Impact Assessment of the Technology Adoption and Commercialization and Knowledge Infrastructure Sub-Activities of the Innovation Component of the Western Diversification Program

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Contractor Name:

Ference Weicker & Company Ltd.
550-475 West Georgia Street
Vancouver, BC
V6B 4M9
Tel: 604-688-2424

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EXECUTIVE SUMMARY

WESTERN ECONOMIC DIVERSIFICATION

Western Economic Diversification was established in 1987 with a mandate to:

"promote the development and diversification of the economy of Western Canada and to advance the interests of Western Canada in national economic policy, program and project development and implementation.[1]"

Towards this end, Western Economic Diversification (WD) Canada implements a suite of coordinated programs which bring together industry, community and different levels of government to help businesses adapt to changing market conditions and advance in the global marketplace. The programming of WD falls into three strategic categories:

- **Policy, Advocacy and Coordination** activities, which foster an improved understanding of Western Canadian economic issues, challenges, opportunities and priorities; advance Western Canada's interests in national policies, priorities and programs; and facilitate better coordinated economic development activities, policies and programs.
- **Community Economic Development** activities, which include economic development and diversification initiatives designed to assist communities adjust to changing economic circumstances as well as strategic investments in public infrastructure.
- **Entrepreneurship and Innovation** activities, which include initiatives geared toward ensuring that the business sector in Western Canada is competitive, expanded and diversified and the innovation system is strong.

Under its innovation component, WD makes strategic investments in six sub-activity areas:

- **Technology Adoption and Commercialization** to lead to an increase in the number of technologies developed in research institutions that have commercialization potential, and an increase in technologies adopted by existing firms.
- **Knowledge Infrastructure** to increase the physical assets and capacity supporting the innovation system.
- **Technology Linkages** to increase connections and synergies among innovation system members.
- **Technology Research and Development** to lead to development of technologies with commercial potential.
- **Community Innovation** to lead to increased technological capacity in a community.
- **Technology Skills Development** to lead to an increase in training, education and skills building to increase the number of Highly Qualified People (HQP) and to ensure that the HQP are retained.

WD works with stakeholders including the not-for-profit sector, academic institutions, industry associations and other levels of government to strengthen the Western Canadian innovation system through both regional and pan-western initiatives.

1 Western Economic Diversification Act, 1988

RESEARCH PURPOSE AND OBJECTIVES

The purpose of this project is to conduct an impact assessment of the Technology Adoption and Commercialization (TC) and Knowledge Infrastructure (KI) sub-activities of the Innovation Component of WD's Western Diversification Program. The impact study is to validate the results data available through WD's web-based project assessment and tracking system, Project Gateway, and to add to that data by examining complementary evidence available from other sources with the objective of assessing outputs and outcomes of individual investments, sub-groups of related investments (such as in a cluster or sector or within an organization), and all investments as a group. The scope of the impact assessment covers a representative sample of approved projects from April 1, 2002 to March 31, 2007.

Based on the information outlined in the Request for Proposal as well as input provided by the Advisory Committee, a series of research questions were developed and grouped under three issues including:

- Profile of the Projects;
- Project Outcomes; and
- Broader Impacts.

A list of the specific research questions is provided in the following table.

RECOMMENDED ASSESSMENT ISSUES AND RESEARCH QUESTIONS

Issues	Research Questions
Profile of the Projects	▪ What are the characteristics of the projects which have received funding under these two sub-activities?
Project Outcomes	▪ What impacts have been generated by these projects, particularly in terms of technology commercialization and adoption and enhancing knowledge infrastructure and capacity in western Canada? ▪ How do the aggregate impacts of these projects vary by province? ▪ To what extent can these impacts be attributed to the investment and other assistance provided by WD?
Broader Impacts	▪ In what manner and to what extent have the WD investments contributed to the development of a strengthened innovation system in Western Canada?

DESCRIPTION OF METHODOLOGY

The study was undertaken in three phases. The purpose of the first phase was to develop a detailed work plan which was then implemented in the second two phases of the study. The specific steps that we undertook to complete the second and third phase of the study are as follows:

- Conducted 105 interviews with the targeted project proponents following an introductory letter distributed by WD to project proponents.

