2000s. R&D is predominately financed from cash flow, which contracts during downturns. This coincides with banks and markets becoming increasingly risk-averse, creating barriers for firms seeking external funding for research. For example, in Australia the global downturn caused Australian mining companies to put fewer resources into R&D. Mineral broker AMIRA estimated that in some quarters, corporate research investment was down 20 to 30 per cent — due to the drop in commodity pricing in 2009.

Knowledge Workers on the Job

Knowledge workers play a key role in knowledge generation and capacity within the industry. From an organizational perspective — hiring and training well-educated employees with varying expertise increases opportunities for employees to combine and exchange their ideas to form new knowledge. A study of top management teams and KWs showed that the rate of innovation is a function of how well organizations share and exchange knowledge.[36] The research supports the value of having a diverse group of KWs to generate innovation, an area of significant opportunity for the mining industry.

Knowledge workers are often found in corporate operations in a variety of occupations and roles, these include; specialized functions (e.g., health and safety), mission critical positions, roles of leadership or management, and specialized technical roles within organizations. The roles that KWs play in organizations will likely become increasingly complex and varied. The challenging environmental and social pressures that are faced by the industry, coupled with shifting regulatory environments demands an increasingly skilled and knowledgeable workforce.

Outside of specific occupational roles, the recruitment of KWs to a mining organization can be valuable for long-term development. At this time, there is recognition amongst mining organizations for the need to develop management and leadership capacity of KWs, specifically for career development, and acknowledging the increase in career mobility, and need for cultural awareness, and diplomacy skills in the new mining environment. Moreover, there is evidence that organizations hire scientists and engineers outside of short-term occupational needs in efforts to build the overall capacity of a firm in relation to its long-term strategic business goals.

36 Smith, Ken, Collins, Christopher, & Clark, Kevin. (2005). Existing Knowledge, Knowledge Creation Capability, and the rate of new product introduction in the High-Technology Firms. *Academy of Management Journal,* Vol.48, No.2, 346–357.

2

Stocks and Flows of Knowledge Workers

To meet the demand for KWs, the mining industry needs to both understand the roles that they play in mining and to define the stocks and flows of KWs in the sector. The Canadian Mining Industry does not function in isolation, and stresses exist in the global supply and demand for KWs. Understanding these challenges will help identify under-utilized sources of KWs in the Canadian mining context, as well as potential threats to current and future supply. In Canada, the mining industry faces both universal and unique challenges in attracting and retaining KWs; a thorough review of global initiatives can provide inspiration for future strategy development.

Despite the growing body of literature on the supply and demand of KWs internationally, the industry lacks systems for monitoring the international stocks and flows of scientific, technical and engineering personnel. Although as early as the 1960s, the number and distribution of KWs within science and technology were acknowledged as important indicators of a nation's S&T effort, countries and international organizations usually saw a need for internationally comparable data only in the context of short-term policy issues. (This was exemplified in the "brain drain" debate and the "aging" of the S&T workforce). This policy-level focus hindered development of more robust monitoring systems that would have been useful for long-term analysis and research on a wider range of issues.

Global Labour Demographics of Knowledge Workers

Globally, there is evidence of a shrinking supply of KWs in developed nations. The causes are consistent, and related to an aging workforce and increasing competition for KWs within the growing global business environment. A recent analysis of the stocks and flows of KWs in England identifies the relationship between globalization and the increasing demand for qualified workers within developed nations[37] — an important parallel to the Canadian situation.

The most dramatic illustration of the shrinking labour supply is observed in the U.K., which has one of the world's most intense skilled-worker labour shortages as a result of an aging workforce. In an effort to mitigate this shortage, the U.K. has looked towards adopting the Australian point system to help attract highly-skilled workers, particularly focusing on entrepreneurs and professionals such as scientists and engineers.

Enrolment Patterns in Mining Related Post-Secondary Education

In Canada, public post-secondary educational institutions are regionally based. Universities in several provinces have specific engineering programs in mining and metallurgy. An inventory of those universities offering programs specific to the metals and minerals sector is shown in Table 3 on page 23.

There are also programs in colleges, university colleges, and technical institutes that prepare students for careers in metals and minerals. In addition, most Canadian universities have geosciences departments that produce professionals in exploration and other geosciences occupations (although their graduates may not necessarily pursue a career in the metals and minerals sector). Similarly, almost all universities offer physical and life science programs, although again, graduates from these programs do not uniquely work in the mining sector.

Despite limited data specific to mining, college enrolment data available from Statistics Canada's *Post-Secondary Information System* still provide a useful indicator of trends relevant to KWs in mining. The data on *College Enrolment by Program Type* show that between 2001–2002 and 2005–2006, enrolments in Physical and Life Science and Technologies programs decreased by nine per cent. In contrast, total enrolments in all program types increased 11 per cent during the same period. Given the growth in the minerals and metals industry, the decline in enrolments suggests the industry will struggle to meet the demand for workers. This gap is of concern to all levels of mining employment and certainly includes KWs.

Throughout Canada, the current number of graduates from mining-specific post-secondary programs is not sufficient to meet the sector's needs. In Canadian universities; in 2009, a total of 860 students were enrolled in Bachelor-level programs within the nine Canadian mining-engineering schools.[38]

37 Bosworth, D., Jones, P., & Wilson, R. (2008). The transition to a highly qualified workforce. *Education Economics*, 16(2), 127–147.

38 Engineers Canada, www.engineerscanada.ca/files/w_report_enrolment_eng.pdf

Table 2
Enrolment in Canadian Mining Engineering Programs, Bachelor-Level

YEAR	NUMBER OF STUDENTS
2000	463
2001	332
2002	313
2003	281
2004	327
2005	323
2006	473
2007	636
2008	755
2009	860

Source: Engineers Canada, MiHR, 2011.

A similar shortage is reflected internationally, in an analysis by the U.S. Bureau of Labour Statistics. This analysis recommends that organizations attempt to fill this gap, by looking at other sources of KWs, such as civil engineering graduates.[39]

In terms of flows of foreign students at university levels, from the available data, it appears that Canada is outperformed by Australia and the U.S. In 2002–2003 Australia granted 83,000 student visas of which 30,000 visas to students that pursed masters/doctorate degrees, while Canada received only about 24,400 university students in total.[40] To combat the shortage of KWs pursuing graduate level education, and pursuing research, strong recruitment efforts to attract migrant researchers and educators will be crucial to the sustainability of Canadian mining education.

Globalization and International Mobility of Knowledge Workers

Knowledge workers are a globally mobile labour segment. This is a factor of educational attainment, access to opportunities and the transferable nature of higher-level skill sets. Knowledge workers often participate in high-tech industries, manage multinational enterprises and occupy scientific and technological professions. They are frequently involved with industries that are largely knowledge-based and global in scope.

A recent study of KWs interested in R&D, including researchers, scientists, and engineers, examined the reasons that influenced whether KWs chose to stay in their home country or relocate. The study found that international income differentials and the freedom to conduct research in the areas that interest them were important influences on the global mobility of KWs. The study also found that increased

39 Madison, A. (2004). Finding tomorrow's miners. *Rock Products*, 107(10), 24–27.

40 Gera, S. and Songsakul, T. (2007). Benchmarking Canada's Performance in the Global Competition for Mobile Talent. *Industry Canada – Canada Public Policy*, 67–84.

Table 3
University Programs Specific to Careers in Metals and Minerals Sector, Canada

PROVINCE	UNIVERSITY	PROGRAM NAME	PROGRAM LEVEL	LANGUAGE	CO-OP	DISCIPLINE
AB	University of Alberta	B.Sc in Mining Engineering	Bachelor's degree	English	Yes	Mining and Mineral Engineering
AB	University of Alberta	PhD in Mineral Engineering	Doctorate	English	No	Mining and Mineral Engineering
AB	University of Alberta	PhD in Mineral Engineering	Doctorate	English	No	Mining and Mineral Engineering
AB	University of Alberta	M.Eng in Mining Engineering	Master's degree	English	No	Mining and Mineral Engineering
AB	University of Alberta	M.Sc in Mining Engineering	Masters degree	English	No	Mining and Mineral Engineering
BC	The University of British Columbia	Bachelor of Applied Science in Mining Engineering (Vancouver)	Bachelor's degree	English	Yes	Mining and Mineral Engineering
BC	The University of British Columbia	PhD in Mining Engineering (Vancouver)	Doctorate	English	No	Mining and Mineral Engineering
BC	The University of British Columbia	M.A.Sc in Mining Engineering (Vancouver)	Master's degree	English	No	Mining and Mineral Engineering
BC	The University of British Columbia	M.Eng in Mining Engineering	Master's degree	English	No	Mining and Mineral Engineering
NL	Memorial University of Newfoundland	Bachelor of Engineering in Process Engineering	Bachelor's degree	English	Yes	Chemical Engineering, Mining and Mineral Engineering, Petroleum Engineering
NS	Dalhousie University	Bachelor of Engineering in Mineral Resources Engineering	Bachelor's degree	English	Yes	Mining and Mineral Engineering
NS	Dalhousie University	PhD in Mineral Resource Engineering	Doctorate	English	No	Mining and Mineral Engineering
NS	Dalhousie University	M.A.Sc in Mining Engineering	Master's degree	English	No	Mining and Mineral Engineering
NS	Dalhousie University	M.Eng. in Mineral Resource Engineering	Master's degree	English	No	Mining and Mineral Engineering
ON	Laurentian University of Sudbury	B.Eng in Mining Engineering	Bachelor's degree	English	Yes	Mining and Mineral Engineering
ON	Laurentian University of Sudbury	PhD Natural Resources Engineering	Doctorate	English	No	Mining and Mineral Engineering
ON	Laurentian University of Sudbury	Masters of Applied Science in Mineral Resources Engineering	Master's degree	English	No	Mining and Mineral Engineering
ON	Laurentian University of Sudbury	Masters of Engineering in Mineral Resources Engineering	Master's degree	English	No	Mining and Mineral Engineering
ON	Queen's University	B.Sc Mining Engineering	Bachelor's degree	English	No	Mining and Mineral Engineering
ON	Queen's University	PhD in Mining Engineering	Doctorate	English	No	Mining and Mineral Engineering
ON	Queen's University	M.A.Sc in Mining Engineering	Master's degree	English	No	Mining and Mineral Engineering
ON	Queen's University	M.Eng in Mining Engineering	Master's degree	English	No	Mining and Mineral Engineering
ON	Queen's University	M.A.Sc in Mining Engineering	Master's degree	English	No	Mining and Mineral Engineering
ON	University of Toronto	B.Sc in Mineral Engineering (The Lassonde Mineral Engineering Program)	Bachelor's degree	English	No	Mining and Mineral Engineering
QC	Université Laval	Baccalauréat coopératif en génie des mines et de la minéralurgie	Bachelor's degree	French	Yes	Mining and Mineral Engineering
QC	Université Laval	Doctorat en génie des mines	Doctorate	French	No	Mining and Mineral Engineering
QC	Université Laval	Maîtrise en génie des mines (avec mémoire)	Master's degree	French	No	Mining and Mineral Engineering
QC	McGill University	Bachelor of Engineering in Mining Engineering — co-op program	Bachelor's degree	English	Yes	Mining and Mineral Engineering
QC	McGill University	PhD in Mining and Materials Engineering	Doctorate	English	No	Metallurgical Engineering
QC	McGill University	Graduate diploma in Mining Engineering	Graduate level certificate/diploma	English	No	Mining and Mineral Engineering
QC	McGill University	M.Eng in Mining and Materials Engineering	Master's degree	English	No	Metallurgical Engineering, Mining and Mineral Engineering
QC	McGill University	M.Sc in Mining and Materials Engineering	Master's degree	English	No	Metallurgical Engineering, Mining and Mineral Engineering
QC	École Polytechnique de Montréal	B.Ing en génie des mines	Bachelor's degree	French	Yes	Mining and Mineral Engineering
QC	École Polytechnique de Montréal	PhD en génie minéral	Doctorate	French	No	Mining and Mineral Engineering
QC	École Polytechnique de Montréal	Diplome d'étude supérieures spécialisées en génie minéral	Graduate level certificate/diploma	French	No	Mining and Mineral Engineering
QC	École Polytechnique de Montréal	Maîtrise en génie minéral	Master's degree	French	No	Mining and Mineral Engineering
QC	Université du Québec en Abitibi-Témiscamingue	Baccalauréat en génie des mines	Bachelor's degree	French	No	Mining and Mineral Engineering
QC	Université du Québec en Abitibi-Témiscamingue	Diplôme d'études supérieures spécialisées en génie minier	Graduate level certificate/diploma	French	No	Mining and Mineral Engineering
QC	Université du Québec en Abitibi-Témiscamingue	Maîtrise en génie minéral	Master's degree	French	No	Mining and Mineral Engineering

Source: Association of Universities and Colleges of Canada, Directory of Canadian Univeristies.

government spending on R&D attracts migrant workers, but the flow of workers will be dependent on access and the international wage-rate differentials. To attract migrant KWs interested in R&D and innovation to Canadian mining, the industry will need to stay knowledgeable about and competitive with global research trends and remuneration levels.

The movement of KWs has significant impact on the labour market of both the source and destination countries. The market for KWs has become increasingly competitive as industrialized countries compete strategically for this human capital. For permanent inflows of highly-skilled workers, Canada, Australia and the U.S. have comprehensive immigration schemes specifically aimed at attracting skilled workers. Although these systems are not industry-specific, Canada and Australia are the major beneficiaries of skilled immigrants; more than half of their permanent inflows are highly skilled.

From the mining industry's perspective, it will be important to attract a fair portion of workers from national migrant inflows, while also developing specific strategies geared to attracting international KWs who will respond to specific opportunities in the Canadian mining industry.

Summary

There is a lack of uniformity in the way KWs are defined globally, both across industries and within the mining sector. Establishing a clear definition of KWs is needed to clarify the scope of this research, and ultimately guide the industry's application of strategies to engage KWs.

Knowledge workers play different roles in the mining industry. They are educators, innovators and employees. As educators, KWs drive the creation and dissemination of knowledge, and foster the development of future KWs in educational institutions. As innovators, KWs develop new technologies and processes, which in their application increase the industry's ability to meet growing sustainability demands and industry competition. As employees, KWs are often placed in mission-critical, leadership and highly specialized roles, and apply innovation and knowledge in an organizational environment.

For a nation, the international nature of the KW labour market creates unique challenges in meeting labour demands. As well, common themes and challenges among industry sectors influence a country's ability to attract and retain KWs. Acknowledging the common challenges, and delineating the challenges unique to Canadian mining will be crucial in determining effective strategies to face this human-capital crisis. By developing awareness of global efforts to increase engagement, and generating a collaborative and unified approach, the Canadian mining industry can face this challenge head-on.

3

Labour Market Trends in Canadian Mining

To identify the unique HR issues associated with KWs in Canadian mining, this study used a combination of primary and secondary research to define KWs, and to research and analyze existing labour market intelligence for these workers in the sector. Research steps included extensive literature reviews; identification and analysis of data sources; and conversations or interviews with key industry stakeholders. The ultimate goal was to understand who KWs are in the Canadian mining industry, as well as their stocks and flows throughout the industry.

Definition and Scope

A careful definition of the KW segment of the workforce allowed for statistical data-collection and information-gathering. Three types of research findings were used to define KWs in the minerals and metals workforce, including:

- Industry stakeholders' views
- Findings from existing literature
- A list of relevant occupations and industries from the National Occupational Classification Statistics (NOC-S) and North American Industry Classification System (NAICS) codes

Information and insight gathered from these three sources are presented in the following sections.

Industry Stakeholders' Views

Mining industry stakeholders were consulted for input on a definition of "knowledge workers" that would be relevant to the sector. To better understand senior managers' experiences and ideas regarding KWs, the researchers interviewed nine senior industry stakeholders across Canada. The interviews explored what the term "KW" meant to them. These leaders also provided their views on the importance of and issues surrounding KWs — both in the industry as a whole and in their specific work environments. The goal was to develop an initial definition of KWs that could be fine-tuned in subsequent steps of the research.

Overall, stakeholders agreed that KWs comprise different and unique combinations of education, skill, experience and other special characteristics. In terms of education, they described KWs as:

- Most likely to hold a Bachelor's degree;
- Perhaps having earned a post-graduate degree (Master's or higher), noting that this level of education is particularly important for exploration and mining-industry academics and researchers; and
- Sometimes having no university degree but possessing very extensive hands-on and specialized experience in the minerals and metals sector (e.g., engineering or geosciences technicians).

In addition to such formal education characteristics, most stakeholders commented that KWs also usually possess direct hands-on experience with increasing levels of responsibility over a 10-to-20-year period. They may also have acquired skills in such specialized areas as mining innovation, technology and project management. Other characteristics mentioned by stakeholders include:

- Technologically savvy;
- Possessing knowledge of all phases of the mining cycle, including exploration, extraction, processing and reclamation; and
- Having the "right combination" of mining-related education, hands-on experience and people skills — including understanding of and sensitivity towards social, political, environmental and community issues, and the ability to navigate or negotiate conflicting interests among these groups.

KW occupations are most likely to include specific types of jobs, for example:

- Mining engineers
- Geological engineers
- Metallurgical engineers
- Mineral processing engineers
- Industrial engineers
- Mechanical, chemical and environmental engineers
- Geologists, geochemists, geophysicists, and other geoscientists
- Metallurgists and mineral processors
- Highly-skilled technologists (who may have a university degree). Examples included surveyors; mineral-processing technicians; chemical-lab technicians; assayers; geological technicians; layout, design, and drafts people; and those working in explosives companies

- Mine managers or mill superintendents with many years of extensive hands-on experience (regardless of educational attainment)
- University and college professors in mining, geology, geosciences and engineering departments
- Mining researchers with expertise in one or more of the above-mentioned areas of specialization

According to the definition of KWs derived from talking to the stakeholders, mining KWs usually attain at least a Bachelor's degree in one of the above specializations. In some instances, many years of extensive hands-on and specialized experience in the minerals and metals sector compensate for the lack of a university degree. In all cases, however, experience working in the minerals and metals industry is essential to the definition of a mining KW. Other professional skills for these individuals include project management, knowledge and experience with current mining technologies, and effective communication skills.

List of Occupations and Industries

To obtain solid labour market information about mining KWs, and to make use of existing data sources, the definition of KWs must be compatible with commonly used categorization indices. Accordingly, the following list of occupations and industries is based on two such indices: the National Occupational Classification for Statistics (NOC-S) and the North American Industry Classification System (NAICS).