- Conducted 4 case studies each involving a series of related projects (12 in total). In selecting the case studies, we considered the reported impacts, the value of making a site visit, whether case studies had been completed in the past, and the presence of related projects which will effectively illustrate the impact of WD's assistance. Each case study covered a group of related investments, with the objective of confirming the outputs and outcomes which have been reported and contribution to the innovation system. For each case study, we reviewed the data obtained from the project files; conducted a site visit to determine first-hand what has been accomplished by the project; conducted further interviews with project proponents; and interviewed a sample of other stakeholders, including users, familiar with the outputs or outcomes of the projects.

- Conducted further review of approximately 45 projects (including the case study projects). These included projects for which a significant impact was reported but which were not selected as part of a case study. The primary purpose of the further review was to assess the validity of the data obtained from the proponents and/or reported in the files. Interviews were conducted with a sample of 50 users and other stakeholders to follow-up on the results of projects selected for further review.

- Compiled data on the reported impacts to compare and analyze the impacts generated by sub-activity and by province.

- Assessed the role of the projects in strengthening the innovation system in Western Canada by reviewing the results of the case studies, the results of the interviews with stakeholders and the interviews with proponents; reviewing available secondary data; and reviewing available documentation regarding the projects.

The analysis of the two target sub-activities – Technology Adoption and Commercialization and Knowledge is based on the sample of 129 projects that comprise the scope of this study. From this point onward it will be understood that all conclusions referring to the target sub-activities, refer to the sample of 129 on which this project is based.

MAJOR FINDINGS

The major findings on the research questions and recommended assessment issues are discussed below.

Question: What are the characteristics of the projects which have received funding under these two sub-activities?

WD has made significant investments in Technology Adoption & Commercialization and Knowledge Infrastructure projects. This review focused on 129 projects including 75 Technology Adoption & Commercialization projects and 54 Knowledge Infrastructure projects. Over the period from April 1, 2002 to March 31, 2007, WD approved funding of $126.5 million for these projects. Some of the characteristics of these projects include:

- The combined project costs for the 129 projects totaled $445.3 million. Therefore, for every dollar provided by WD, $2.52 was invested in the projects from other sources.

- The project funding was distributed to 64 distinct organizations. Forty-nine organizations were approved for funding under the Technology Adoption & Commercialization sub-activity while 29 organizations were approved for funding under the Knowledge Infrastructure sub-activity. Fourteen organizations were funded under both sub-activities.

- Most of the proponent organizations (31%) are educational institutions. Other types of organizations include: industry associations (16%); non-profit organizations (16%); R&D consortia (16%); and provincial government and provincial health authorities (13%).

- The life sciences sector accounted for 44% of approved funding for the sample of projects. The IT sector accounted for 17% of approved project funding.

- Within both sub-activities, projects were designed to accomplish a wide range of objectives. Project types included projects aimed at: improving research capacity, building technology commercialization capacity, demonstrating new technologies, developing markets, improving service delivery, providing education and training, developing new products, and community outreach.

Question: What impacts have been generated by these projects, particularly in terms of technology commercialization and adoption and enhancing knowledge infrastructure and capacity in western Canada?

Most projects were implemented as planned and successful in achieving their objectives. Of the projects which were reviewed:

- 98% of projects were implemented largely as planned. Even though some adjustments were made as projects were moving forward (e.g. broadened project scopes, refinements to the work plan, and project revisions), most adjustments created positive impacts and timing delays were not substantial; and

- 90% were rated by proponents as being successful or very successful in achieving their stated objectives. When asked to rate how successful the project has been in achieving the objectives on a scale of 1 to 5, where 1 is not at all successful, 3 is somewhat and 5 is very successful, the proponents provided an average rating of 4.6.

- 65% of projects were rated by WD project officers as having met or exceeded expectations. 13% of projects were still in progress during the course of this impact assessment.

This report aggregates the reported outcomes of the projects reflecting the key indicators outlined in WD's Program Activity Architecture (PAA) and the logic model established for each sub-activity. At the project level, the report identifies immediate and intermediate outcomes. Immediate outcomes refer to a project's achievement on performance indicators during the reporting period (i.e. from the time when the project is funded until the final report is prepared). Intermediate outcomes use the same indicators and cover the period extending beyond the reporting period to the present date.

The projects supported under the Technology Adoption and Commercialization sub-activity and Knowledge Infrastructure sub-activity generally met or exceeded their targets related to the standard performance indicators. Intermediate outcomes reported by the 75 Technology Adoption & Commercialization projects include:

- 227 patents filed or issued;
- 52 technologies adopted;
- 343 prototypes developed;
- 164 technology demonstrations;
- 251 licenses executed;
- 37 technologies to market;
- 30 spinoff companies; and
- $9 million in venture capital invested.

Intermediate outcomes reported by the 54 Knowledge Infrastructure projects include:

- The development of over 22,000 square metres of space dedicated to R&D and skills training (with another 9,300 square metres close to completion); and

- Approximately $16.4 million in R&D undertaken in the new facility or using new equipment supported under the WD project.

Other outcomes reported by these Knowledge Infrastructure projects included 35 patents filed or issued and 6 spinoff companies. Within both of the sub-activities, some projects are still in progress and are not yet in a position to report on their indicators.

Question: How do the aggregate impacts of these projects vary by province?

- Within both the Technology Adoption and Commercialization and Knowledge Infrastructure sub-activities, the projects across all four provinces were generally successful in achieving their objectives.

- The aggregate impact of the Technology Adoption and Commercialization and Knowledge Infrastructure sub-activities varies by province, largely reflecting the allocation of projects by province as well as variations in the use of standard performance indicators among provinces. The main body of the report summarizes the reported impacts by province and sub-activity.

Question: To what extent can these impacts be attributed to the investment and other assistance provided by WD?

On average, project proponents estimated that there was a likelihood of only 17% that their projects would even have been implemented in the absence of assistance from WD. Most proponents report that they would not have been successful in accessing similar levels of funding from other sources. Even those that may have proceeded would have been delayed or reduced in scope in the absence of WD funding.

In addition to funding, WD also provided other assistance which plays a key role in the development and implementation of many projects. Of the proponents we interviewed for the 122 projects, 54% indicated that WD representatives played an important role in design, development and implementation. More specifically, WD representatives provided important feedback on project design, oversight and monitoring, participated in steering committees during project implementation, helped to secure other sources of funding, assisted in publicity and media relations, and facilitated linkages with other organizations.

Question: In what manner and to what extent have the WD investments contributed to the development of a strengthened innovation system in Western Canada?

Taken together, the projects supported by WD in the Technology Adoption and Commercialization and Knowledge Infrastructure sub-activities have helped to strengthen the innovation system in western Canada. More specifically, the projects have:

- Improved research capacity (e.g. through acquisition of new equipment and development of new facilities).

- Strengthened capacity for technology commercialization (through establishment of infrastructure, processes and personnel for technology commercialization).

- Increased access to education and training (increased numbers of students going through programs, use of new equipment or facilities, increased co-op placements, improved curriculum delivery).

- Improved service delivery (e.g. improved service delivery to industrial and academic clients through equipment upgrades or purchase of new equipment which enable cost effective services with faster turnaround times).

- Attracted funding and HQP (e.g. enabled universities to recruit distinguished faculty and better compete for research grants).

- Sustained and expanded operations. For example, users of project outputs reported improved profitability through increased revenues and/or decreased costs, employment growth, and applications of new technology.

- Produced scientific discoveries and publications.

- Led to successful technology demonstrations within many industries.

- Led to follow-on projects. Twenty-seven proponents associated with Knowledge Infrastructure projects estimated approximately $138.7 million was invested in related projects, investments or developments. Thirty-two proponents indicated that their Technology Adoption & Commercialization projects led directly to other projects, investments or developments worth approximately $125.6 million.

Projects have enabled industry players to respond proactively to market and demand conditions; developed the R&D and technology infrastructure; contributed to the development of skilled human capital, improved access to capital; and developed industry structure by improving competitiveness and supporting the development of key technology developers. The projects facilitated linkages among players in the innovation system and contributed to the further development of emerging clusters.