Four-digit NOC-S codes relevant to KWs in minerals and metals include:

C012	Chemists
C013	Geologists, geochemists and geophysicists
C015	Other professional occupations in physical sciences
C021	Biologists and related scientists
C031	Civil engineers
C032	Mechanical engineers
C033	Electrical and electronics engineers
C034	Chemical engineers
C041	Industrial and manufacturing engineers
C042	Metallurgical and materials engineers
C043	Mining engineers
C044	Geological engineers
C048	Other professional engineers, n.e.c.
C054	Land surveyors
C111	Chemical technologists and technicians
C112	Geological and mineral technologists and technicians
C121	Biological technologists and technicians
C131	Civil engineering technologists and technicians
C132	Mechanical engineering technologists and technicians
C133	Industrial engineering and manufacturing technologists and technicians
C134	Construction estimators
C141	Electrical and electronics engineering technologists and technicians

C153	Drafting technologists and technicians
C154	Land survey technologists and technicians
C155	Mapping and related technologists and technicians
A121	Engineering managers
A371	Construction managers
A381	Primary production managers (except agriculture)

When examining KWs, the minerals and metals sector must include the following industry sub-sectors as defined by the North American Industry Classification System 2007 (NAICS 2007):[41]

2121	Coal mining
2122	Metal ore mining
2123	Non-metallic mineral mining and quarrying
2131	Support activities for mining and oil and gas extraction (excluding the proportion related to support activities for oil and gas extraction)
3311	Iron and steel mills and ferro-alloy manufacturing
3313	Alumina and aluminum production and processing
3314	Non-ferrous metal (except aluminum) production and processing
5413	Architectural, engineering and related services (only as related to mineral exploration)
6113	Universities (only to the extent such services are directly related to mining, data permitting)[42]
911	Federal government public administration (only to the extent such services are directly related to mining, data permitting)[43]
912	Provincial and territorial public administration (only to the extent such services are directly related to mining, data permitting)[44]

From a statistical point of view, the most ideal process for defining KWs in mining is to select specific occupational groups in mining-related industries. This approach allows for reference to data available in public sources and can be easily updated with new data series.

There are, however, some limitations to such a definition of KWs in mining (as in any other industries). Occupations in the National Occupational Classifications (NOC) are designed to include individuals who perform specific job duties with a certain skills-level — as defined by the formal education credentials generally required to perform such duties. On the other hand, statistical data collected for individuals in a specific occupation may actually show that their educational attainment does not meet the minimum standards required by the NOC definition. Using an educational requirement alone does not address the fact that skills can be acquired through years of experience.

41 For a description of how industries are classified in the Canadian economy and the classification codes, refer to Statistics Canada's website www.statcan.gc.ca/subjects-sujets/standard-norme/naics-scian/2007/list-liste-eng.htm

42 To net out the proportion of employment directly related to mining, one can assume that the proportion of employment in each of the KW occupational groups working in mining is the same as the proportion of mining industry employment to employment in all industries.

43 To net out the proportion of employment directly related to mining, one can make use of data available from Statistics Canada's publication *Federal Scientific Activities*, which shows expenditures on scientific research and development by different federal government departments and agencies.

44 In the absence of specific data, one can assume that the proportion of provincial government expenditures on scientific research and development allocated to mining is the same as the proportion derived from federal government expenditures.

Another related issue concerns how industries are defined using NAICS and how over-estimation of employment is possible. A useful example is *NAICS 5413 Architectural engineering and related services*, which contains relevant geophysical surveying and mapping sectors. A geophysicist working in this industry does not provide services to mining exclusively. In this case, it is necessary to adjust the employment estimates of geophysicists by using other sources of data.

In summary, KWs are defined for statistical purposes via a combination of NAICS and NOC-S codes. The NAICS codes used to define the mining industry include those components of the various administrative and service sectors that support mining. In terms of occupations, a definition of KWs for mining includes relevant engineering and science professionals, technicians and technologists, and certain managerial positions.

Data shown in the following section have been compiled using information available from Statistics Canada's 2006 Census and the Labour Force Survey (updated monthly). The occupation-by-industry data represent the best estimate of the size of the KW workforce in mining. Census data is used to provide a snapshot of the KW workforce and estimates are built following year-over-year trends in the Labour Force Survey.[45]

According to a 2010 Ernst & Young business risk report, skills shortage is the second-most important business risk facing the global mining and exploration industry — up from sixth place in 2009.[46] According to a recent labour-supply forecast from The Conference Board of Canada for 66 different mining-related occupations, by 2014 there will be insufficient numbers of new workforce entrants to replace those who are leaving. This gap will widen as new entrants to the workforce gradually decline through 2020.[47]

In Canada, MiHR estimates that approximately 60,000 to 100,000 new employees will be required by 2020 — mainly due to the age profile of the current workforce and the predicted number of retirements.[48] Two occupational categories expected to be in high demand in the mining and exploration industry include "Professional and Physical Science" and "Managers and/or Financial" occupations, all of which require a university education. These occupations alone will account for approximately six per cent of hiring requirements by 2020.[49] (see Table 4 on page 31.)

45 For information on employment in industries, Statistics Canada also has data available from its *Survey of Employment, Payrolls and Hours* (SEPH). The main reason that SEPH data is not used here is that it does not cover employment of the self-employed.

46 Ernst & Young. (2010). *The 2010 Ernst & Young business risk report: Business risks facing mining and metals*, London: EYGM Limited.

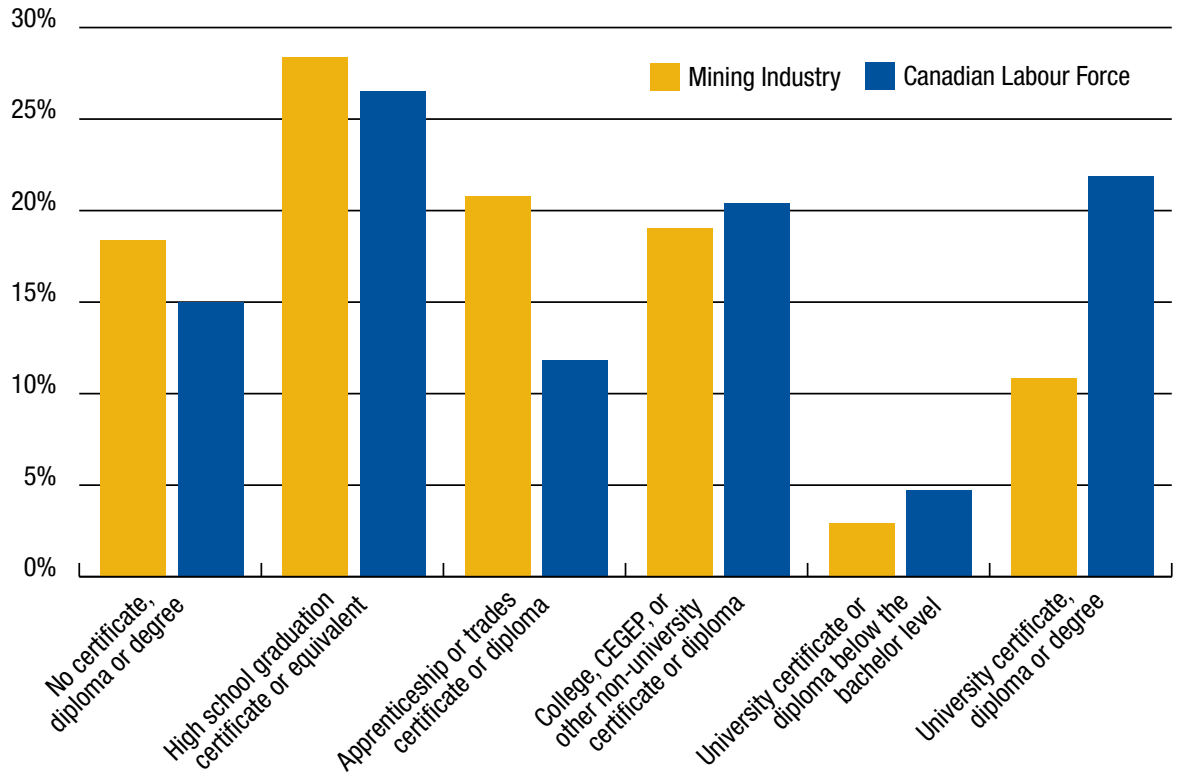
47 The Conference Board of Canada. (2011). *Knowledge Makes You Smarter: Improving Corporate IQ By Transferring Tacit Knowledge.* Organizational Excellence Report, Ottawa: The Conference Board of Canada.

48 Mining Industry Human Resources Council. (2010). "Canadian Mining Industry Employment and Hiring Forecasts 2010." *A Mining Industry Workforce Information Network Report.* July 2010. www.mininghrforecasts.ca/en/resources/MiHR_Canadian_Mining_Employment_Forecasts_July2010.pdf

49 *Ibid.*

As shown in Figure 1, in 2010, KWs accounted for 11 per cent of the Canadian mining and exploration labour force. This percentage was significantly lower than the 22 per cent of KWs found in the overall labour force in Canada.[50]

Figure 1
Proportion of Canadian Mining Workforce by Highest Level of Educational Attainment



Source: Mining Industry Human Resources Council, 2010, 15.

As shown in Table 5 on page 32, at the time of the 2006 Census, the total number of individuals employed in KW occupational groups in core mining-related industries was about 24,800 people. This accounted for just over five per cent of individuals in the selected occupational groups employed in all industries.[51]

50 Mining Industry Human Resources Council. (2010). "Canadian Mining Industry Employment and Hiring Forecasts 2010." A *Mining Industry Workforce Information Network Report.* July 2010. www.mininghrforecasts.ca/en/resources/MiHR_Canadian_Mining_Employment_Forecasts_July2010.pdf.

51 To arrive at this conclusion, data on industrial research and development expenditures by industry was used to estimate the number of employed workers in architectural engineering and related services that provide services directly related to mining. Expenditures in mining-research (including mining, support activities to mining and oil and gas, and primary metal manufacturing industries) account for about 2.4 per cent of the total expenditures. It is assumed that an equal percentage of the labour force in these occupations provides services to mining. The only exception is the occupation of mining engineers, which has a factor of one.

Table 4

Cumulative Hiring Requirements of Selected Knowledge Workers in Canadian Mining, Baseline Scenario—2012, 2015, 2020

	CUMULATIVE HIRING REQUIREMENTS		
	2012	2015	2020
OVERALL MINING INDUSTRY	**29,080**	**53,150**	**99,990**
PROFESSIONAL AND PHYSICAL SCIENCE OCCUPATIONS			
Engineering managers	60	105	190
Chemists	30	60	115
Geologists, geochemists and geophysicists	380	680	1,260
Other professional occupations in physical sciences	50	90	180
Biologists and related scientists	<25	<25	<25
Civil engineers	30	50	105
Mechanical engineers	100	185	350
Electrical and electronics engineers	55	105	200
Chemical engineers	45	80	155
Industrial and manufacturing engineers	100	180	370
Metallurgical and materials engineers	50	90	195
Mining engineers	175	320	615
Geological engineers	20	30	55
Other professional engineers	<25	<25	<25
TOTAL: PROFESSIONAL AND PHYSICAL SCIENCE OCCUPATIONS	**1,095**	**1,990**	**3,810**
MANAGERS AND/OR FINANCIAL OCCUPATIONS			
Financial managers	100	185	345
Human resources managers	100	180	340
Financial auditors and accountants	305	555	1,025
Financial and investment analysts	30	50	105
Specialists in human resources	90	160	315
TOTAL: MANAGERS AND/OR FINANCIAL OCCUPATIONS	**625**	**1,135**	**2,130**

Source: Mining Industry Human Resources Council 2010. Numbers do not add perfectly due to rounding.

Table 5
Employment of Knowledge Workers in All Mining-Related Industries in Canada, Age 15–64, 2006

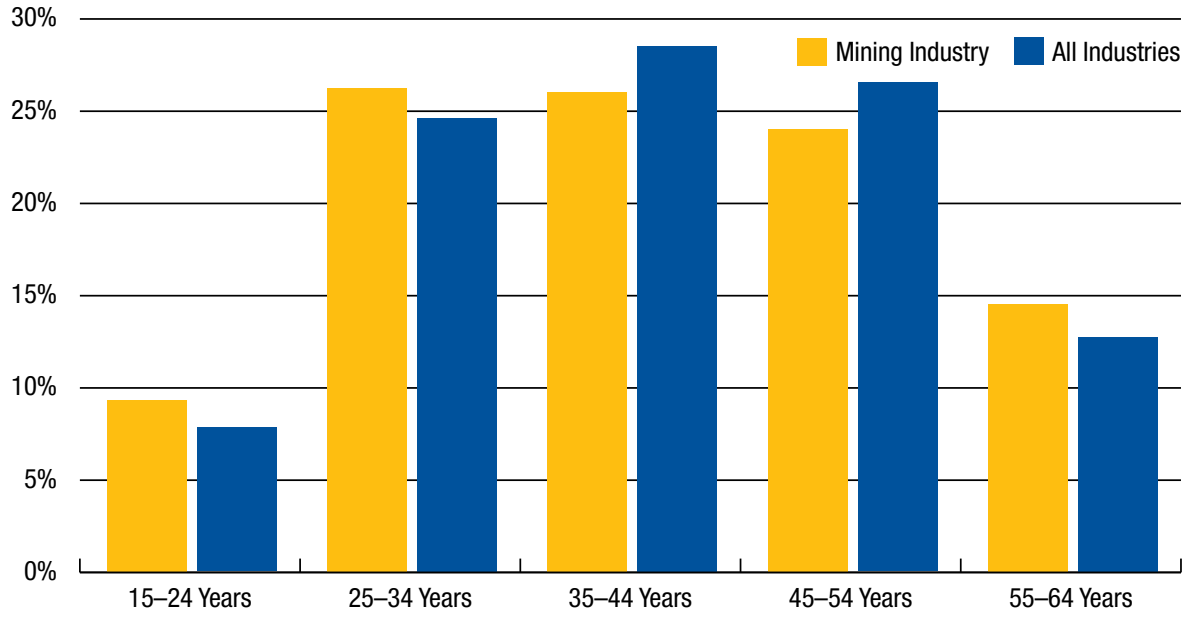
KNOWLEDGE WORKER OCCUPATIONS	ALL INDUSTRIES	SELECTED MINING-RELATED INDUSTRIES
Engineering managers	17,660	486
Construction managers	56,215	422
Primary production managers (except agriculture)	12,860	5,812
Chemists	17,270	329
Geologists, geochemists and geophysicists	11,635	2,714
Other professional occupations in physical sciences	1,445	419
Biologists and related scientists	17,235	52
Civil engineers	40,675	708
Mechanical engineers	35,005	1,022
Electrical and electronic engineers	31,920	622
Chemical engineers	8,970	428
Industrial and manufacturing engineers	18,970	918
Metallurgical and materials engineers	2,095	530
Mining engineers	2,485	1,895
Geological engineers	1,650	144
Other professional engineers	2,815	44
Land surveyors	9,490	496
Chemical technologists and technicians	28,370	1,181
Geological and mineral technologists and technicians	9,825	2,951
Biological technologists and technicians	10,155	64
Civil engineering technologists and technicians	12,760	197
Mechanical technologists and technicians	12,925	542
Industrial engineering and manufacturing technologists and technicians	16,892	601
Construction estimator	13,750	98
Electrical and electronic engineering technologists and technicians	32,095	1,015
Drafting technologists and technicians	32,895	862
Land survey technologists and technicians	4,415	144
Mapping and related technologists and technicians	6,935	108
TOTAL: SELECTED OCCUPATIONS	**469,410**	**24,803**

Source: 2006 Census, Statistics Canada. Adapted by Roslyn Kunin & Associates, 2010.

Age

Due to their higher educational requirements, the average age of KWs is slightly higher than that of the overall labour force in Canada.[52] However, the age distribution of KWs in mining and exploration is very similar, if not slightly younger, than the age distribution of employees holding the same occupations in the rest of the Canadian labour force.[53] Figure 2 compares the age distribution of the workers in mining-related occupations to that of the same occupations in all industries in Canada.

Figure 2
Age Distribution of Knowledge Workers in Mining-Related Industries and in All Industries in Canada, 2006



Source: Roslyn Kunin & Associates, MiHR, 2010.
See Appendix B for more details.

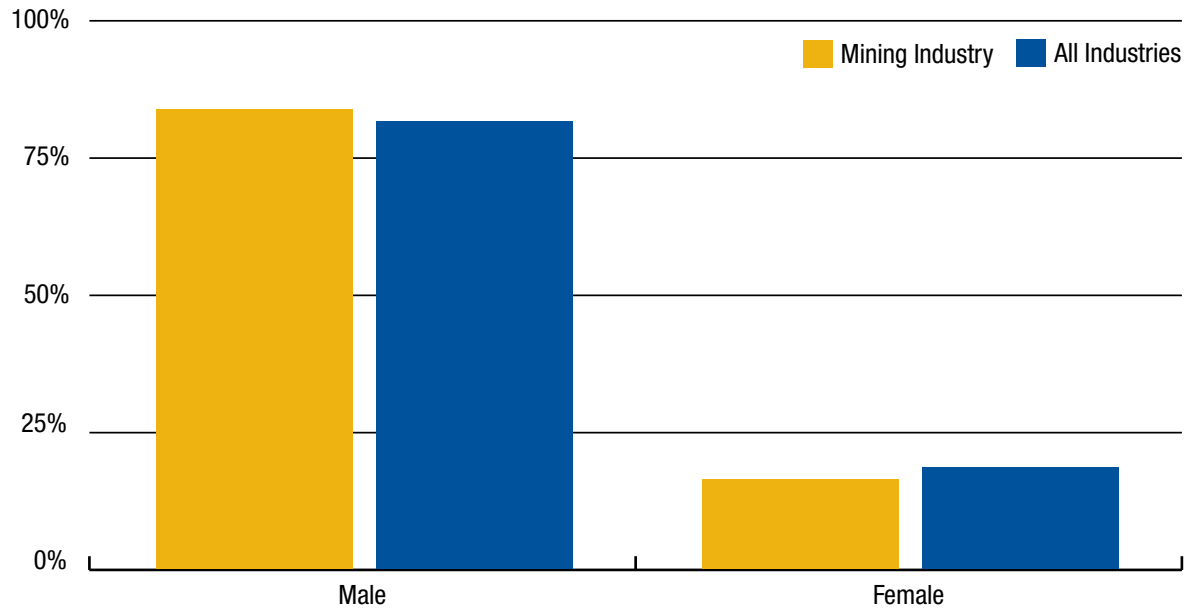
52 Roslyn Kunin & Associates, Inc. (2009). *Making the Grade: Current and Projected Supply and Demand for Highly Qualified People in the Canadian Minerals and Metals Industry*. Situational Analysis, unpublished report for MiHR.

53 *Ibid.*

Gender

Mining and exploration has traditionally been a male-dominated industry; today, women are still significantly under-represented in the sector's labour force.[54] Furthermore, women are also under-represented in KW occupations in mining and exploration.[55] This pattern is not restricted to the mining and exploration sector, as women are not as prevalent as men in these occupations across all industries in Canada. Figure 3 compares the gender distribution of KWs in the mining sector with all industries in Canada. If the mining and exploration industry could find ways to attract more women KWs (and better retain the ones they have), this would help alleviate the projected future shortage of KWs in the sector.

Figure 3
Female Knowledge Workers in Mining and Exploration and in All Industries in Canada, 2006



Source: Roslyn Kunin & Associates, MiHR, 2010.
See Appendix B for more details.

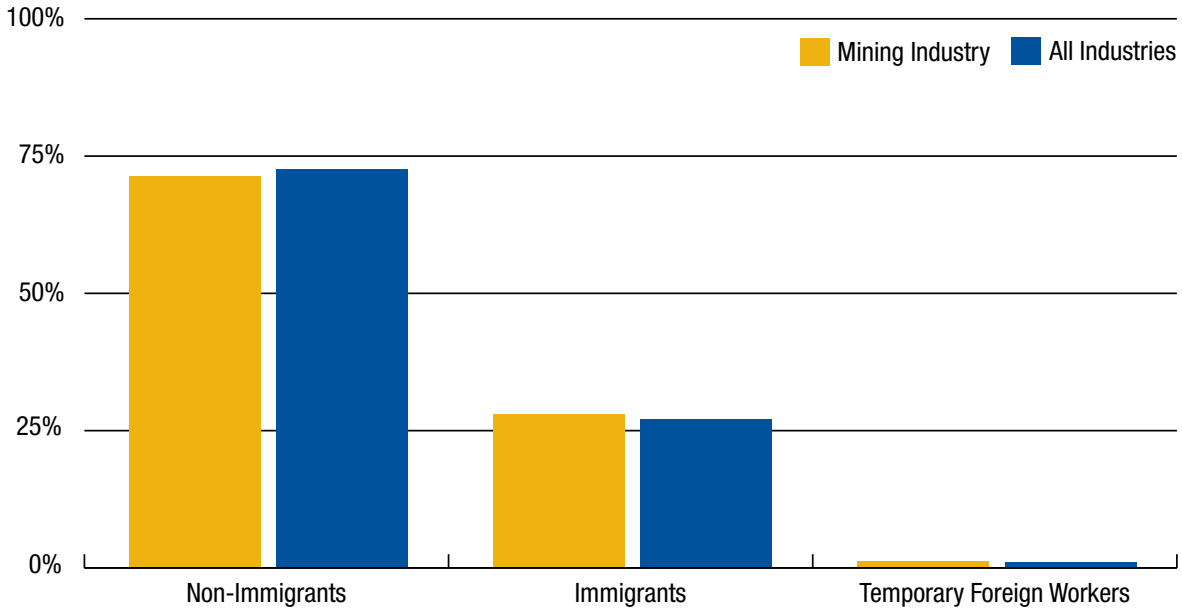
54 Women in Mining Canada. (2010). *Ramp-UP: A Study on the Status of Women in Canada's Mining and Exploration Sector*. Ottawa: Women in Mining Canada.

55 Roslyn Kunin & Associates, Inc. *Making the Grade: Current and Projected Supply and Demand for Highly Qualified People in the Canadian Minerals and Metals Industry*. Situational Analysis, unpublished report for MiHR.

Immigrant Status

The Canadian mining and exploration sector must compete for its KWs on a global scale. This can be seen as both a challenge and a potential opportunity, since many of the major mining companies are multinationals and require an internationally mobile workforce. In fact, the Canadian mining and exploration industry appears to be successful in attracting foreign workers — particularly engineers — since the proportion of immigrant KWs in the sector is higher than in all industries in Canada.

Figure 4
Immigrant Status of Knowledge Workers in Mining and Exploration and in All Industries in Canada, 2006



Source: Roslyn Kunin & Associates, MiHR, 2010.
See Appendix B for more details.

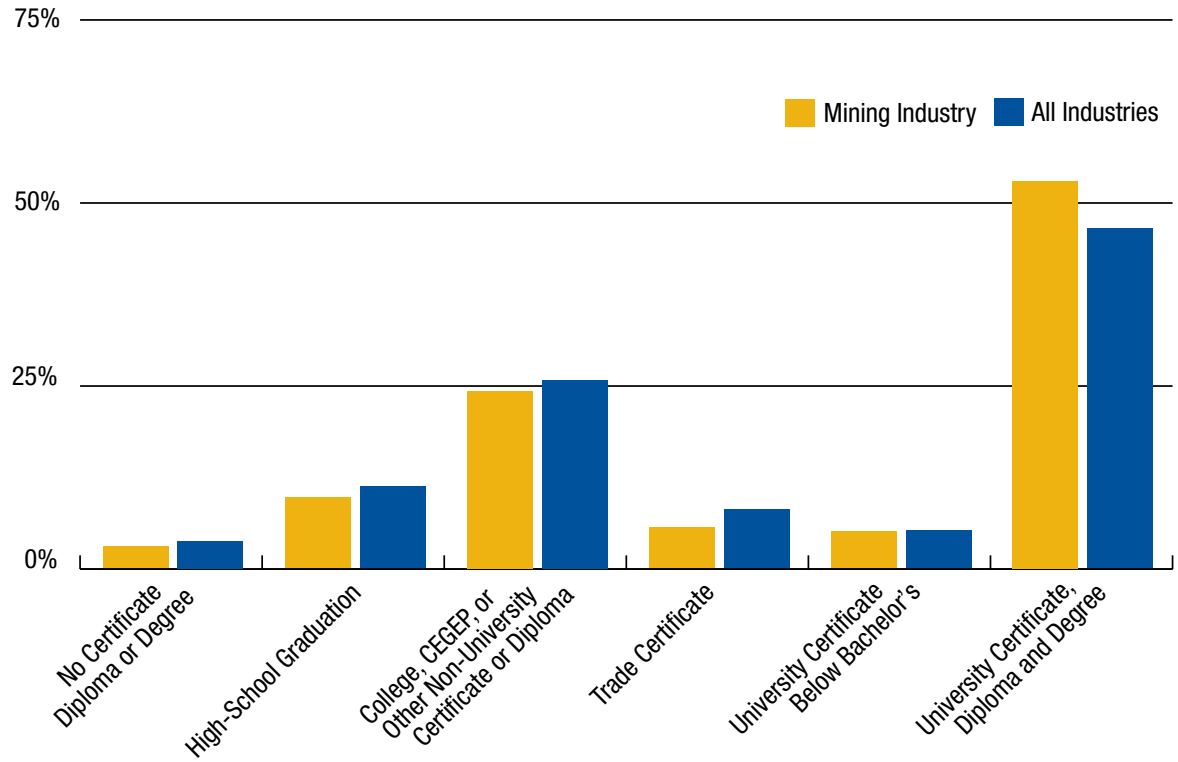
Educational Attainment

Not surprisingly, individuals employed in the KW occupational groups have attained higher levels of education and training than the general workforce, especially given that these workers need a minimum of a Bachelor's degree to be considered for employment.

Almost 70 per cent of individuals in the KW occupational groups have completed at least a college-level education. This level is remarkably higher than the 41 per cent in the general workforce. Figure 5 shows the educational attainment of the portion of the KW workforce between the ages of 15 and 64 and includes all industries, including mining. Figure 5 shows that the KW workforce in general is comprised of highly educated individuals, and thereby reinforces the importance of ensuring Canadian universities and other educational institutions continue to produce a reliable supply of these individuals.

Comparing the KW workforce in two industry groupings, 82.1 per cent of those individuals in mining-related industries have at least a college diploma as their highest level of educational attainment, while only 77.2 per cent in all industries have this level of education.

Figure 5
Educational Attainment of Knowledge Worker Workforce in Mining-Related Industries and in All Industries, Canada, Age 15–64, 2006



Source: 2006 Census, Statistics Canada
See Appendix B for more detail.

Generational Forces in the Workplace

Much has been written lately about the working styles and preferences of the youngest cohort in the workforce. The members of "Generation Y" (those born after 1980) are in many ways similar to their baby boomer parents: they are ambitious, seek job stability and have a strong sense of loyalty.[56] They do not, however, want to emulate the "workaholic" lifestyles typified by their parents' generation, so lifestyle factors such as work-life balance and the ability for personal growth must be addressed to attract and retain this generation of KWs.[57]

One key to attracting and retaining the KWs of Generation Y lies in ensuring their continued professional development and advancement. Generation Y is a highly educated cohort, and they seek opportunities to engage in work that is personally meaningful and contributes to society at large.[58] This need to feel like valued contributors means that these younger employees expect their employers to provide ample opportunities for performance development and feedback; they are especially interested in advancement within their organizations.[59]

Unlike their job-hopping Generation X-predecessors, Gen Ys have a fairly strong sense of organizational commitment.[60] Employers, however, may need to work harder to maintain that loyalty, as the increasing global demand for KWs ensures that those who become dissatisfied and look elsewhere will be likely to quite easily find other opportunities. Approaches that would help to ensure that Gen Y KWs remain in organizations include providing them with stimulating and fulfilling work; giving them the opportunity to constantly improve their skill set through a culture that promotes learning and development; and offering ample opportunities for recognition, advancement, and autonomous work.

The Conference Board of Canada research suggests that encouraging mature workers to extend their careers by a few years is another strategy for mitigating skills shortages. Nevertheless, while many Canadians are delaying retirement plans as a result of the recession,[61] baby boomers will still be leaving organizations in significant numbers over the next few years. With large numbers of retirements looming, organizations must work to understand motivators that will retain older workers; plan far ahead to fill retirement vacancies; and ensure smooth transfer of knowledge when KWs do leave.[62]

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56 Hewlett, Sylvia A, Laura Sherbin, and Karen Sumberg. (2009). How Gen Y & Boomers Will Reshape Your Agenda. *Harvard Business Review*, July–August: 71–76.

57 Business and Professional Women's Foundation. (2011). *Gen Y Women in the Workplace: Focus Group Summary Report*. Young Careerist Report, Washington: BWP.

58 *Ibid.*

59 Hewlett, Sylvia A, Laura Sherbin, and Karen Sumberg. (2009). How Gen Y & Boomers Will Reshape Your Agenda. *Harvard Business Review*, July–August: 71–76.

60 *Ibid.*

61 Antunes, Pedro, and Brent Dowdall. (2011). Recession Hit Expected to Keep Boomers Working. *Hot Topics in Economics*. Ottawa: The Conference Board of Canada. www.conferenceboard.ca/economics/hot_eco_topics/default/11-02-25/Recession_Hit_Expected_to_Keep_Boomers_Working.aspx.

62 Hewlett, Sylvia A, Laura Sherbin, and Karen Sumberg. (2009). How Gen Y & Boomers Will Reshape Your Agenda. *Harvard Business Review*, July–August: 71–76.

Industry Needs for Information and Regular Reporting on Knowledge Workers

Secondary research and data analysis, together with stakeholder interviews in the minerals and metals industry, shows that there are several areas to address with respect to information needs and regular reporting on KWs. Industry, government and the education sector must combine efforts to obtain and track this information. Topics that would be valuable to monitor for further and ongoing KW planning include:

- Basic statistics on where KWs are coming from and where they are going;
- Number of KWs leaving and entering the industry;
- Number of KW job postings and how long have they been open;
- Breakdown of data related to specific occupations as defined at the four-digit NOC-S level to be reflective of true occupational profiles in the sector and different working conditions (for example, C013 Geologists, geochemists, geophysicists should be further broken down to separate out greenfield geologists, mining geologists, geochemists, etc.);
- Better understanding of KWs' foreign credentials in mining;
- Breakdown of data by province or region of the country, to better understand KW challenges throughout Canada in terms of both similarities and differences; and
- Detailed follow-through and analysis of the career paths of university graduates in mining-related study programs.

Primary research (surveys, or ideally, a census of those working in KW roles in the mining sector) would be needed to cover most of the data requirements described above. Some of the material may be obtained from special runs and detailed breakdowns of existing data, but this information is limited by several factors. For example, these data sources will continue to restrict a definition of KWs in mining to the combination of relevant NAICS and NOC-S codes. In addition, information will be suppressed by Statistics Canada to protect individuals' privacy when numbers in some cells are small enough to risk identification.

All stakeholder groups interviewed for this research (private sector, government and education) felt strongly about the impacts of KWs on the economic success of the industry, and expressed their commitment to long-term workforce planning for KWs. There is a sense of urgency for ongoing research on KWs, given their labour market demographics, as discussed above. This study provides the baseline for further research and analysis of the HR challenges and opportunities related to KWs in the sector, to assist industry stakeholders in ongoing strategic workforce planning.

Implications for the Mining and Exploration Sector

The mining and exploration sector is not exempt from the broad changes occurring in today's workforce and workplace. As a result, the industry already faces serious human resources challenges. According to MiHR research, over a third of the sector's workforce will be eligible to retire by 2015.[63] To meet the industry's baseline production targets, it is expected that one out of every two current employees in the sector will need to be replaced over the next 10 years.[64] Therefore, mining and exploration organizations will need to increase their focus on recruitment, retention and succession planning.

Furthermore, the need for highly educated workers is increasing due to the importance of advanced technology in today's mining and exploration industry. The industry will require geologists and geoscientists, metallurgists and mining engineers, as well as employees skilled in computer and information technology, among others.[65] Given the intense competition for these newly graduated KWs, the mining and exploration sector will need to ensure that its opportunities, incentives and work environments are competitive with other sectors.

The mining sector has traditionally relied on lucrative wages and the chance to engage in exciting, challenging work to attract new workers to the sector.[66] However, there are a number of unique lifestyle challenges and deterrents to working in the industry. These issues might factor more heavily in the career plans of young KWs and women of all generations than the traditional benefits can address. While administrative and corporate services roles are often located in urban areas, other occupations require relocation to isolated mining communities, extensive travel, and fly-in/fly-out working arrangements.[67] If compensation and benefits are not primary motivators for younger KWs, the mining and exploration sector could experience difficulties in recruiting and retaining these key people.

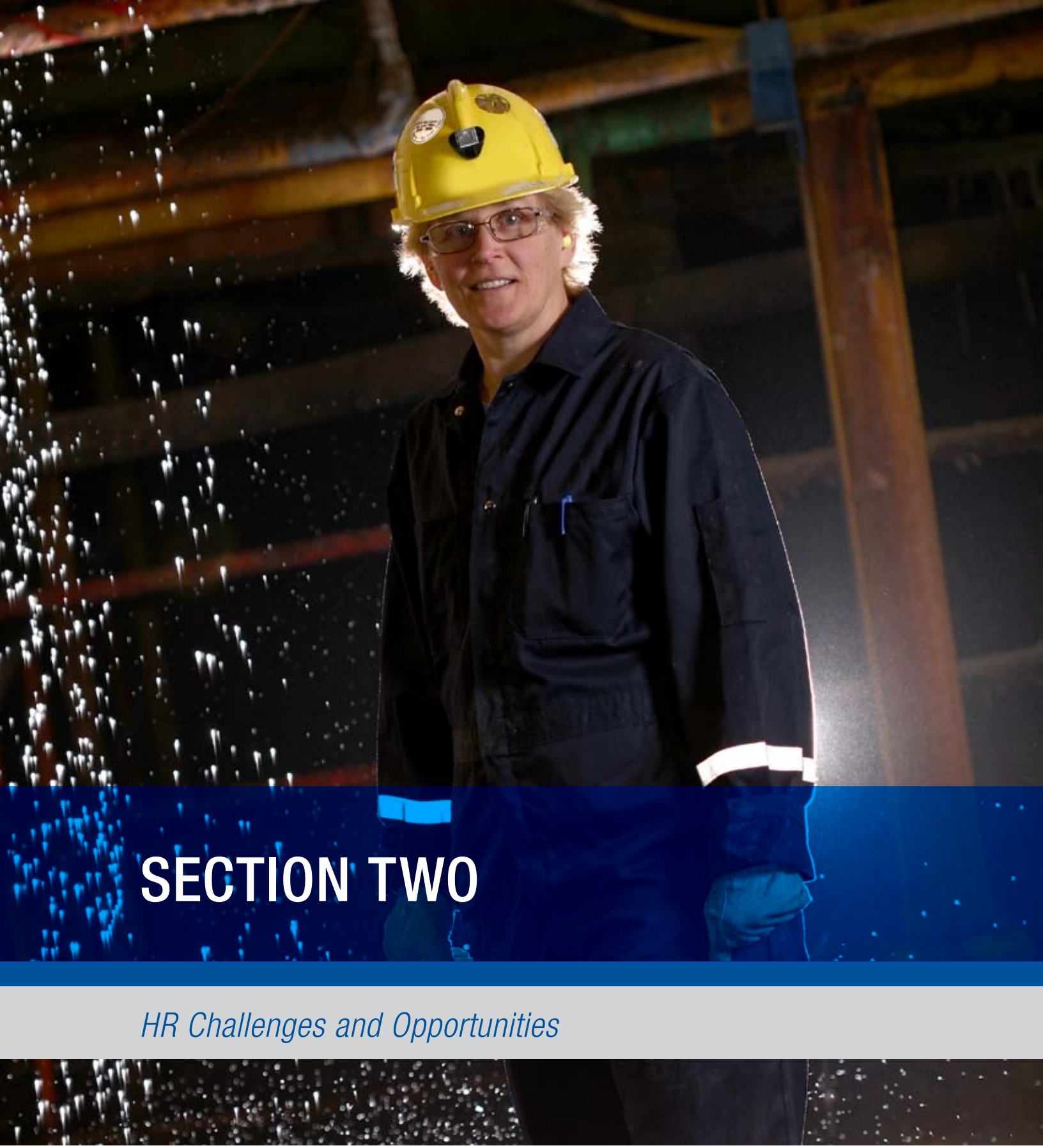
63 Mining Industry Human Resources Council. (2010). Canadian Mining Industry Employment and Hiring Forecasts 2010. *A Mining Industry Workforce Information Network Report.* July 2010. www.mininghrforecasts.ca/en/resources/MiHR_Canadian_Mining_Employment_Forecasts_July2010.pdf

64 The Mining Association of Canada. (2010). *A report on the state of the Canadian mining industry: facts and figures 2010.* Ottawa: MAC.

65 Mining Industry Human Resources Council. (2010). Canadian Mining Industry Employment and Hiring Forecasts 2010. *A Mining Industry Workforce Information Network Report.* July 2010. www.mininghrforecasts.ca/en/resources/MiHR_Canadian_Mining_Employment_Forecasts_July2010.pdf

66 *Ibid.*

67 Ritter, Archibald. (2001). Canada: From Fly-In, Fly-Out to Mining Metropolis. *Large Mines and the Community: Socioeconomic and Environmental Effects in Latin America, Canada, and Spain.* Ottawa: International Development Research Centre.



SECTION TWO

HR Challenges and Opportunities

4

Industry Consultation Approach and Methodology

Overview of Research Process

Primary research involved a series of focus groups, interviews and questionnaires; as well as both formal and informal roundtables and discussions. The researchers held focus groups in association with industry events and conducted interviews with stakeholders across the country. Research participants included students, workers, employers, educators, government representatives and industry associations. Over 700 individuals participated in the various research activities supporting project findings. A project steering committee comprised of representatives from education, employers, government and industry associations met regularly throughout the research process to offer insight, guidance and expertise.

Focus Groups

Three focus group sessions were held in three major cities over the course of the primary research phase. Focus group participants discussed a series of issues guided by background research and the situational analysis phases of research. Focus groups ranged from three to 12 participants, with an average size of 10.

Questionnaires

Using information collected in the qualitative and background research, both an employee and a student questionnaire were developed. Questionnaires were deployed in an online format. Invitations were distributed to potential participants in the industry and to industry-related programs of study, through the project steering committee and project partners.

Interviews

Key informant interviews were conducted with 25 industry stakeholders representing industry; professional and industry associations; government; educational institutions; and students. Interview content was tailored to suit the expertise of each informant. Each interview was between 60 and 90 minutes in length. In some cases, follow-up interviews were conducted to clarify or delve deeper into key issues. Key informant interviews were conducted throughout the primary research phase, ending in March 2011. Completed questionnaires included 408 KW and 237 student surveys.

Validation interviews were conducted with eight industry stakeholders. The purpose of these interviews was to verify findings from primary research; content of the interviews was tailored for each stakeholder perspective. The profile of validation informants mirrored that of key informants, but included a different subset of individuals. Each validation interview lasted between 60 and 90 minutes. Validation interviews were conducted throughout May 2011.

Findings

The HR challenges and opportunities identified in the industry consultation and primary research activities were aggregated and organized into four main sections: attraction and recruitment; retention and engagement; succession planning; and education and development. In each section, the perspectives of the various stakeholders (students, educators, employees, employers and others) are discussed individually. This report notes patterns and themes and makes recommendations for addressing the issues raised for each of the four broad sections.