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Appendices are provided in a separate document as follows:

LIST OF ACRONYMS

Acronyms which are used in this report include:

AACTI Alberta Association of Colleges and Technical Institutes
ACM Advanced Composites Materials
ARO Applied Research Office
BC British Columbia
BCIT British Columbia Institute of Technology
BCKDF British Columbia Knowledge Development Fund
CANARIE Canadian Network for the Advancement of Research Industry and Education
CARSI Centre for Applied Research in Sustainable Infrastructure, Red River College
CDRD (DDI) Centre for Drug Research and Development (Drug Development Inc.)
CFI Canada Foundation for Innovation
CIC Composites Innovation Centre
CIGI Canadian International Grains Institute
CIHR Canadian Institutes of Health Research
CME Canadian Manufacturers and Exporters
DNA Deoxyribonucleic acid
HQP Highly Qualified Personnel
IP Intellectual property
IRAP Industrial Research Assistance Program
ISIS Intelligent Sensing for Innovative Structures Canada Research Network
KI Knowledge Infrastructure
MITACS Mathematics of Information Technology and Complex Systems
MOU Memorandum of Understanding
MRI Magnetic Resonance Imaging
NAIT Northern Alberta Institute of Technology
NHP Natural Health Products
NINT National Institute of Nanotechnology
NRC National Research Council
NRCan Natural Resources Canada
NSERC National Science & Engineering Research Council

ORIC Okanagan Research & Innovation Centre
PAA Program Activity Architecture
R&D Research and Development
RRC Red River College
SFU Simon Fraser University
SME Small and Medium-sized Enterprises
SPG Saskatchewan Pulse Growers
TC Technology Adoption and Commercialization
TRU Thompson Rivers University

UBC University of British Columbia
(U)ILO (University)-Industry Liaison Office
U of S (CDC) University of Saskatchewan (Crop Development Centre)
UTI University Technologies International Inc.
VIDO Vaccine and Infectious Disease Organization at the University of Saskatchewan
WD Western Economic Diversification
WDP Western Diversification Program

I. INTRODUCTION

A. BACKGROUND

Western Economic Diversification was established in 1987 with a mandate to:

> *"promote the development and diversification of the economy of Western Canada and to advance the interests of Western Canada in national economic policy, program and project development and implementation.[2]"*

Towards this end, Western Economic Diversification (WD) Canada implements a suite of coordinated programs which bring together industry, community and different levels of government to help businesses adapt to changing market conditions and advance in the global marketplace. The programming of WD falls into three strategic categories:

- **Policy, Advocacy and Coordination** activities, which foster an improved understanding of Western Canadian economic issues, challenges, opportunities and priorities; advance Western Canada's interests in national policies, priorities and programs; and facilitate better coordinated economic development activities, policies and programs.

- **Community Economic Development** activities, which include economic development and diversification initiatives designed to assist communities adjust to changing economic circumstances as well as strategic investments in public infrastructure.

- **Entrepreneurship and Innovation** activities, which include initiatives geared toward ensuring that the business sector in Western Canada is competitive, expanded and diversified and the innovation system is strong.

Innovation is the process of transforming knowledge into new products, processes and services which, in turn, generates new economic benefits. For this process to succeed, a complete system must be available that supports the movement of a new idea from the initial concept through to research and development to commercialization of a ready-for market product. A highly developed innovation system is focused on a specific area of strength and includes:

- Universities, research facilities, industry, government labs, and other knowledge infrastructure that develop new technologies and a skilled workforce;
- Early-stage venture capital financing to help bring technologies to markets;
- Industry associations and other organizations that link the players in the innovation system;
- Firms capable of developing, adopting and marketing new technologies, and that are connected to local and global markets; and
- A business environment that fosters innovation[3].

Under its innovation component, WD makes strategic investments in six sub-activity areas:

- **Technology Adoption and Commercialization** to lead to an increase in the number of technologies developed in research institutions that have commercialization potential, and an increase in technologies adopted by existing firms. Examples of investments include technology demonstration projects, benchmarking products, and projects that focus on commercialization of technologies.

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2 Western Economic Diversification Act, 1988.
3 Western Economic Diversification Canada, Report on Plans and Priorities 2008–2009.

- **Knowledge Infrastructure** to increase the physical assets and capacity supporting the innovation system. Examples of investments include development or expansion of infrastructure such as buildings and equipment dedicated to R&D or training as well as facility feasibility or planning studies.

- **Technology Linkages** to increase connections and synergies among innovation system members. Examples of investments include support for networks, industry associations and other knowledge sharing/networking initiatives or events, and initiatives that build linkages between researchers and investors.

- **Technology Research and Development** to lead to development of technologies with commercial potential. Examples of investments include applied research and development projects leading to a new product or process with near or mid-term commercial potential.

- **Community Innovation** to lead to increased technological capacity in a community. Examples of investments include planning, cluster or competitive studies used by the community for economic development.

- **Technology Skills Development** to lead to an increase in training, education and skills building to increase the number of Highly Qualified People (HQP) and to ensure that the HQP are retained. Examples of investments include projects that support training, education and skill building in new economy sectors.

WD works with stakeholders including the not-for-profit sector, academic institutions, industry associations and other levels of government to strengthen the Western Canadian innovation system through both regional and pan-western initiatives.

B. PURPOSE OF THE IMPACT ASSESSMENT

The purpose of this project is to conduct an impact assessment of the Technology Adoption and Commercialization and Knowledge Infrastructure sub-activities of the Innovation Component of the Western Diversification Program (WDP). The impact study is to validate the results data available through WD's web-based project assessment and tracking system, Project Gateway, and to add to that data by examining complementary evidence available from other sources with the objective of assessing outputs and outcomes of individual investments, sub-groups of related investments (such as in a cluster or sector or within an organization), and all investments as a group.

The scope of the impact assessment covers a representative sample of 129 approved projects from the period from April 1, 2002 to March 31, 2007. The table on the following page shows the number and value of approved WD projects from 2002/03 to 2006/07 broken down by sub-activity. The sample of 129 projects covered by this study was chosen from these projects. In selecting the projects, those funded under certain sub-programs (e.g. First Jobs in Science and Technology, Canada Foundation for Innovation Support, IRAP, Conference Support, or Export Readiness) were excluded as were projects for which less than 70% of the approved funds had been paid out to date, those with under $100,000 in funding approved (except in some cases to improve regional representation), and those involving feasibility studies or proposal development.

SUB-PROGRAM BREAKDOWN OF APPROVED WD PROJECTS (02/03-06/07) UNDER SUB-ACTIVITIES OF INTEREST

	Number of Projects Approved	Total Project Funding	WD Funding
Sub-activities			
Technology Adoption & Commercialization	467	$256,369,560	$91,961,138
Knowledge Infrastructure	120	$237,554,004	$58,976,595
Total	***587***	***$493,923,564***	***$150,937,733***
Sub-programs			
First Jobs in Science and Technology	370	$18,104,492	$8,545,017
Canada Foundation for Innovation Support	59	$2,063,222	$1,650,592
IRAP	4	$24,000,000	$12,000,000
Conference Support	5	$1,080,600	$62,000
Projects removed from consideration	*438*	*$45,248,314*	*$22,257,609*
Western Diversification Program (includes projects completed through the Innovation and Community Investment Program, the Winnipeg Partnership Agreement, and the Western Economic Partnership Agreement)	*149*	*$448,675,564*	$128,680,124
Total	***587***	***$493,923,564***	***$150,937,733***

Based on the information outlined in the Request for Proposal as well as input provided by the Advisory Committee, we developed a series of research questions which are grouped under three issues including:

- Profile of the Projects;
- Project Outcomes; and
- Broader Impacts.

A list of the specific research questions is provided in the following table.

RECOMMENDED ASSESSMENT ISSUES AND RESEARCH QUESTIONS

Profile of the Projects	▪ What are the characteristics of the projects which have received funding under these two sub-activities?
Project Outcomes	▪ What outcomes have been generated by these projects, particularly in terms of technology commercialization and adoption and enhancing knowledge infrastructure and capacity in Western Canada? ▪ How do the aggregate outcomes of these projects vary by province? ▪ To what extent can these outcomes be attributed to the investment and other assistance provided by WD?
Broader Impacts	▪ In what manner and to what extent have the WD investments contributed to the development of strengthened innovation system in Western Canada?

C. METHOD OF THE STUDY

The study was undertaken in three phases. The purpose of the first phase was to develop a detailed work plan which was then implemented in the second and third phase of the study. The specific steps undertaken in each phase are outlined below.