5

HR Challenges and Opportunities

Responses to interviews with employers and industry experts revealed that the most pressing HR concerns within the industry are attraction and retention. Although issues relating to impending retirements and succession planning did not emerge as a primary concern during the interviews, demographic data for the industry as a whole indicate that the loss of senior professionals will become an issue for the sector in the near future.

Data from MiHR's *Student Survey* and *Knowledge Worker Survey* were analyzed to better understand the challenges and opportunities for organizations with regard to the key HR issues. The results of these analyses are presented in the sections that follow.

Attraction Challenges and Opportunities

Mining and exploration-industry employers are very concerned about attracting KWs to the sector. During this research, students and current KWs identified several workplace elements which greatly influence their career decisions. While competitive compensation is essential to attract KWs to the sector, they also require opportunities to:

- Engage in rewarding work;
- Apply their skills;
- Learn and develop their careers; and
- Have flexibility at work.

The respondents to the *Student and Knowledge Workers Surveys* also identified key challenges that may deter them from choosing a career in the sector. These include:

- The remote locations of some mining and exploration operations;
- Lack of awareness of the sector;
- Concerns about the environmental impacts of the industry; and
- Perception of employment instability due to the boom-and-bust nature of the work.

These areas of opportunities and challenges are discussed in more detail in the following sections.

Work Motivators

Employee work motivation is typically comprised of two elements: intrinsic motivators and extrinsic motivators. Intrinsic motivators involve internally-generated rewards such as challenge, excitement, and the opportunity to demonstrate one's skills and abilities. Extrinsic motivators are externally-generated, and typically involve factors provided by the organization, such as compensation, benefits, and opportunities for advancement. Knowledge workers, in general, are more highly motivated by the intrinsic aspects of their work. Specifically, KWs need to feel that they are making progress and engaging in meaningful work that is free of organizational obstacles and hindrances.

While one extrinsic factor (compensation) emerged as a prime motivator for the future career decisions of all students surveyed, the remaining factors were mostly intrinsic in nature. They included the opportunity to engage in rewarding work and apply one's skills; opportunities for learning and development; and having a flexible work environment. Viewed as a whole, the primary motivators for students in both mining and non-mining-related programs were not reward-based, but tied more to issues related to personal fulfillment and career advancement. (see Table 6.)

Table 6
Top Factors* Influencing Students' Future Career Decisions

	STUDENTS IN MINING-RELATED PROGRAMS	STUDENTS IN NON-MINING-RELATED PROGRAMS
1	Rewarding work	Rewarding work
2	Compensation	Learning and development opportunities
3	Exciting work	Job security
4	Learning and development opportunities	Compensation
5	Ability to apply skills	Flexible work environment

* Respondents were asked to choose three options from a list of 26 factors.
Source: MiHR Student Survey, 2011.

The findings from the student survey do differ slightly, however, from the motivations of KWs working in the sector. When current mining KWs were asked what attracted them to the industry in the first place, the overwhelming majority chose compensation as their primary motivator. (see Table 7.) This difference between motivators for older and younger generations aligns with the findings from previous research into

the different motivators emerging with the highly-skilled members of Generation Y as compared with Baby Boomers. While the mining and exploration sector was able to count on its lucrative wages as the number-one attractor for young workers in the past, the student-survey findings illustrate that the industry may not be able to rely on compensation alone to attract the new generation of KWs.

Table 7
Top Factors* that Attracted Current Mining and Exploration Knowledge Workers to the Sector

	ATTRACTIVE FACTORS
1	Compensation
2	Ability to apply skills
3	Intense/exciting work
4	International work opportunities
5	Positive/rewarding work

* Respondents were asked to choose three options from a list of 26 factors.
Source: MiHR Professional Survey, 2011.

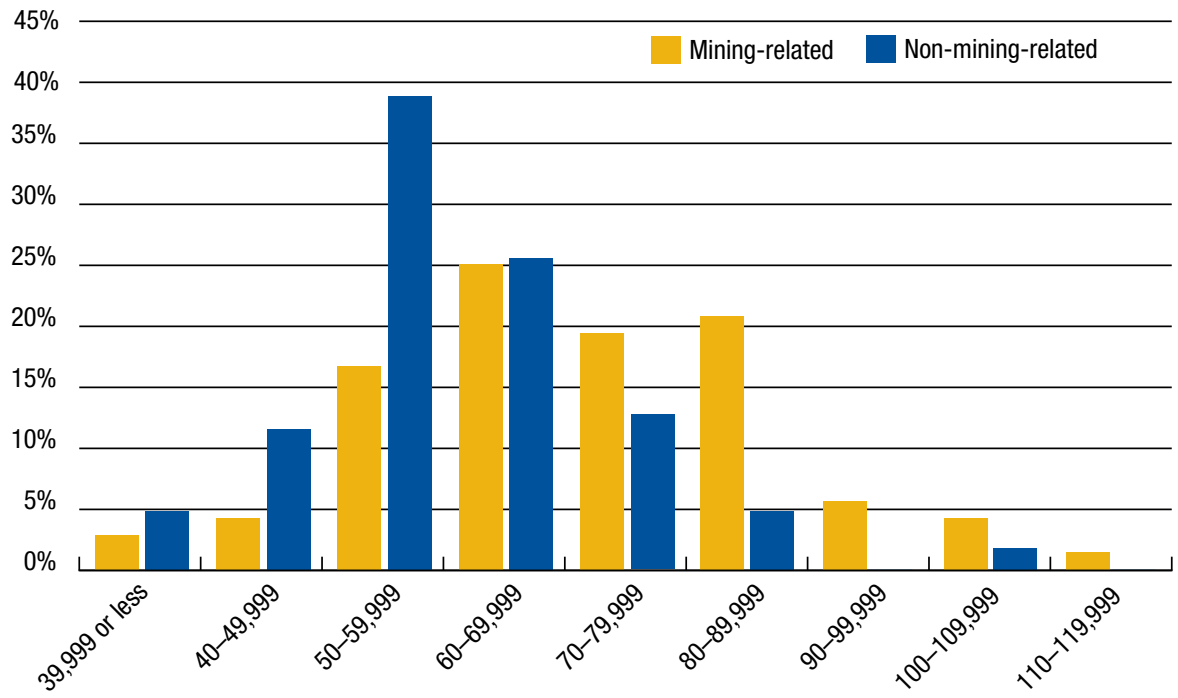
While money may not be the primary attractor for students in the industry, they do have some clear expectations that they will be well-compensated for their efforts. Students currently in mining-related programs had significantly higher expectations for starting salaries than did students in non-mining-related programs, as can be seen in Figure 6.

Students in mining-related programs believe their starting salaries will outpace those of students from other programs, yet only 65 per cent of KWs currently employed in mining and exploration indicate that the mining industry offers better incentives than other sectors (66 per cent men and 58 per cent women).[68] Yet, according to Statistics Canada's 2006 Census, a KW in mining earned an average salary that was 25 per cent higher than the national average.[69] Perhaps KWs currently employed in mining are not aware of the competitiveness of their compensation and better communication of the employees' total compensation package would resolve this issue.

While the majority of KWs rated the incentives highly, the 65 per cent figure is not a resounding endorsement. Knowledge workers may be acknowledging that other sectors are now offering increased compensation and benefits, in an effort to attract a shrinking pool of KWs. This should pose a potential concern for employers: while students currently in mining-related programs expect higher wages, they may ultimately be disappointed by the competitiveness of the sector's compensation. This could lead to retention issues for this cohort of workers if compensation levels do not keep pace with expectations over time.

68 MiHR Professional Survey, 2011.
69 Statistics Canada, *2006 Census*, custom table for MiHR.

Figure 6
Starting Salary Expectations of Students in Mining-Related and Non-Mining-Related Programs
(N=237)



Source: MiHR Student Survey, 2011.

Also of note is the lower proportion of women who see the industry's incentives as competitive. This may reflect a perceived inequality in salaries or the fact that the women in the survey were younger than the men — thus at a lower salary level.[70] According to the 2006 Census, the average salaries of male KWs in mining are nearly double that of women. In the broader labour force, the wage gap for female KWs is somewhat smaller, with a difference of about 40 per cent.[71]

Deterrents to a Career in the Industry

As shown in Table 8, the number-one deterrent for both groups of students (in mining and non-mining-related programs) was the remoteness of work locations. Not surprisingly, the majority of students in both mining and non-mining-related programs would prefer their future careers to be located in major urban centres in Canada.

70 To properly address this issue, the salary levels of men and women across age ranges would need to be compared directly; however, the sample size obtained in this survey did not allow for this analysis.

71 Statistics Canada, *2006 Census*, custom table for MiHR.

Table 8

Top Deterrents* to a Career in Mining and Exploration Identified by Students, by Program of Study

(N=273)

	MINING-RELATED PROGRAMS	NON-MINING-RELATED PROGRAMS
1	Remote work locations	Remote work locations
2	Perceptions about poor environmental impacts	Nature of work
3	(Tie) Boom-bust nature of the sector; Nature of work	Boom-bust nature of the sector
4		Perceptions about poor environmental impacts
5	Work schedules	Lack of cooperative education opportunities

* Respondents were asked to choose three options from a list of 26 deterrents.
Source: MiHR Student Survey, 2011.

As Table 9 shows, nearly 30 per cent of students in mining-related programs were more likely to indicate a preference for work locations in rural Canada, while less than 20 per cent of those in non-mining-related programs indicated such a preference. Perhaps the largest difference between the two groups was in preferences for locations outside Canada. While 19 per cent of students in mining-related programs indicated a preference for international work opportunities, only 10 per cent of those in non-mining programs preferred international work locations. For the mining group, Australia emerged clearly as the top choice among possible international work locations.

Table 9

Preferred Future Work Location for Students

(Per cent, N=237)

LOCATION	MINING-RELATED PROGRAMS	NON-MINING-RELATED PROGRAMS
Rural Canada	28	19
Urban Canada	50	70
Flexible/will relocate	1	1
Africa	3	1
Asia	0	1
Australia	6	1
Brazil	1	0
Europe (unspecified)	0	1
Germany	0	2
South America (unspecified)	1	0
United States	1	1
Other	7	3
Don't know	1	1

Source: MiHR Student Survey, 2011.

Lack of Awareness/Negative Perceptions of the Industry

In a 2008, a MiHR poll conducted by IPSOS-REID, asking Canadian youth about their familiarity with various industries, over 84 per cent of respondents indicated that they were unfamiliar with the mining and exploration industry. Of those who were familiar with the industry, 32 per cent indicated that their impressions of the industry were negative.[72]

As shown in Table 9, the *Student Survey* conducted for this study revealed that a significant number of students had concerns about the environmental impacts of the mining and exploration industry. While the industry has made great environmental strides, this message may not be reaching students.

Negative perceptions of the industry pose a significant deterrent to attracting the next generation of KWs. A 2009 poll of over 3,700 college graduates indicated that 86 per cent of Gen Ys felt an obligation to "give back" through their work, by making a positive contribution to society and the health of the planet.[73] Since the students who responded to the *Student Survey* held negative perceptions of the sector's environmental impacts, this commitment to societal benefit could deter young people from choosing a career in mining and exploration. Yet, this perception of negative impacts is at odds with the reality of mining today, as evidenced by the many "green" programs currently in place. It is possible that the students' concerns arise from a general lack of knowledge about environmental practices within the industry, which could be dispelled through increased career-awareness campaigns.

When asked how the industry could improve overall awareness of mining careers, respondents of the *Student Survey* overwhelmingly chose strategies involving work opportunities. (see Table 10.) The students clearly expressed the desire to gain hands-on experience in the industry, and saw such opportunities as the most effective way to raise career awareness among young people.

When current mining KWs were asked a similar question (using an abbreviated list of career-awareness strategies), they showed a preference for outreach starting with an even younger audience. The responses, shown in Table 11, indicated that KWs believed that raising awareness among high-school students would be the most effective strategy for increasing overall career awareness, followed by co-operative educational opportunities.

72 Mining Industry Human Resources Council. (2006). *A Career in Mining Brochure Test. Unpublished report prepared for MiHR by Ipsos-Reid.*

73 Hewlett, Sylvia A, Laura Sherbin, and Karen Sumberg. (2009). How Gen Y & Boomers Will Reshape Your Agenda. *Harvard Business Review*, July–August: 71–76.

Table 10

Student Ideas of Effective Mining Awareness Strategies

(Per cent effective/extremely effective, N=237)

AWARENESS STRATEGY	STUDENTS IN MINING-RELATED PROGRAMS	STUDENTS IN NON-MINING-RELATED PROGRAMS
Providing summer work experience opportunities	92	85
Providing co-operative education opportunities for post-secondary students	85	85
Providing summer jobs to post-secondary students in the sector	83	82
Providing high-quality professional training opportunities for new graduates	82	82
Sponsoring scholarship programs	78	61
Raising awareness among high-school students regarding employment opportunities in the sector	68	56
Providing education materials to teachers to give concrete examples of application of knowledge when working in the sector	61	55
Social media marketing strategy to increase the awareness and attractiveness of the sector to Canadians	54	36
Providing summer jobs to high-school students in the sector	53	64
TV and other mass media campaigns	46	27

Source: MiHR Student Survey, 2011.

Table 11

Mining Knowledge Workers' Choices for Most Effective Industry Awareness Strategy

(Per cent)

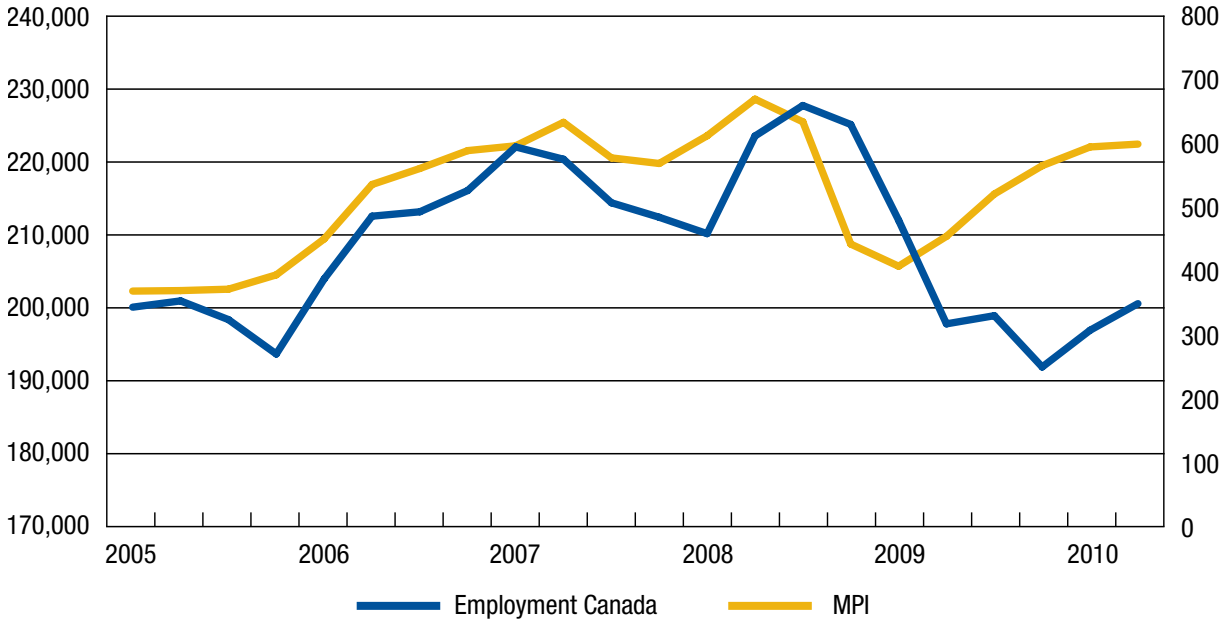
AWARENESS STRATEGY	
Raising awareness among high-school students regarding employment opportunities in the sector	37
More co-operative education opportunities for post-secondary students	25
Providing summer jobs to high-school students in the sector	20
Social media marketing strategy to increase the awareness and attractiveness of the sector to Canadians	13
Other (e.g., emphasize the necessity of minerals, improve teachers' knowledge, provide a better environmental image)	4

Source: MiHR Knowledge Worker Survey, 2011.

Boom-Bust Nature of the Sector and Job Stability

The third-most endorsed deterrent to a career in the industry for students in both mining and non-mining-related programs was the boom-bust nature of the mining and exploration sector (selected as one of the top three for both student groups). This finding is likely due to Generation Y's expressed need for career stability. As seen in Figure 7, employment opportunities in mining and exploration are tightly linked to changes in commodity prices.[74] If this group of KWs sees the industry as unlikely to provide a source of steady employment, they may choose careers in industries perceived as less volatile.

Figure 7
Mining Employment and the Minerals Price Index (MPI)



Source: Mining Industry Human Resources Council, 2011.

Recruitment Practices

Data from interviews and the *Student Survey* indicate that recruitment efforts aimed at students in mining-specific programs are reaching the intended audiences — with the majority of students in these programs seeing the industry as competitive in attracting new graduates. However, there are indications that a large pool of students outside of mining-related programs would also be interested in mining careers. As competition for KWs increases, recruitment of these types of students will become increasingly important.

74 Mining Industry Human Resources Council. (2010). Canadian Mining Industry Employment and Hiring Forecasts 2010. *A Mining Industry Workforce Information Network Report.* July 2010. www.mininghrforecasts.ca/en/resources/MiHR_Canadian_Mining_Employment_Forecasts_July2010.pdf

Interview data regarding current recruitment strategies within organizations revealed that these strategies are still very traditional, involving campus recruitment at mining-specific job fairs, newspaper advertising and posts on corporate websites.[75] Few organizations mentioned use of social media for recruitment; those that are early adopters of new media are still in the initial phases of exploring use of sites such as LinkedIn and Facebook for their recruiting efforts.

Due to the rather restricted scope of some of the more traditional recruiting methods, it is not surprising that students outside mining-related programs did not see the sector as competitive with other industries in attracting new recruits. (see Table 12.) This difference in the ratings between students in the different programs likely indicates that university job fairs (targeting mining-related programs) are reaching the majority of students in those programs — but not others elsewhere on campus. This was verified in interviews with educators and students, who indicated that the industry needs to engage in more outreach to students.[76]

Table 12
Competitiveness Ratings in Attracting New Graduates
(Per cent, N=273)

SECTOR IS	MINING STUDENTS	NON-MINING STUDENTS
Competitive	71	48
Not Competitive	29	52

Source: MiHR Student Survey, 2011.

Data from a nationwide poll of university students points to the advantages of a campus-recruiting strategy that targets students beyond those in mining-specific programs. As shown in Table 13 on page 52, more than half of the students who indicated that they were seeking a career in mining were enrolled in programs other than those typically targeted through mining-specific campus-recruiting efforts. This finding aligns with data from the *Student Survey*, in which 77 per cent of students in non-mining-related programs indicated that they would be interested in the mining and exploration sector as a future career.

75 MiHR Making the Grade Project Interviews, 2011.
76 *Ibid.*

Table 13
Students Seeking a Career in Mining, by Program of Study

PROGRAM OF STUDY	N
Geological engineering	51
Geomatics engineering	43
Geophysical engineering	3
Metallurgical engineering	6
Mining and mineral engineering	43
Petroleum engineering	36
Geology	94
GIS	8
All other programs	289
TOTAL	**573**

Source: 2010 Canada's Top Campus Employers Report.

Retention Challenges and Opportunities

The mining and exploration industry's demographic profile indicates that the loss of senior KWs will become a critical concern in the near future. This loss will be due to both retirements and mid-career attrition for many professions. In our interviews, employers indicated that retention issues were a secondary concern, after attraction and recruitment, but they still do represent a significant upcoming challenge.

Three groups of KWs require particular attention, in terms of mid-career attrition:

- Engineers
- Women
- Geoscientists

In terms of factors influencing decisions to leave the sector, there were some gender-related differences in the *Student Survey* and *Employee Survey* responses. Specifically, women KWs were more likely to cite non-competitive compensation, raising a family and stress as among their top factors. For both men and women, lifestyle and work-life balance emerged as the primary factor influencing a decision to leave the sector.

Both students and current KWs agreed on many of the most rewarding and attractive aspects of careers in mining and exploration. These factors included compensation, the ability to apply skills, and the opportunity to engage in exciting and rewarding work. In terms of unattractive or least-satisfying job factors, both students and current KWs listed factors related to the location of work sites, industry uncertainty and scheduling.

Mid-Career Attrition

In interviews, employers and industry experts raised concerns about the attrition rates of skilled technical professionals who leave either their professions or their organizations midway through their careers.[77] The replacement costs alone for KWs can average 50 to 60 per cent of an employee's salary.[78] This is not the only cost associated with turnover, however, as organizations must also factor in lost production time, time spent by human resources in filling the vacancy, and the time it takes for the replacement worker to reach the same performance level as the departing employee. When all factors are considered, the estimates of the total costs associated with KW turnover range from 90 to 200 per cent of annual salary.[79]

Organizations should focus on three important groups in their retention efforts: engineers, women and geoscientists. For engineers in all industries, there is a steep mid-career attrition pattern that often results from dissatisfaction with the profession and a perceived lack of career-progression opportunities. For female KWs, the decision to leave the industry may be triggered by dissatisfaction with wages, working conditions or work-life balance. For geoscientists, there are concerns about severe skills shortages leading to fierce global competition for seasoned KWs.

Engineers: The Mid-Career Exodus from the Profession

Engineers in general have very high attrition rates as they reach mid-career, with as many as half of all engineers leaving the field entirely within their first 10 years in the profession.[80] Several studies confirm that this trend is not specific to mining engineers, but rather a pattern found throughout the engineering profession as a whole.[81] According to 2001 census data, although 350,000 Canadians were engineers, only 190,000 worked in their field — 46 per cent had chosen other careers. There are three main factors that lead so many engineers to abandon the profession at a relatively young age.[82]

- Their value to the organization diminishes over time, leading to a lack of recognition for their efforts;
- Learning and development on the job peaks after the first five years, leading many to become bored; and
- Senior engineers reach an advancement plateau early in their careers, meaning that advancement is often only possible by entering management or leaving the field entirely.

77 MiHR Making the Grade Interviews, 2011.

78 Allen, David G. (2008). Retaining Talent: A Guide to Analyzing and Managing Employee Turnover. *SHRM Foundation's Effective Practice Guideline Series, Alexandria*, VA: SHRM Foundation.

79 *Ibid.*

80 Frehill, Lisa. (2010). "Satisfaction: Why Do People Give Up Engineering?" *Mechanical Engineering Magazine*. January. http://memagazine.asme.org/Articles/2010/january/Satisfaction.cfm?

81 Kennedy, Donald A. (2006). Attrition Rates of Mature Engineers. *Engineering Management Journal* 18, no. 3: 36–40.

82 Kennedy, Donald A. (2009). Best Before Forty: The Shelf Life of an Engineer. *Engineering Management Journal* 21, no. 1: 19–26.

Improved advancement opportunities are one way to help alleviate the mid-career plateau faced by many engineers. Organizations concerned about engineer attrition due to career advancement concerns should consider implementing alternate career-development approaches. These could include dual-career ladders; increased opportunities for experience in other functional areas; and ongoing professional development.

Women: Mid-Career Attrition in Science, Engineering, and Technology

The attrition trend seen among mid-career engineers is similar to that of women in the fields of science, engineering and technology. In these professions, women's mid-career attrition rates are as high as 50 per cent, according to recent U.S. data.[83] In the United States alone, cutting the attrition rates of women in these key KW fields by just 25 per cent would add an estimated 220,000 highly-skilled people to the workforce.[84]

Why are women so likely to leave these professions? It appears that job dissatisfaction is a factor, driven largely by concerns about work-life challenges and an apparent disconnect between women's concerns and employer awareness of these challenges. In the mining and exploration industry, women are already under-represented in most roles, so it is crucial for employers to clearly understand any underlying reasons for job dissatisfaction that may lead women to leave the industry.

Responses from the *Knowledge Worker Survey* revealed that significantly fewer women (72 per cent) than men (89 per cent) report being very satisfied with their careers in mining. Not only are the women less satisfied than men, but it appears that more of them will eventually leave the industry as a result of that dissatisfaction. While 92 per cent of women indicated that they would remain in mining for the next year, the number interested in remaining for more than three years dropped to 72 per cent. The figures for men indicated a much more gradual decline, with 80 per cent indicating they would remain in the industry for the next year and 73 per cent indicating more than three years.

The finding that women may not stay in the industry as long as men is particularly noteworthy, given that the women surveyed were significantly younger than the men. When respondents who planned to leave the sector within next five years were asked why, 42 per cent of men cited retirement, which was not the case for women.[85] Table 14 highlights the different proportions of men and women of various age ranges within the *Knowledge Worker Survey* sample.

83 Hewlett, Sylvia Ann, Carolyn Buck Luce, and Lisa J Servon. (2008). Stopping the Exodus of Women in Science. *Harvard Business Review*, June: 22–24.

84 *Ibid.*

85 While none of the women surveyed cited retirement as a reason for leaving in the next five years, the small sample size for this group warrants caution in interpreting the findings.

Table 14
Age Ranges of Mining Knowledge Workers Surveyed, by Gender
(Per cent, N=214)

AGE RANGE	OVERALL	MEN	WOMEN
20–29	17	13	36
30–39	22	23	22
40–49	26	26	28
50–59	26	28	14
Over 60	9	11	0

Source: MiHR Knowledge Worker Survey, 2011.

Given the difference in age distributions between men and women, the two groups may differ in the relative importance they attach to work-life balance and family concerns. This is evident in the survey responses of women KWs. Substantially more women than men cite raising a family as a top factor that could affect their decision to leave the sector (see Table 15.) Furthermore, a recent study by Women in Mining (WIM) Canada, in partnership with MiHR, found that two-thirds of women employed in the mining and exploration sector identified several challenging working conditions negatively impacting their success in the industry. Clearly, more women are indicating a desire to leave mining at early to mid-career stages due to personal and work-related factors. These include:

- The need for flexible work arrangements;
- The male-oriented work culture;
- The lack of notice and flexibility when assigned work in remote locations; and
- The lack of child care and parental leave.[86]

With the exception of the need for more flexible work arrangements, employers who participated in the WIM study reported that no barriers existed to the success of women in the sector.[87] This finding highlights a lack of connection between the perceptions of women and their employers about the challenges in working in the industry.

Organizations can take action to reverse this trend. In a recent study, the Association of Professional Engineers, Geologists and Geophysicists of Alberta reported that women KWs no longer employed in their profession would be interested in returning to the field — if certain lifestyle options were available. These included:

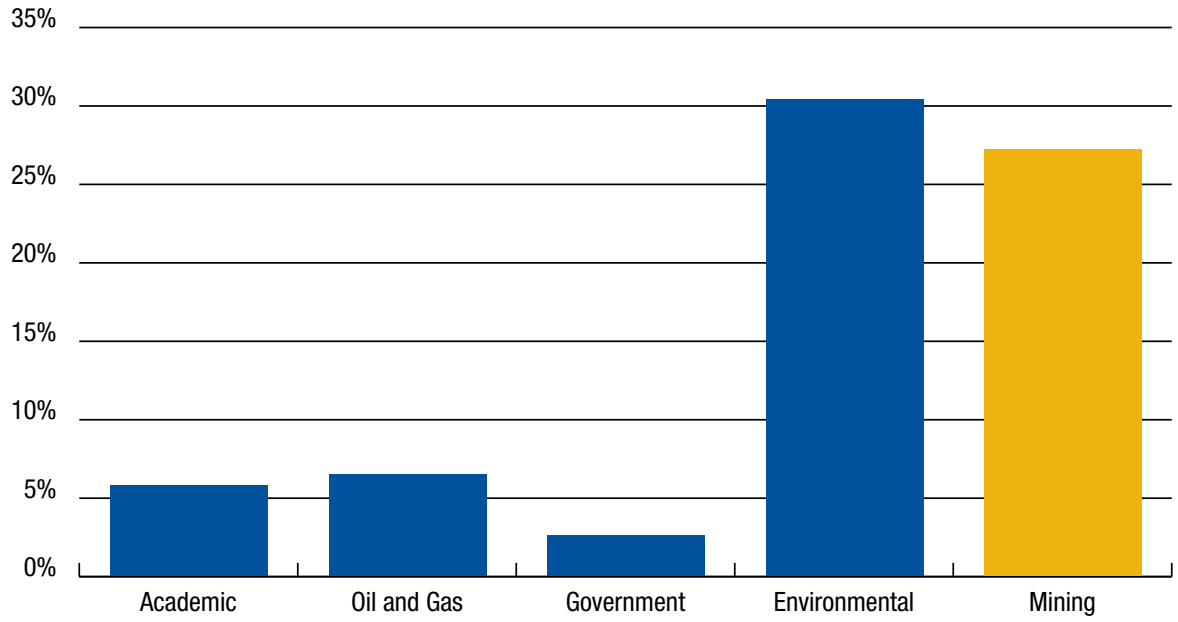
- Access to day-care;
- Corporate sponsorship of emergency child care; and
- Part-time work opportunities.

86 Women in Mining Canada. (2010). *Ramp-UP: A Study on the Status of Women in Canada's Mining and Exploration Sector.* Ottawa: Women in Mining Canada.
87 *Ibid.*

Geoscientists: Increased Need for Talent Leads to Fierce Competition

In a 2008 report, the Canadian Federation of Earth Sciences (CFES) examined the upcoming geoscientist shortage in various industries in Canada, including mining and exploration. The expected net change in the number of geoscientists required in the mining and exploration sector was considerably higher than in other sectors (except for the environmental sector). As shown in Figure 8, the mining and exploration sector is expected to require almost 30 per cent more geoscientists in the next five years. This is due to the increased demand for minerals and metals globally. However, the global supply of new geosciences graduates from high-quality universities is expected to be tight, generating heavy competition for this group of KWs.

Figure 8
Net Change in the Number of Geoscientists Required by Sector, in Five Years

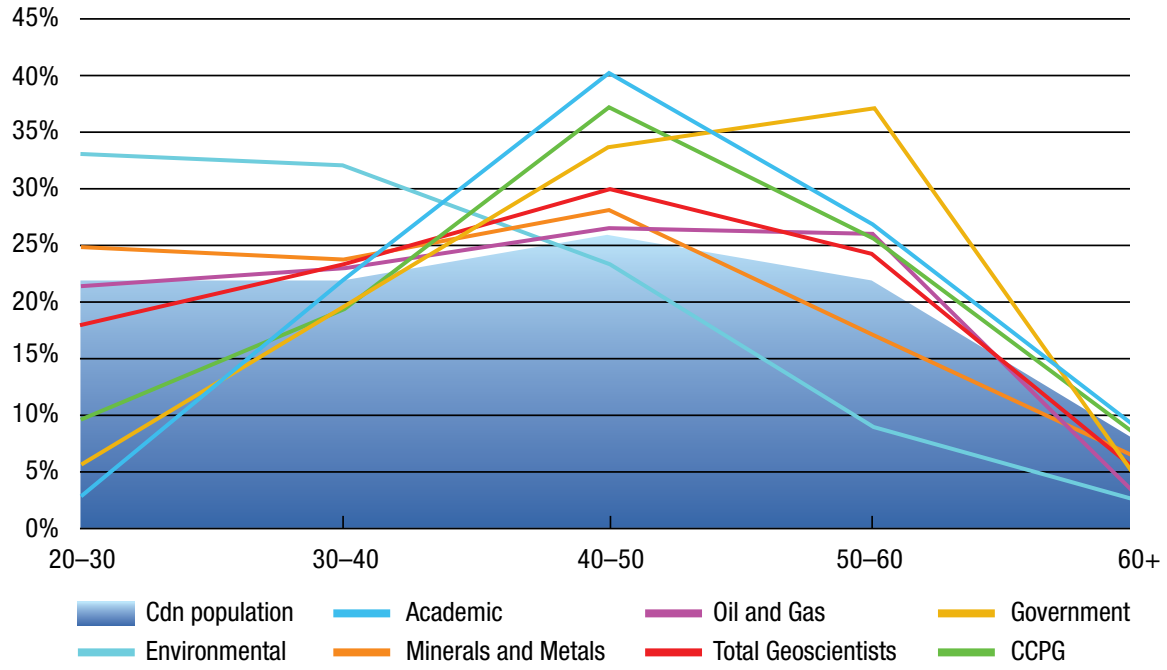


Source: Canadian Federation of Earth Sciences 2008, 10.

This increased need for geoscientists in mining and exploration is predicted to occur at the same time as many of these KWs will reach the age of 50 years. As shown in Figure 9, this is critical, as the age demographic of geoscientists in mining is flat in the 20–50 age range — followed by a sharp drop for the over-50 category.[88] This suggests that the mining and exploration sector does not retain its more-experienced geoscientists as well as do other industries. Therefore, the elevated hiring requirement for geoscientists will potentially be exacerbated by an increase in the number of these workers leaving the sector in five years.

88 Canadian Federation of Earth Sciences. (2008). *Human Resources Needs in Earth Sciences in Canada a Preliminary Survey.*

Figure 9
Age Profile of Geoscientists by Sector, in Canada



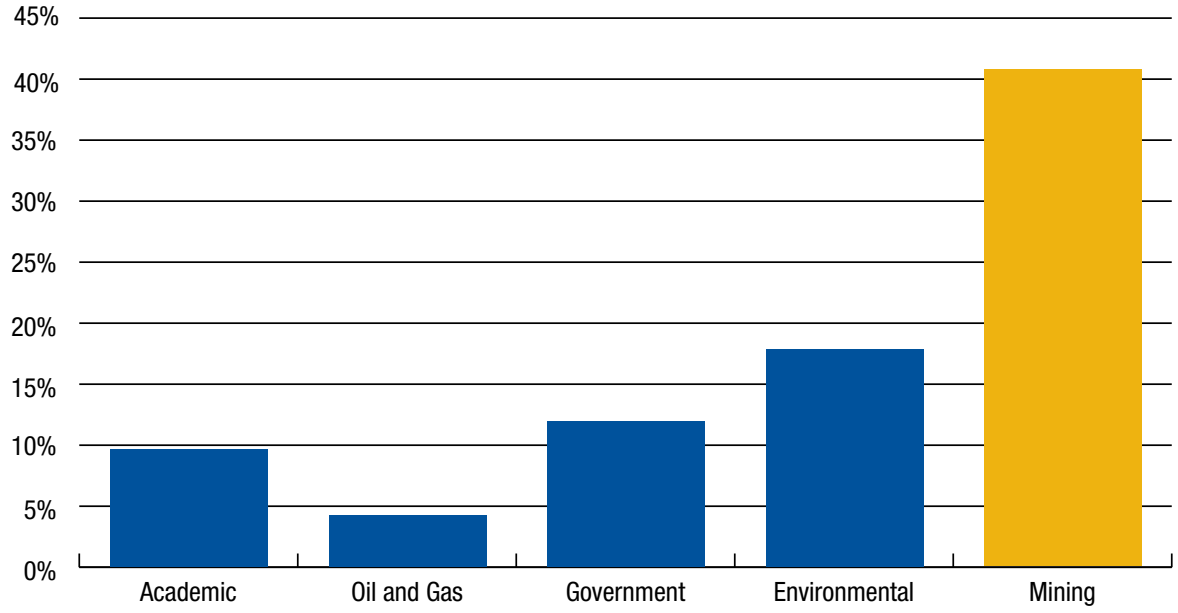
Source: Canadian Federation of Earth Sciences 2008, 8.

Why are more experienced geoscientists leaving the sector? The CFES report highlighted another interesting difference between geoscientists in mining and exploration and those in other industries. In the mining and exploration sector, temporary or contract employees make up 40 per cent of all geosciences personnel.[89] (see Figure 10 on page 58.) This is significantly higher than in other sectors. It appears that the more experienced employees are leaving the sector to form their own consultancies and are then rehired by sector employers on contract.[90]

89 Canadian Federation of Earth Sciences. (2008). *Human Resources Needs in Earth Sciences in Canada a Preliminary Survey.*

90 *Ibid.*

Figure 10
Temporary and Contract Geoscience Employees, by Sector



Source: Canadian Federation of Earth Sciences 2008, 9.

These findings appear to demonstrate that the mining and exploration will fill the demand for geoscientists with contractual expertise. However, there will be significant competition for these KWs, especially from the environmental sector. This intense competition may lead to an increase in "poaching" over the coming decade — with organizations actively engaged in trying to lure top talent in the geosciences away from competing organizations and industries.[91] The group that is likely to be in greatest demand during this highly competitive phase is largely comprised of those in mid-career — who tend to leave the mining and exploration sector. As organizations struggle to fill knowledge gaps, they will be especially interested in finding experienced mid-career candidates to fill their succession pipelines and assume key leadership roles.

Factors Influencing Decisions to Leave the Sector

The pattern of responses by men and women revealed some differences in the job factors that could influence a decision to leave the sector. (see Table 15 on page 59.) For women, raising a family was seen as a much stronger factor, as were stress, non-competitive compensation and labour-relations issues.

91 Schlumberger Business Consulting. March 29, 2011. www.sbc.slb.com/About_SBC/Press_Releases/SBC_2010_SBC_Oil_Gas_HR_Benchmark_Released_29_Mar_2011.aspx.

Table 15
Factors Affecting Decision to Leave the Mining Sector, by Gender
(Per cent agree, N=214)

FACTORS	OVERALL	MEN	WOMEN
Lifestyle/work-life balance	70	68	81
Want a change	53	52	58
Non-competitive compensation, salary and/or benefits*	51	47	69
Job volatility and uncertainty	50	48	56
Stress**	48	43	72
Raising a family**	41	34	75
Age	37	39	25
Interprofessional conflicts	34	32	47
Paperwork/administrative burdens	33	33	33
Occupational health and safety concerns	29	27	42
Union/labour relations*	28	25	44
Legal/regulatory concerns	24	25	17
Environmental impacts	21	21	22

*Denotes a significant gender difference (p<.05).
**Denotes a significant gender difference (p<.01).
Source: MiHR Knowledge Worker Survey, 2011.

Job Rewards and Deterrents

Current and future KWs hold very similar views on the attractive and unattractive aspects of working in the mining and exploration industry. As shown in Table 16 on page 60, chief among the attractive factors listed by both groups were issues related to the excitement and personal growth associated with the job itself. Men reported a stronger preference for compensation than women, who placed it much lower on their list of rewarding job factors.

Table 16
Most Rewarding Job Factors* for Knowledge Workers in Mining and Exploration, by Gender

	ALL RESPONDENTS	MEN	WOMEN
1	Financial compensation	Financial compensation	Positive/rewarding work
2	Positive/rewarding work	Positive/rewarding work	Flexible work environment
3	Ability to apply skills	Ability to apply skills	Learning/career development opportunities
4	Intense/exciting work	Intense/exciting work	Ability to apply skills
5	(Tie) Learning/career development opportunities; International work opportunities; Flexible work environment	International work opportunities	(Tie) Intense/exciting work; Financial compensation; Excitement of an industry in growth

* Respondents were asked to choose three options from a list of 26 factors.
Source: MiHR Knowledge Worker Survey 2011

In terms of least satisfying job factors, women KWs put financial compensation at the top of the list. (see Table 17.) This finding is not surprising, since women give a low rating to the job rewards associated with compensation. This pattern has emerged throughout the *Knowledge Worker Survey* data, and warrants attention in future research to track salary levels for men and women KWs in the industry. In particular, such research must determine whether women are in fact inequitably compensated throughout the industry (as is the case in many other industries), or whether the age-distribution differences between men and women in the industry mean that more women are in junior roles — thus paid less due to issues of seniority or tenure.

Table 17
Least Satisfying Job Factors* for Knowledge Workers in Mining and Exploration, by Gender

	ALL RESPONDENTS	MEN	WOMEN
1	Location of work sites	Uncertainty of industry growth	Financial compensation
2	Uncertainty of industry growth	Location of work sites	Job security; Location of work sites
3	Holiday/vacation time	Holiday/vacation time	(Tie) Lack of positive/rewarding work; Lack of learning/career development opportunities; Flexible work environment
4	Flexible work environment	Flexible work environment	
5	Financial compensation	Financial compensation	

* Respondents were asked to choose three options from a list of 26 factors.
Source: MiHR Knowledge Worker Survey 2011.

Students are clearly aware that compensation levels, international work placements, and the chance for exciting work are the primary attractors to mining and exploration. This list aligns quite closely with the top factors listed by students as influencing their future career decisions. (see Table 18.) While the ordering is different, only international work opportunities failed to make the student list of influences on career decisions; they opted instead for opportunities for learning and development. This could mean that industry concerns about top Canadian graduates rushing to overseas jobs might not be warranted, and that offering better opportunities for job development within the organization might draw even more young KWs to organizations.

Table 18
Attractive/Unattractive Aspects of Mining and Exploration Careers as Identified by Students in Mining-Related Programs
(N=86)

	ATTRACTIVE ASPECTS	UNATTRACTIVE ASPECTS
1	Financial compensation	Location of work sites
2	International work opportunities	Perceptions of poor environmental impacts
3	Intense/exciting work	(Tie) Boom-bust nature of the sector/ job security; Nature of work
4	Positive/rewarding work	
5	Ability to apply skills	Work schedules

Source: MiHR Student Survey 2011.

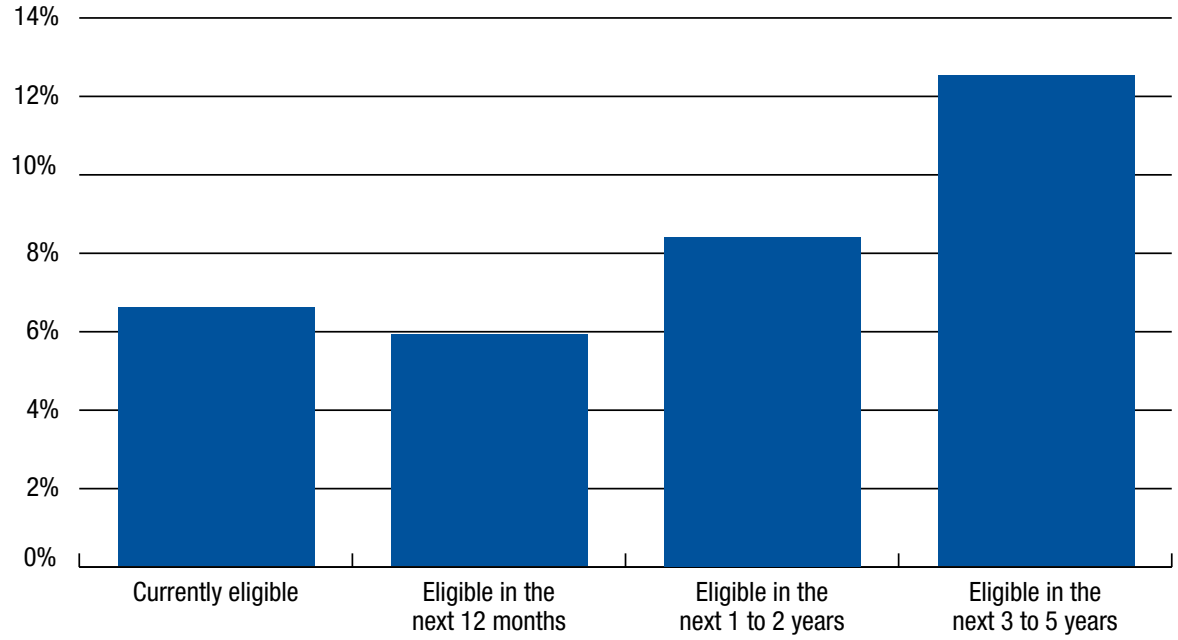
Succession Planning Challenges and Opportunities

Anticipated Retirements

Overall, the employers interviewed did not express pressing concerns about impending retirements in the sector. This may be due in part to the fact that many senior employees are now considering delaying retirement in the wake of the recession,[92] and as a result, mining organizations are not yet experiencing major skills shortages due to retirements. Over the next several years, however, there will be increasing numbers of people eligible to retire within the sector. (see Figure 11.)

92 Antunes, Pedro, and Brent Dowdall. "Recession Hit Expected to Keep Boomers Working." *Hot Topics in Economics*. The Conference Board of Canada. February 25, 2011. www.conferenceboard.ca/economics/hot_eco_topics/default/11-02-25/Recession_Hit_Expected_to_Keep_Boomers_Working.aspx.

Figure 11
Proportion of Mining Workforce Eligible to Retire



Source: Mining Industry Human Resources Council 2010, 22.

Data from the *Knowledge Worker Survey* provide a picture that supports employers' apparent lack of concern about pending retirements. Respondents in almost all occupational categories (except senior management) indicated that retirement would not be the primary reason for leaving the sector over the next three years; a greater proportion of employees indicated that they would be leaving due to other factors. (see Table 19.) This finding highlights the need for organizations to continue to focus on retention efforts, particularly for their mid-career KWs.

In general, employees' decisions to retire are based on a range of factors including their:

- Health status
- Financial circumstances
- Attachment to their work
- Work conditions
- Desire for work-life balance

In certain types of mining, commodity prices can also affect an employee's decision to retire. Some on-site mining employees make more than two times their base salary through various forms of incentive bonuses linked to commodity prices. These incentive bonuses can help employers attract new employees in a tight labour market, as well as support retention of mature workers — until commodity prices fall.

Table 19
Anticipated Retirements by Job Classification
(Per cent)

OCCUPATIONS	SHORT-TERM (WITHIN 1 YEAR)		MEDIUM-TERM (1–3 YEARS)		LONG-TERM (OVER 3 YEARS)		TOTAL HIRING REQUIREMENT
	RETIREMENT	NON-RETIREMENT	RETIREMENT	NON-RETIREMENT	RETIREMENT	NON-RETIREMENT	
Engineer	1.1	4.6	2.3	2.3	4.6	6.9	21.8
Geologist, geoscientist, geochemist, geophysicist	2.6	2.6	0.0	5.1	2.6	17.9	30.8
Metallurgist, mineral processor	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mine manager, mill superintendent	0.0	7.7	7.7	0.0	7.7	7.7	30.8
Industry research and development	0.0	0.0	0.0	18.2	9.1	18.2	45.5
General management	0.0	0.0	0.0	10.5	5.3	10.5	26.3
Senior management	0.0	0.0	0.0	0.0	16.7	8.3	25.0
OVERALL	**1.0**	**3.0**	**3.0**	**4.0**	**5.9**	**9.9**	**25.2**
Non-engineers	*0.9*	*1.7*	*0.9*	*5.2*	*7.0*	*12.2*	*27.8*

Source: MiHR Knowledge Worker Survey.

While retirements may not be the primary reason for the loss of KWs in mining and exploration over the next few years, the time is coming when this group will be leaving in significant numbers. As a result, it will become increasingly important for employers to take a proactive approach to succession planning and knowledge transfer. Because so much of the value of KWs is their creation and dissemination of knowledge and innovation, organizations will require a significant amount of time to prepare successors for senior KW positions. If organizations are proactive throughout this process, they will not be caught unaware when the inevitable retirement wave does arrive — whether due to demographic or economic factors.

Ensuring Knowledge Transfer

Because of the very nature of their work, KWs amass a wealth of essential organizational knowledge during their tenure. This knowledge is often lost the moment the KW leaves the organization, unless steps have been taken to ensure transfer of the essential information to a successor(s). Organizations need to begin planning years ahead of time in order to ensure a smooth transition period with sufficient time to properly transfer the knowledge and expertise of the departing employee.

If mining employers are not currently concerned about succession issues, it is likely that many organizations have not yet put in place practices to deal with upcoming retirements. This may pose problems in the future, given that the time to begin planning for future skills shortages occurs long before large numbers of retirees begin contemplating departure.

Advance preparation for the knowledge-transfer process can eliminate the creation of a knowledge vacuum after the departure of a senior KW.[93] Organizations should take the following steps:

- Consult MiHR resources for knowledge transfer (e.g., knowledge transfer videos);
- Assessing the number of eligible retirees across key organizational positions and sites to establish a pattern of future need;
- Mapping projected departures against the number of KWs currently in the organization's talent pipeline;
- Targeting key skills gaps that will need to be filled; and
- Proactively engaging senior staff in key areas in order to capture their knowledge through:
  - Expert interviews
  - Mentoring of younger employees
  - Documentation (legacy information, expert blogs, wikis, videos).[94]

Education of the Next Generation of Knowledge Workers

According to the Canada Mining Innovation Council:

> *"Canada has a strong mining education base in terms of the scope, depth and diversity of its educational institutions and the quality of its intellectual capital across the entire mining life cycle. In addition to the well-known major Canadian centres for mining education (some 9 to 15 centres depending on the criteria applied), at least some 30 other institutions (both colleges and universities) are making major contributions to mining education in Canada."*

93 The Conference Board of Canada. (2011). Knowledge Makes You Smarter: Improving Corporate IQ By Transferring Tacit Knowledge. *Organizational Excellence Report*, Ottawa: The Conference Board of Canada.

94 *Ibid.*

Increasing Industry Awareness Among Students

As cited earlier, more than 84 per cent of students in a recent national poll indicated that they were unfamiliar with the mining industry.[95] Data from the *Student Survey* indicate that this lack of awareness is more prevalent among students currently enrolled in non-mining-related programs (this point becomes more relevant when talking about Geosciences programs of study than Mining Engineering programs). Given that more than three-quarters of this student group indicated interest in working in the industry in the future,[96] awareness campaigns should be broad enough in scope to reach this target audience. Messaging aimed at a wider audience would likely attract more (and more diverse) students to mining-related programs.

Student Work Opportunities

Responses from the *Student Survey* highlighted the importance of providing work opportunities for students in the industry. These types of opportunities build career awareness, generate excitement about the work and help dispel misconceptions about the industry. Given the students' concerns about the boom-bust nature of the industry and their need for job stability, it is vital to ensure that these types of programs continue to run, even during tough economic times. If programs are cut during downturns, the negative perceptions of instability within the industry will only be reinforced in the minds of students.

Perceptions About Poor Environmental Impacts

In the *Student Survey*, 47 per cent of respondents cited perceptions about the environmental impact of mining as a deterrent to entering the industry.[97] The industry is well-aware of this image and is working to correct it. According to Natural Resources Canada's 2010 *Mining Sector Performance Report*, "Over the past 10 years, new scientific research, regulatory systems, oversight and industry actions have led to continuous improvements in the sector's environmental performance".[98] However, this good news is often not widely shared outside of the industry.

Among others, several of the initiatives that do reach a wider audience beyond the industry are the Geoenvironmental Option at the University of New Brunswick, the Natural Resources Canada (NRCan) Green Mining Initiative, the Mining Association of Canada's Towards Sustainable Mining Initiative, and the Prospectors & Developers Association of Canada's e3 Program.

95 Mining Industry Human Resources Council. (2008). Presentation to the CMIC Working Group on HQP. *Highly Qualified People Working Group*. Toronto.

96 MiHR Student Survey 2011.

97 *Ibid.*

98 Natural Resources Canada. (2010). Green Mining Initiative to Reduce Mining's Environmental Footprint. *Natural Elements, NRCan's Monthly Newsletter.* 05 2010. www.nrcan.gc.ca/com/elements/issues/47/initiative-eng.php (accessed May 20, 2011)

6

Recommendations to Address HR Challenges

Based on the analyses of the primary survey and interview data and with relevant secondary sources, several recommendations fall out for both the mining and exploration industry as whole, and specifically for employers and academic institutions. These recommendations seek to provide practical strategies and tactics to ensure that sufficient numbers of KWs are available to the sector. The recommendations address attraction and retention issues primarily, the two areas of most concern to the industry at this time.

The recommendations include:

- Expand KW attraction and recruitment campaigns to a broader audience.
- Expand efforts to attract and integrate highly-skilled immigrants into the mining workforce.
- Implement alternative career-development options for technical KWs.
- Implement programs that support improved work-life balance.
- Increase programs aimed at enabling people in northern, Aboriginal and mining communities to gain the skills necessary for knowledge work in the industry.
- Expand career awareness by offering more work opportunities for students in mining and exploration.
- Broaden awareness of industry successes to audiences not currently connected to the sector.

Attraction and Recruitment

University Talent Pools

In the *Student Survey*, 77 per cent of students in non-mining-related programs expressed interest in working in the mining and exploration sector in Canada. However, interviews with employees and academics indicated that campus recruiting efforts focus largely on mining-related programs. Given that KWs are needed by the sector in many non-technical roles (e.g., operations, finance and human resources), the industry would do well to reach out to a broader base of students.

Attracting International Students

The number of international students enrolled at Canadian universities is increasing. As a result, Canadian mining educational institutions have the opportunity to draw from this talent pool and develop strong international reach and linkages. By 2010, about 90,000 full-time and 13,000 part-time international students studied on Canadian campuses, and international student enrolment increased 10 per cent last year. International students are far more likely than Canadian students to study business, engineering and math.[99] These combined disciplines represent an important talent pool for the mining and exploration sector.

Skilled Immigrants and New Canadians

Skilled immigrants will play a increasingly critical role in alleviating Canada's anticipated talent and skills shortage. According to 2006 Census data, immigrants represent approximately 19 per cent of Canada's total population, with a 13 per cent increase in the immigrant population occurring between 2001 and 2006.[100] Statistics Canada estimates that this growth will continue over the coming decades, resulting in a total foreign-born population of roughly 28 per cent by 2031.[101] Between 2001 and 2006, 57 per cent of immigrants who came to Canada were in the prime working-age group of 25 to 54, compared to 42 per cent of those born in Canada. A continued decline in fertility rates, coupled with an increasingly aging population, mean that highly-skilled immigrants will grow in importance to organizations looking to fill KW skills gaps.

While mining and exploration currently has higher numbers of immigrant KWs than the national average, the sector must increase its efforts to tap into this talent pool in the coming years. Responses from employer interviews indicated that few organizations currently have targeted recruitment campaigns directed at skilled immigrants. In addition, a recent mining report found that only five per cent of companies in the sector had targeted recruiting efforts aimed at new Canadians, and no organizations had branding or attraction initiatives targeting new Canadians.

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99 Statistics Canada. *Distribution of international and Canadian students, by field of study, Canada, 1992 and 2008.* 02 24, 2011. www.statcan.gc.ca/pub/81-004-x/2010006/chrt-graph/desc/desc-6-eng.htm

100 Statistics Canada. (2006). *2006 Census: Immigration in Canada: A Portrait of the Foreign-born Population, 2006 Census: Findings.* www12.statcan.gc.ca/census-recensement/2006/as-sa/97-557/index-eng.cfm

101 Statistics Canada. (2001) *Canadian Demographics at a Glance*, www.statcan.gc.ca/pub/91-003-x/2007001/4129904-eng.htm

Despite the growing importance of skilled immigrants in driving innovation and performance, many still face barriers to successful integration into the Canadian labour market. A 2002 survey of newly arrived immigrants found that 70 per cent of job-seekers reported problems finding employment.[102] Common challenges faced by immigrants include:

- Arduous, costly and time consuming foreign credential recognition procedures;[103]
- Lack of recognition of foreign work experience;
- Earnings gaps (especially for more highly educated immigrants);
- Language and communication barriers;
- Lack of information about settlement expectations; and
- Lack of personal and business networks.[104]

Canadian employers have established effective practices to help skilled immigrants succeed, including:

- **Help in obtaining recognition of foreign qualifications** — Credential service agencies or in-house competency tests allow employers to pre-screen prospective immigrants prior to admittance to Canada, to ascertain Canadian equivalencies for international education and work experience. This type of pre-immigration educational assessment policy has been implemented very successfully in Australia, where it has been in place since 1999.[105]

- **Language and communication skills training** — Communication skills and language fluency often present challenges for skilled immigrants. According to Elizabeth McIsaac, Executive Director of the Toronto Region Immigrant Employment Council (TRIEC), language deficiencies are one of the biggest barriers to career progression and access to developmental opportunities for skilled immigrants.[106] Since health and safety policies and procedures may not be clearly understood when communicated, language deficiencies also represent a risk to employee occupational health and safety.[107] Employer-provided language training is a highly effective means of addressing these challenges. The advantage of in-house training is that it can be customized to meet the needs of different occupation groups and to complement the corporate culture of the organization.

- **Mentoring and coaching programs** — Mentors can help immigrant employees gain confidence in their organization through better understanding of not only Canadian norms, but also the behavioural norms and culture of their new workplace. Effective mentoring programs usually select mentors on a voluntary basis from an organization's most experienced staff. The key to successful mentoring is ensuring a good match between the needs and expectations of the mentor and the mentee. Mentees gain insight and guidance from interactions with an experienced member of the organization, and mentors benefit by growing their professional network and developing leadership capacity.

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102 Statistics Canada. (2003). Longitudinal Survey of Immigrants to Canada: Process, progress and prospects. Ottawa: Statistics Canada.

103 Jeans, Mary Ellen, Fran Hadley, and Christine DaPrat. *Navigating to Become a Nurse in Canada: Assessment of International Nurse Applicants*. Canadian Nurses Association, 2005.

104 Downie, Michelle. (2010). *Immigrants as Innovators Boosting Canada's Global Competitiveness*. Ottawa: The Conference Board of Canada, 2010.

105 *Ibid.*

106 McIsaac, Elizabeth, interview by Elise Wohlbold. *Engaging and Integrating Skilled Immigrants into the Workplace* (April 13, 2011)

107 The Conference Board of Canada. (2009). *Learning and Development Outlook: Learning in Tough Times*. Ottawa: The Conference Board of Canada.

Organizations benefit through organizational knowledge-transfer, increased leadership capabilities among senior staff, and improved networking skills and resources for immigrant employees.

- **Bridging and internship programs** — Bridging programs and internships can provide skilled immigrants with valuable Canadian work experience. This is particularly important for regulated occupations, where skilled immigrants need to gain Canadian work experience before they can obtain recognition of their foreign credentials and get accredited in Canada. The programs are established to facilitate the entry of skilled immigrants into the Canadian workplace. Most bridging programs are administered by non-profit organizations or immigrant services.[108]

- **Inclusive and culturally sensitive work environments** — Inclusive organizations reap the benefits of engaged employees, by providing a workplace that recognizes the value of all employees and fosters an environment of knowledge-sharing and open communication.[109] While some organizations have a diverse workforce, employees may not feel that all of their social identities are appreciated and included — leaving some employees feeling excluded in the workplace. Cross-cultural understanding and awareness can be fostered through supports such as specific diversity-related Intranet sites, multicultural calendars, and communicating the importance of diversity and inclusion through blogs and newsletters.

Organizations with policies and practices that address the needs of skilled immigrants will be in a better position to attract and retain key KWs. Employers need to help skilled immigrants transition into the labour market, by providing supportive programs and creating inclusive work environments. By integrating and engaging skilled immigrants into the workplace, organizations will have the opportunity to benefit and succeed in utilizing this increasingly valuable talent pool.

Retention and Engagement

Exploring Dual-Career Paths

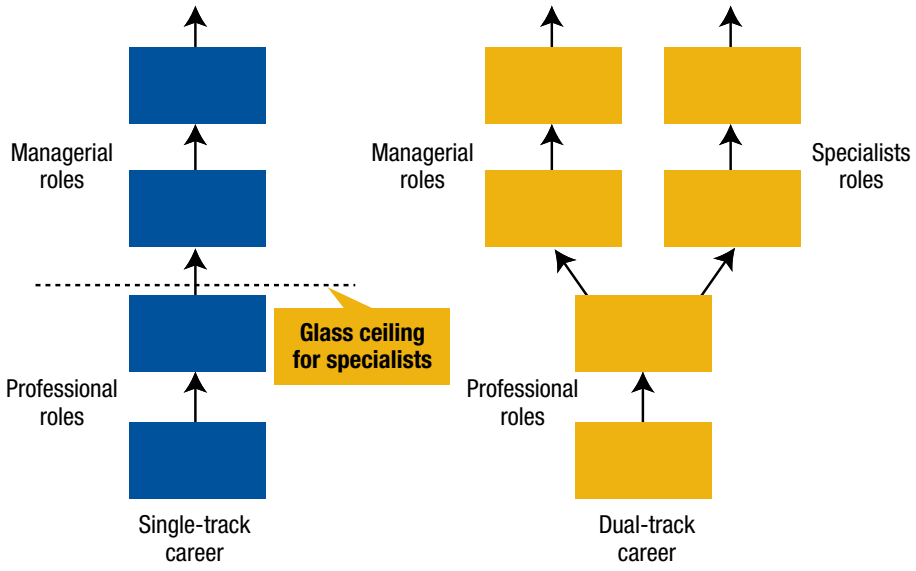
Dual-career development paths (also referred to as "dual-ladder" schemes) involve the creation of alternate advancement paths for technical and managerial employees. The dual-career path concept has been around for more than 40 years, and is still used almost exclusively in technical and scientific fields (e.g., engineering, computer scientists, and researchers in the natural and physical sciences). The primary goal of this type of development approach is to enable greater advancement possibilities for highly-skilled technical employees who might otherwise plateau too early within their area of specialty.

Typically, in a dual-career path, technical employees who do not wish to move into upper management are given the opportunity for increased responsibilities in the technical sphere. This is not always the case, however, as the example from Teck (see page 71) illustrates a dual-career path in which both streams eventually lead to executive positions.

108 Downie, Michelle. (2010). *Immigrants as Innovators Boosting Canada's Global Competitiveness*. Ottawa: The Conference Board of Canada.

109 Cowan, Allison, Nancy Huggett, and Sandra Parris. (2006). *Report on Diversity. Priorities, Practices and Performance in Canadian Organizations*. Ottawa: The Conference Board of Canada.

Figure 12
Single- and Dual-Track Careers



Source: Institute for Employment Studies — Hirsh 2006.

Dual-career paths have often led to mixed results when implemented in organizations. The most common problem encountered with these types of systems stem from perceptions of inequity between the two paths:

- Managerial employees are seen as more powerful, and in general the managerial stream is viewed by employees as being more prestigious.
- Those who are promoted through the non-managerial path are not as well-networked within the organization than those with managerial positions.
- Career-development plans are seen as more clearly defined for the (well-established) management path.

All three of these factors can make the technical career path seem less attractive to employees, who will then opt for the management path regardless of whether it is suitable for them personally. Organizations considering implementing dual-career paths need to ensure that people in both development streams receive equivalent treatment — in terms of progression through the path, salary increases and "respect" from the organization. Otherwise, organizations are left with a system in which one path is seen as inherently unattractive, and it fails to retain highly-skilled technical KWs vital to the knowledge work needs of the organization.

Case Study: Dual-Career Paths at Teck

Teck, Canada's largest diversified mining company, has offered dual-career development paths to its knowledge workers (engineers, geologists, scientists and technologists) since 1999. The move towards a dual-career path offering was prompted by several factors, including:

- Retention concerns (particularly for mid-career engineers)
- A lack of clarity in the development path for technical professionals
- The clear need for proper recognition of the efforts of highly-skilled employees
- Requests from younger employees for improved advancement opportunities

Teck's dual-career system is closely aligned with its core competency framework for employees. For the first four years with the organization, employees are part of the flagship "Professionals in Training Program". This program involves intensive, defined development within the technical stream, and is implemented across all of Teck's sites and operations. Following completion of this initial program, employees have the option of exploring either of the two career-development paths. These development paths are closely tied to the rest of Teck's learning and development opportunities, including:

- Custom training
- Job rotations
- Mentorships
- Business education and leadership programs

The most unique aspect of Teck's dual-career path is its flexibility. Employees are not restricted to choosing and then remaining in one path until the end of their careers. In their dual-path design, there is room for movement back and forth between the two streams throughout one's career. Only at the very top (VP-levels), do the paths converge again. This kind of flexibility allows employees to try out different roles within the organization, and eliminates problems encountered in other organizations where one path is seen as inherently "better" than the other. At Teck, if people believe that the "grass is greener" along the other path, they are free to pursue their next opportunity there, and then move back to their original path later on if they so choose.

By all accounts, the dual-path offering has been a success. Teck's attrition numbers are below the industry average, particularly for early- to mid-career technical employees. Perhaps even more importantly, this flexible approach to development has proven especially attractive to younger employees, and has served Teck well in its recruitment efforts with Gen Ys. The success of this program is largely due to the fact that Teck's approach has avoided the two biggest dual-path pitfalls: perceived inequity across the paths and a lack of clear development goals. The company achieved this by ensuring that people are free to move between the paths, and by aligning both paths with a comprehensive, clearly defined set of learning and development activities.

Teck offers several recommendations to other organizations looking to implement dual-career paths, based on their experiences over the last 12 years:

- Solicit input from stakeholders about the program's goals and objectives prior to program design
- Gather materials throughout the implementation that can be used for both internal communications and external marketing/recruitment
- Set up an implementation group/committee that involves the input of technical professionals from all roles/site locations
- Ensure that employees have a "voice" and a feeling of empowerment throughout the process

These recommendations are largely focused on providing open communication about the program, both within and outside of the organization, to ensure a smooth implementation and continued interest in the development paths.

Implementing Innovation Paths

In this development approach, top performers are encouraged to use their creative thinking and ability to launch, promote and accelerate new processes or lines of business, and are streamed through development paths accordingly. This approach might be especially useful in the mining industry for developing KWs whose roles are instrumental in the innovation of processes and products.

Implementing an innovation path for these employees involves the creation of three distinct development streams. Each stream has its own set of core competencies based on the three key phases of innovation: discovery, incubation and acceleration:

- Discovery involves the creation or identification of new business opportunities;
- Incubation involves the design of new business lines; and
- Acceleration involves the development of a new business line until it is running smoothly.

The rationale behind creating specific types of innovation paths is that people tend to excel in competencies particular to one of the streams. Career development for these KWs would see employees focus on their area of particular strength. Career progression would involve taking on more responsibility for larger projects within each employee's chosen innovation stream. The difficulty in creating a set of innovation paths would lie in specifically defining the kinds of projects and roles that would best fit with each path, and ensuring consistency in performance management across the different paths.

Managing Lifestyle Concerns

Some mining and exploration employers are beginning to change how they do business both structurally and culturally to accommodate the lifestyle concerns of their workforce. These organizations recognize that increased family responsibilities for both genders may require a more flexible approach to work. For example, Rio Tinto has focused on creating family-friendly and flexible work arrangements. Flexible rosters allow employees to spend more time at home with their families. Employees can also live at the mine site or commute to sites, depending on their individual needs or preferences, and telecommuting is available for some occupations. Prior to and following the birth of their child, women can job share, work part-time or modify their roles to suit their specific needs.

Given the significant concerns expressed by both students and KWs about the remoteness of work locations, organizations must consider alternative strategies for dealing with this particular lifestyle issue. One potential solution is to tap into the local talent pool in northern, Aboriginal and mining communities. A potential barrier to filling KW positions from these communities is their lack of access to higher educational opportunities.

If the industry wants to target talent located in these remote locations, the educational institutions serving these communities need to ensure the resources are in place to provide students with the skills necessary to fill KW positions. However, Laurentian University, Lakehead University and the University of Quebec–Abitibi are the only institutions actually located in mining centres.

Institutions located far from mining operations have had to adapt their programming, often through educational partnerships, in order to meet the growing needs of the industry. Some new initiatives in northern and Aboriginal communities are discussed below.

- **University of Northern British Columbia (UNBC)** — In collaboration with the University of British Columbia, UNBC offers a program in Environmental Engineering among its natural-resources management courses. This four-and-a-half year program combines engineering and environmental science to offer students a learning experience aligned with the needs of the British Columbia mining industry.[110]

- **First Nations University of Canada (FNUniv)** — Through a partnership with the University of Regina Faculty of Arts and the Saskatchewan Institute of Applied Science and Technology, the FNUniv offers a Bachelor of Arts degree in Resource and Environmental Studies (BARES). This degree program is intended for Aboriginal and non-Aboriginal students who would like to pursue a career in natural-resources management. In this program, students have a unique opportunity to learn Indigenous knowledge and perspectives regarding environmental issues and conservation of our natural resources.[111]

- **University College of the North (UCN)** — Located in Northern Manitoba, the UCN is Canada's newest post-secondary establishment. While the campuses are situated in The Pas and Thompson, programs are offered in 10 northern communities through a network of regional centres. Their programs currently include degree programs in natural-resources management. Through partnerships with mining industry employers and associations, the UCN provides education and training that aligns with the workplace needs in Northern Manitoba and Canada.[112]

Learning and Development

Opportunities for continued professional development and engaging work are especially important to both current and future KWs. Organizations wishing to retain their highly-skilled talent must ensure that they are proactive in creating and maintaining a culture of learning to keep their KWs engaged.

Up-Skilling for Current Employees

Organizations looking for skilled KWs who are familiar with the industry can look to their existing employee base. There are several programs in place that address this opportunity by providing up-skilling for current employees. Several examples of such programs are provided below.

110 University of Northern British Columbia — *Engineering Introduction.* (2011). www.unbc.ca/ensc/engineeringintroduction.html (accessed May 27, 2011)

111 First Nations University of Canada. *Programs, First Nations University Canada.* www.firstnationsuniversity.ca/default.aspx?page=119 (accessed May 27, 2011)

112 *Faculty of Arts and Science — University College of the North.* (2011). Homepage: www.ucn.ca/ics/Programs/Degree_Programs/Faculty_of_Arts_and_Science

Cameco

Cameco offers a career-transition program for high-potential employees. It allows employees at its Northern Saskatchewan sites to follow post-secondary education in a related field like geology, chemistry or engineering. Employees who participate in this program receive:

- Financial assistance equaling up to 80 per cent of their salary
- Subsidies for tuition, registration fees and books
- Employment during vacations and school breaks
- Guaranteed employment in their new field upon graduation

Furthermore, all Cameco employees receive financial assistance for courses associated with their occupation and may also obtain financial support for courses unrelated to their current position. The company also provides:

- A short leave of up to two days monthly that allows employees to study for exams. An extended paid education leave (up to 35 days per year)[113]

Golder

Golder provides tuition reimbursement of up to $5,500 for employees enrolled in courses related to their position. The company has also set up scholarship funds that enable employees to pursue studies at academic institutions.[114]

Teck

Teck encourages its workers to upgrade their educational qualifications by offering financial assistance for approved programs. Teck also offers graduate-level business courses in conjunction with the Business Education Program at Simon Fraser University. These MBA-level courses lead to a Graduate Diploma in Business, and include:

- The Economic Basis of Managerial Decision-making
- Financial Management
- Industrial Marketing Management
- Organizational and Leadership Effectiveness
- Business, Community and Government
- Commercial Law[115]

113 Cameco (2011) *Canada's Top Employers*. www.eluta.ca/top-employer-cameco

114 *Ibid.*

115 Teck. (2011). *Teck Mining Jobs, Careers in Mining — Career Development Educational Advancement.* www.teck.com/Generic.aspx?PAGE=Teck+Site%2fCareers+Pages%2fCareer+Development+Pages%2fEducational+Advancement&portalName=tc

Providing Adequate Informal and Social Learning Opportunities

The move towards a knowledge-based economy has given rise to the need for a view of learning as a fluid, employee-driven process — rather than a static, content-driven product.[116] Increasingly, 21st century workplaces must rapidly adjust to the learning needs of their employees and arm them with the "on-demand" learning tools and resources necessary for performance. This shift to more learner-centered approaches, has produced a significant increase in both informal and social learning over the last five years.[117] Many of the tools that enable collaboration and team-based work are social media based, and organizations are increasingly leveraging these tools to engage learners.

As an increasing number of organizations move towards collaborative, networked learning, highly-skilled employees will come to expect this type of learner-based approach.[118] Organizations in the mining industry will need to ensure that their learning and development approach is meeting the expectations of these employees, if they want to attract and retain them in the long-run.

Online (Distance) Education

The last decade has seen a rise in the use of distributed online education in both academia and industry. Although online learning can present challenges for highly technical degree programs, it does offer the advantages of space and time convenience, and access for those in remote locations. Currently, no Canadian universities offer mining-related degrees via distance learning.[119] The Mining Engineering Department at the University of Missouri-Rolla does offer an online graduate program in Mining Engineering. Leading to the degree of Master of Engineering, this program is intended primarily for non-mining engineers and scientists working in the mining industry, and for the mining engineers who wish to bring their knowledge of the profession up-to-date.[120]

Building Career and Industry Awareness

Targeting Younger Audiences

As the results of the student and knowledge worker surveys demonstrated, employer outreach to younger audiences is seen as one key to future attraction of KWs. Respondents indicated support for the concept of industry involvement prior to post-secondary levels, with programs targeting high-school and elementary students. Hiring high-school students for summer jobs will keep students in longer term contact with operations. Outreach to both students and teachers needs to happen as early as elementary school — delivered by people who are articulate, understand both the industry and students, and can emphasize the new technical opportunities the industry offers.[121] This type of

116 Internet Time Alliance. (2011). *The Working Smarter Fieldbook.*

117 Hart, Jane. (2011). *Social Learning Handbook: A Practical Guide to Using Social Media to Work and Learn Smarter.* Wiltshire, UK: Centre for Learning and Performance Technologies.

118 Steelcase. (2009). How the Workplace Can Attract, Engage & Retain Knowledge Workers. *Deep Dive*, August: 1–9.

119 Under the current guidelines, an online course would not be accredited as meeting the requirements for licensure.

120 Houlding, Simon. (2008). *The Changing Face of Education in Mining*. http://go.mining.com/feb08-a2

121 Interview with industry expert.

early outreach will help dispel some of the myths about mining and exploration, through the sharing of good news and promotion of environmental initiatives. Two examples of existing outreach programs are the Prospectors and Developers Association of Canada's (PDACs) *Mining Matters* and the Mining Industry Human Resources Council's (MiHR's) *Explore for More* programs.

The Prospectors and Developers Association of Canada's (PDACs) Mining Matters Program

The *Mining Matters* program brings information about Canada's mineral and metal resources to students and teachers. In partnership with government, industry and educators, the program produces and provides bilingual educational resources for Grades 4 and 7, as well as other teaching materials. In 2007, the program also created a module and a newsletter for high-school students.[122]

The Mining Industry Human Resources Council's (MiHR's) Explore for More Program

The *Explore for More* program was designed to create an overall brand for the mining industry when promoting careers in the sector. It brings together a photo gallery, specific messaging and video library, to promote mining careers, dispel myths and support attraction of target groups to the sector.[123] The *Explore for More* website:

- Provides background information on the mining industry in Canada and on careers in the sector;
- Spotlights videos of individuals in a wide range of occupations and careers in the sector; and
- Showcases a speaker's bureau on mining and exploration and a virtual mentorship program.

Utilizing Social Media

Social media provide an ideal opportunity for the industry and employers to reach out to the next generation of KWs. The number of people connected through social media is increasing at an exponential rate, particularly among younger generations. Organizations are increasingly turning to social media campaigns for recruitment, awareness and branding opportunities. Sites such as YouTube could be used to present short videos highlighting environmental campaigns. Employers could also work with student and association groups to set up blogs, websites and discussion forums to spread the word about work opportunities within the sector. Finally, experts within the industry should be encouraged to increase their online presence by sharing their expertise through blogging and microblogging (e.g., on sites such as Twitter and Quora). This kind of information-sharing would highlight industry programs for a wider audience, further enhance the industry's reputation, and provide timely information to people who might be curious about the specifics of career paths in mining and exploration.

122 Prospectors and Developers Association of Canada and Canadian Mining Industry Research Organization — Exploration Division. (2002). *Innovation in Canada's Mineral Exploration and Development Sector*. Submission to Industry Canada.

123 Mining Industry Human Resources Council. (2010). Canadian Mining Industry Employment and Hiring Forecasts 2010. *A Mining Industry Workforce Information Network Report*. July 2010. www.mininghrforecasts.ca/en/resources/MiHR_Canadian_Mining_Employment_Forecasts_July2010.pdf

One current example of the use of social media in mining and exploration is seen at Noront Resources. The organization's mineral-exploration operations are located in a remote location north of Thunder Bay, Ontario. Senior managers at Noront were interested in improving their communication and consultation process with the Aboriginal communities surrounding their operations. They created a consultation portal based on a social-networking platform to allow for dialogue with the neighbouring Aboriginal communities. For example, the portal includes online videos on Aboriginal employees at the mining camp and discussion boards. Through the information available in this portal, Noront hopes to inspire young people in the Aboriginal communities to pursue further education and potentially obtain work in the mining industry in the future.[124]

Collaboration between Academic Institutions, Employers, Government and Industry Associations

Mining companies are making significant contributions (both financial and in-kind) to mining education institutions across the country. However, this contribution may not be as widely recognized or appreciated as it could be beyond specialized audiences. These kinds of efforts should be widely promoted, both within the mining industry, and to the public at-large. Below are some selected partnerships that might be of interest:

Centre for Excellence in Mining Innovation (CEMI), Laurentian University

Located in the Willet Green Miller Centre at Laurentian University, the Centre, in partnership with industry employers, conducts critical research for the mining industry in:

- Mineral exploration;
- Deep mining;
- Environmental and sustainability; and
- Integrated mine engineering.

The Inco Innovation Centre (IIC), Memorial University of Newfoundland

As a partnership between Vale Canada Ltd. (formerly Vale Inco, CVRD Inco, Inco Ltd.), the Atlantic Canadian Opportunities Agency (ACOA), Memorial University and others, the IIC is a research facility located at Memorial University's St. John's campus. The focus of the Centre's research is mining-related innovation in four areas:

- Geochemistry;
- Geophysics;
- Process engineering (process control and hydrometallurgy); and
- Process engineering (safety and environmental).

124 The Mining Industry Human Resources Council. (2011). *Aboriginal Community Engagement Using Social Media*. MiHR. www.mihrinnovate.ca/en/hrBestPractices/noront_aboriginal_engagement.asp

The Lassonde Institute, University of Toronto

The Institute conducts research and graduate studies in geophysics, geology and engineering (engineering geoscience). Composed of several laboratories and research groups within UoT, the Institute's focus is on:

- Seismology;
- Rock fracture dynamics;
- Rock physics;
- Soil and rock mechanics;
- Computational geomechanics; and
- Mineral engineering.

MIRARCO-Mining Innovation, Laurentian University

For the past decade, with support from both the private and public sectors, MIRARCO-Mining Innovation has used a hybrid academic and professional approach to develop innovative solutions for the mining and exploration sector. Experienced professionals and students work together to advance research in:

- Geomechanics;
- Visualization and optimization;
- Geohazard assessment and risk mitigation;
- Environmental monitoring and rehabilitation;
- Energy, carbon management, and climate change adaptation; and
- Sustainability.

Norman B. Keevil Institute of Mining Engineering, University of British Columbia

In 2006–2007, the mining engineering department at UBC received a major donation from Teck (then Teck Cominco) Ltd. and industry associates, as well as financial support from the B.C. Government, to create the Norman B. Keevil Institute of Mining Engineering (NBK). The Institute's research focuses on sustainability and better working processes in the mining industry and covers:

- Mine safety;
- Robotics; and
- Environmental and social issues, among others.

Canada Mining Innovation Council (CMIC)

Incorporated in 2009, the CMIC is a collaboration of academics, government and business leaders whose goal is to strengthen mining research and improve the competitiveness of the Canadian mining and exploration industry. The CMIC links the needs of industry employers to research capability in Canada and the appropriate funding.

Appendix A

Global Strategies for Knowledge Workers

Knowledge Worker Strategies — International Case Examples

The following specific case examples outline a number of innovative strategies that have been utilized to successfully attract and retain KWs (also referred to in some literature as Highly Qualified Personnel (HQPs).

Skills Gap Awards — U.K.

An innovative approach to retaining KWs nationally and to growing innovation during economic downturns was outlined in the Research Councils U.K.'s Skills Gap Awards. The objective of these awards was to recruit KWs into research and technology-transfer posts throughout the country, and through rapid appointments and interim project funds. These awards strengthened the link between academia and industry, while promoting research and development to retain KWs during an economic crisis. A key component of the program was the idea of rapid placement, with expected placements within four weeks.

> *"By keeping top talent in the U.K. research base, we ensure that U.K. universities and our research institutions have the wide range of expertise they need to support innovation. Forging ever closer links between academia and industry will be key to future growth in innovative companies."*[125]

Cooperative Research Projects

When 30 per cent of European university teaching programs closed in the 1990s there was a need to respond, and a joint MSc curriculum in resource management was developed between Finnish, German, and Dutch technical universities. The program covered a wide range of topics including Mining Engineering and Geotechnical and Environmental Engineering — creating the European Minerals and Environmental Program. The number of institutes increased to nine in 1999, and relations were formalized to create the Federation of European Mineral Programs. The next step is to generate cooperative research among the schools.[126]

125 Zolfagharifard, E. (2008). Careers: Research and Rescue. *The Engineer,* 48.

126 Casteel, K. (2007). Europe Advances Educational Efforts in Mining Engineering. *Engineering and Mining Journal*, 44–48.

Global Mining Educational Programs

Sandvik International Mining School is in the process of developing six modules that will combine theoretical education and practical field work to provide international experience. The School, which includes mining schools from the U.S., Australia, South Africa, Austria and Great Britain will allow each university to provide courses on their special field of expertise. Current efforts included the development of collaborative projects between universities, technical colleges and industry to further the training and development of the current mining workforce and to increase the accessibility of the industry to post-secondary students. In addition, Sweden's Innovation strategy focuses on geosciences research and the Swedish governments Mining Research Program in 2006 — a jointly funded project between the government and industry.[127]

Cooperative and Strategic Resource Agenda

In conjunction with the launch of the Technology Platform on Sustainable Mineral Resources (SMR) in 2005 by the European Commission, industry players and other stakeholders from the mining sector are developing a Strategic Research Agenda intended to guide research for the sector acknowledging that active engagement from all industry stakeholders in the research-framing adds value to the research.[128]

Strategic Partnerships with Related Industries and Governments

The Bergesfork project "Faster and Better Tunnelling" connects the mining industry with other agencies of interest outside the sector, including the National Rail Administration and National Road Administration. There has also been a concerted effort by Finnish and Swedish governments to work together to face challenges related to research access and funding and industry support, as well as immigration and market competitiveness.[129]

Development of Consortiums Focused on Knowledge Workers

Consortiums that link industry leaders, post-secondary institutions, foundations and governments can be developed to generate specific strategies for addressing the financial and socio-economical barriers that students face in the completion of post-secondary qualifications. These strategies can be deployed through targeted applications of resources, beyond current government aid. Examples of consortiums that focus on the development of KWs include the following:

- **Canada Mining and Innovation Council (CMIC)** — CMIC has developed a strategy with goals in five action areas, including KWs with a focus on attracting, developing and retaining a steady flow of KWs (students, faculty and practitioners) into mining research and innovation, and strengthening the research capacity of Canadian mining schools and their linkages.

127 Casteel, K. (2007). Europe Advances Educational Efforts in Mining Engineering. *Engineering and Mining Journal*, 44–48.

128 *Ibid.*

129 *Ibid.*

- **The Business Higher-Education Forum (BHEF)** — BHEF is a coalition of corporate, academic and foundation members that work to advance innovative solutions to education challenges, by investing in student achievement, post-secondary readiness and success.
- **Australian Businesses, Industry and Higher-Education Collaboration Council** — This Council seeks to coordinate the role of business within the higher-education sector — bringing business into the policy discussion by enabling dialogue with the country's universities and technical/vocational sector, with a focus on regional engagement.

Intensive Corporate Development Programs

Vale Inco (then Inco Ltd.) offered a progressive 18-month development program involving employees throughout the global operations. Through the program, groups of 15 employees received education that included learning about broader corporate issues and developing leadership abilities. During their program enrolment, employees were provided a mentor to support their leadership development.[130]

Customized Training Programs

Through a series of tools, such as behavioural interviews and leadership simulation, emerging leaders at Placer Dome were recognized through their "Leadership Development Program", which enabled employees to take ownership of their development. Through a series of consultations, employees developed a program that was tailored to their specific development needs. Employees had access to coaching, mentoring, external courses and work on special projects to help them reach their leadership objectives.[131]

130 Ednie, H. (2004). Human resources — innovative solutions for mining's human resource challenges. *CIM Bulletin*, 97(1076), 9–15.

131 *Ibid.*

Appendix B

Table B-1
Age Distribution of Knowledge Workers in Mining-Related Industries and in All Industries in Canada, 2006
(Per cent)

OCCUPATIONS		15–24 YRS	25–34 YRS	35–44 YRS	45–54 YRS	55–64 YRS
Engineering managers	Mining-related	1.1	13.8	29.4	34.5	21.2
	All industries	1.2	14.4	33.4	34.7	16.3
Construction managers	Mining-related	4.5	19.4	25.0	28.7	22.4
	All industries	3.8	16.7	30.0	32.4	17.2
Primary production managers	Mining-related	1.8	22.3	30.3	31.9	13.6
	All industries	1.8	18.2	28.4	36.5	15.1
Chemists	Mining-related	5.9	30.4	33.3	17.8	12.5
	All industries	3.5	29.5	35.4	20.8	10.8
Geologists, geochemists, geophysicists	Mining-related	3.1	24.9	24.7	30.9	16.4
	All industries	3.0	23.2	24.4	34.9	14.4
Other professionals, physical sciences	Mining-related	6.8	20.5	24.8	31.6	14.5
	All industries	10.0	15.9	26.0	30.4	17.6
Biologists and related scientists	Mining-related	11.0	41.2	28.9	15.4	3.1
	All industries	5.3	34.3	27.6	23.4	9.4
Civil engineers	Mining-related	4.2	27.9	27.2	24.1	16.6
	All industries	3.2	24.7	28.2	28.4	15.5
Mechanical engineers	Mining-related	3.6	27.4	29.5	22.0	17.5
	All industries	3.2	28.5	32.0	22.7	13.6
Electrical and electronics engineers	Mining-related	5.0	25.4	27.3	24.9	17.3
	All industries	3.5	25.1	32.8	26.2	12.4
Chemical engineers	Mining-related	4.4	35.4	29.4	21.7	9.3
	All industries	2.9	33.1	30.0	23.1	10.8
Industrial/manufacturing engineers	Mining-related	3.8	32.3	26.5	23.0	14.5
	All industries	2.9	32.3	30.5	23.6	10.7
Metallurgical and materials engineers	Mining-related	1.8	29.3	24.9	25.3	18.2
	All industries	2.4	30.1	27.9	25.5	13.8
Mining engineers	Mining-related	5.2	24.9	28.3	24.4	17.3
	All industries	4.0	25.6	27.8	24.7	17.7
Geological engineers	Mining-related	6.6	30.7	28.8	21.0	12.5
	All industries	5.5	29.7	28.8	25.2	11.2
Other professional engineers	Mining-related	4.9	14.6	35.0	20.3	24.4
	All industries	5.3	23.4	32.3	23.4	15.6
Average all KW occupations	Mining-related	9.3	26.2	26.0	24.0	14.5
	All industries	7.8	24.6	28.5	26.5	12.7

Source: Roslyn Kunin & Associates, MiHR, 2010.

Table B-2

Female Knowledge Workers in Mining and Exploration and in All Industries in Canada, 2006

(Per cent)

OCCUPATIONS		MALE	FEMALE
Engineering managers	Mining-related All industries	90.1 89.8	9.9 10.2
Construction managers	Mining-related All industries	92.7 91.9	7.3 8.1
Primary production managers	Mining-related All industries	95.7 92.0	4.3 8.0
Chemists	Mining-related All industries	57.1 56.4	42.9 43.6
Geologists, geochemists and geophysicists	Mining-related All industries	83.1 80.4	17.0 19.6
Other professionals, physical sciences	Mining-related All industries	83.8 81.3	16.2 18.7
Biologists and related scientists	Mining-related All industries	48.2 53.1	51.3 46.9
Civil engineers	Mining-related All industries	86.4 87.4	13.6 12.6
Mechanical engineers	Mining-related All industries	91.2 90.0	8.8 9.1
Electrical and electronics engineers	Mining-related All industries	89.8 89.8	10.2 10.2
Chemical engineers	Mining-related All industries	77.9 77.5	22.2 22.6
Industrial and manufacturing engineers	Mining-related All industries	84.6 84.5	15.4 15.5
Metallurgical and materials engineers	Mining-related All industries	88.9 87.1	10.7 12.6
Mining engineers	Mining-related All industries	91.1 92.2	8.9 8.0
Geological engineers	Mining-related All industries	86.4 85.8	13.6 14.2
Other professional engineers	Mining-related All industries	82.1 81.9	17.9 18.1
Average all KW occupations	Mining-related All industries	83.7 81.5	16.3 18.5

Source: Roslyn Kunin & Associates, MiHR, 2010.

Table B-3

Immigrant Status of Knowledge Workers in Mining and Exploration and in All Industries in Canada, 2006

(Per cent)

OCCUPATIONS		NON-IMMIGRANTS	IMMIGRANTS	TEMPORARY FOREIGN WORKERS
Engineering managers	Mining-related	62.3	35.6	2.0
	All industries	66.4	32.1	1.5
Construction managers	Mining-related	77.2	21.6	1.2
	All industries	80.7	18.9	0.4
Primary production managers	Mining-related	91.2	8.0	0.9
	All industries	90.0	9.3	0.8
Chemists	Mining-related	51.5	45.5	2.6
	All industries	50.3	47.4	2.3
Geologists, geochemists and geophysicists	Mining-related	75.0	23.9	1.3
	All industries	74.2	23.9	1.9
Other professionals, physical sciences	Mining-related	76.9	21.4	0.7
	All industries	72.0	28.0	0.0
Biologists and related scientists	Mining-related	83.8	15.8	0.9
	All industries	71.8	25.6	2.6
Civil engineers	Mining-related	62.0	36.7	1.3
	All industries	67.2	31.8	1.0
Mechanical engineers	Mining-related	55.9	43.2	0.9
	All industries	57.3	41.5	1.1
Electrical and electronics engineers	Mining-related	54.7	43.9	1.5
	All industries	59.8	39.0	1.2
Chemical engineers	Mining-related	69.1	28.8	1.9
	All industries	63.8	34.6	1.6
Industrial and manufacturing engineers	Mining-related	71.6	26.7	1.3
	All industries	65.9	32.7	1.4
Metallurgical and materials engineers	Mining-related	74.8	22.3	3.1
	All industries	74.6	22.1	3.2
Mining engineers	Mining-related	68.1	28.8	3.1
	All industries	70.9	27.0	2.4
Geological engineers	Mining-related	68.1	28.8	3.1
	All industries	70.9	27.0	2.4
Other professional engineers	Mining-related	60.2	38.2	1.6
	All industries	67.1	32.1	0.9
Average all KW occupations	Mining-related	71.2	27.8	1.0
	All industries	72.3	26.8	0.9

Source: Roslyn Kunin & Associates, MiHR, 2010.

Table B-4

Educational Attainment of Knowledge Workers in Mining-Related Industries and in All Industries, Canada, Age 15–64, 2006

(Per cent)

KNOWLEDGE WORKER OCCUPATIONS		NO CERTIFICATE DIPLOMA OR DEGREE	HIGH-SCHOOL GRADUATION	TRADE CERTIFICATE	COLLEGE, CEGEP, OR OTHER NON-UNI CERT/DIP.	UNI. CERT. BELOW BACHELOR'S	UNI. CERT DIP. & DEGREE
Engineering managers	Mining-related	0.7	3.8	2.5	13.2	4.3	75.3
	All industries	1.0	4.7	3.6	15.7	4.9	70.1
Construction managers	Mining-related	6.7	13.6	12.0	30.3	6.7	31.0
	All industries	12.0	22.1	20.0	23.6	4.6	17.7
Primary production managers (except agriculture)	Mining-related	23.6	28.0	11.3	15.5	3.8	17.9
	All industries	19.0	25.5	11.4	16.8	3.8	23.4
Chemists	Mining-related	0.7	3.0	0.7	10.6	3.6	82.2
	All industries	0.9	2.7	1.0	7.2	3.0	85.1
Geologists, geochemists and geophysicists	Mining-related	0.4	1.0	0.3	2.9	2.1	93.3
	All industries	0.3	0.9	0.3	2.7	2.2	93.6
Other professional occupations in physical sciences	Mining-related	3.4	6.8	1.7	37.6	8.5	41.9
	All industries	2.8	9.3	4.8	23.5	6.2	53.6
Biologists and related scientists	Mining-related	0.0	0.0	0.0	2.6	3.5	93.9
	All industries	0.2	1.0	0.5	4.0	2.1	92.3
Civil engineers	Mining-related	0.4	1.4	0.7	6.5	3.4	87.6
	All industries	1.5	3.4	3.1	10.6	4.3	77.2
Mechanical engineers	Mining-related	0.2	2.2	1.8	16.1	5.7	74.0
	All industries	0.4	2.1	3.4	15.0	4.8	74.2
Electrical and electronics engineers	Mining-related	0.4	1.9	2.5	12.7	5.0	77.6
	All industries	0.3	2.1	2.1	11.6	45.0	79.2
Chemical engineers	Mining-related	0.0	0.6	1.0	1.7	2.5	94.6
	All industries	0.5	1.8	1.8	5.1	3.6	87.2
Industrial and manufacturing engineers	Mining-related	0.9	2.8	3.7	9.2	2.4	81.3
	All industries	1.3	4.7	3.6	14.5	5.0	70.8
Metallurgical and materials engineers	Mining-related	0.0	0.9	2.7	6.2	2.2	88.0
	All industries	0.5	1.4	2.6	10.0	2.6	82.8
Mining engineers	Mining-related	1.6	6.0	3.1	8.1	3.9	76.9
	All industries	1.4	5.8	2.6	8.5	3.6	77.9
Geological engineers	Mining-related	0.0	1.9	0.0	3.5	2.3	92.6
	All industries	0.0	1.8	0.6	3.3	2.1	92.4
Other professional engineers n.e.c.	Mining-related	0.0	4.1	7.3	10.6	6.5	71.5
	All industries	1.4	3.2	4.3	15.1	5.3	70.7
Land surveyors	Mining-related	7.2	16.6	8.6	31.1	6.0	30.4
	All industries	7.5	17.1	9.2	31.8	5.5	28.9
Chemical technologists and technicians	Mining-related	2.6	16.9	4.8	37.7	6.9	31.0
	All industries	4.0	18.4	5.0	34.6	6.5	31.5
Geological and mineral technologists and technicians	Mining-related	8.0	26.9	6.9	32.8	5.9	19.5
	All industries	6.1	24.8	6.5	36.9	5.9	19.9
Biological technologists and technicians	Mining-related	1.6	20.3	3.3	26.0	9.8	40.7
	All industries	4.1	16.9	5.1	30.6	64.0	36.8
Civil engineering technologists and technicians	Mining-related	0.6	14.8	5.7	54.9	7.4	16.8
	All industries	1.6	17.0	6.9	55.1	7.4	12.0
Mechanical engineering technologists and technicians	Mining-related	0.6	13.0	6.7	57.0	9.2	13.2
	All industries	1.9	12.4	13.0	54.2	7.4	11.1
Industrial engineering and manufacturing technologists and technicians	Mining-related	1.4	16.7	6.6	49.5	7.0	18.8
	All industries	5.9	20.0	11.2	37.1	6.5	19.4
Construction estimators	Mining-related	1.2	15.9	11.6	31.7	7.3	32.3
	All industries	4.5	18.8	17.0	35.5	5.3	18.9

Table B-4 (continued)

Educational Attainment of Knowledge Workers in Mining-Related Industries and in All Industries, Canada, Age 15–64, 2006

(Per cent)

KNOWLEDGE WORKER OCCUPATIONS		NO CERTIFICATE DIPLOMA OR DEGREE	HIGH-SCHOOL GRADUATION	TRADE CERTIFICATE	COLLEGE, CEGEP, OR OTHER NON-UNI CERT/DIP.	UNI. CERT. BELOW BACHELOR'S	UNI. CERT DIP. & DEGREE
Electrical and electronics engineering technologists and technicians	Mining-related	0.7	8.6	10.0	63.4	6.5	10.6
	All industries	2.1	11.4	11.0	56.8	7.4	11.4
Drafting technologists and technicians	Mining-related	1.5	12.3	13.8	48.3	5.9	18.1
	All industries	1.8	12.5	15.4	47.4	5.9	17.0
Land survey technologists and technicians	Mining-related	8.4	37.6	13.7	31.9	2.9	5.5
	All industries	7.7	34.8	11.6	36.7	4.1	5.3
Mapping and related technologists and technicians	Mining-related	1.9	9.1	2.4	31.2	5.9	49.5
	All industries	1.4	9.5	2.9	31.1	6.0	49.2
Total selected occupations	Mining-related	2.9	9.6	5.5	24.2	5.0	52.9
	All industries	3.7	11.1	8.0	25.7	5.1	46.4

Source: 2006 Census, Statistics Canada

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