Phase I: Preparation of the Detailed Work Plan

The specific steps that we undertook to prepare the detailed work plan are as follows:

- Conducted an initial meeting with the WD Advisory Committee consisting of WD representatives to clarify the scope of the study and the specific outputs desired;

- Reviewed the available documentation regarding the Technology Adoption and Commercialization and Knowledge Infrastructure projects funded by the Innovation component of the Western Diversification Program from April 1, 2002 to March 31, 2007. A partial listing of the documents we reviewed includes:

  - Evaluation of the WDP by the Audit, Evaluation & Disclosure Branch, October 2008;
  - WD: A Catalyst for Innovation in Western Canada;
  - Impact Study of WD's Investments in Western Canada's Life Sciences Sector;
  - WD Program Activity Architecture & Results-Based Management Accountability Framework;
  - WD Performance Reports and Reports on Plans and Priorities; and
  - Project Documents: Attachment A Statement of Work, Res Reports, Progress Reports.

- Developed a "logic" model and prepared a profile of WD's support for the two sub-activities of the Innovation component of the WDP;

- Developed the specific research questions which were addressed in the impact assessment;

- Defined the performance indicators and data sources that will be used in addressing each issue;

- Developed a series of questionnaires to be used in the evaluation; and

- Prepared the Detailed Work Plan.

Phase II: Field Research

The specific steps taken to complete the impact assessment included:

- Encouraged WD to distribute an introductory letter to project proponents.

- Conducted telephone interviews with 105 proponents associated with 122 of the targeted projects[4]. An introductory letter was first sent to the proponents by WD. Each interview took from 25 minutes to one hour to complete. The purposes of these interviews were to:

  - Determine the perceived success of the project;

  - Confirm the output and impact data contained in the project files;

  - Collect data on the standard performance indicators, where relevant and not already

4 Of the sample of 129 projects covered by this study, four were not contacted as advised by WD, two projects had no contact remaining, and one project never proceeded. The 105 interviews cover the 122 remaining projects. For one of the projects with no remaining contact, the project had proceeded as per its objectives and concluded. A proponent for a related project summarized the outcomes for the project.

available;

- Identify related developments and associated impacts and effects occurring subsequent to completion of the project;
- Identify any significant unintended or unanticipated impacts;
- Obtain input on the extent to which the impacts and effects can be attributed to the support provided by WD;
- Determine the perceived contribution of the assistance provided by WD to the development of a strengthened innovation system in Western Canada; and
- Obtain referrals to other stakeholders who have used the results of the project or are otherwise familiar with the project and can be approached to confirm the impacts reported.

A copy of the draft interview guide for these interviews is provided in Appendix-I: Research Instruments.

- Conducted 4 case studies each involving a series of related projects (12 projects in total). One case study was completed in each of the four provinces. In selecting the case studies, we considered the reported impacts, the value of making a site visit, whether case studies had been completed in the past, and the presence of related projects which will effectively illustrate the impact of WD's assistance. Each case study covered a group of related investments, with the objective of confirming the outputs and outcomes which have been reported and contribution to the innovation system. For each case study, we reviewed the data obtained from the project files; conducted a site visit to determine first-hand what has been accomplished by the project; conducted further interviews with project proponents; and interviewed a sample of other stakeholders, including users, familiar with the outputs or outcomes of the projects.

- Conducted a further review of approximately 45 projects (these included the case study projects). These included projects for which a significant impact was reported but were not selected as part of a case study. The primary purpose of the further review was to assess the validity of the data obtained from the proponents and/or reported in the files. Interviews were conducted with a sample of 50 users and other stakeholders to follow-up on the results of projects selected for further review. A tabulation of the representatives contacted by province is provided in Appendix-II. The purpose of these interviews was to:

  - Confirm the output, outcome and impact data contained in the project files and/or provided by the proponent, specifically as it relates to the stakeholders or user;
  - Obtain an outside opinion on the importance and success of the project;
  - Obtain input on the contribution of the project to a strengthened innovation system in Western Canada (including the development of specific clusters if any); and
  - Obtain referrals to other users or stakeholders who may be able to provide input.

Phase III: Data Analysis

The analysis of the two target sub-activities – Technology Adoption and Commercialization and Knowledge Infrastructure is based on the sample of 129 projects that comprise the scope of this study. From this point onward, it will be understood that all conclusions referring to the target sub-activities refer to the sample of 129 on which this project is based.

The final phase of the research included tabulating, analyzing and comparing the impacts generated by the projects by sub-activity and by province. The quantitative and qualitative data collected through the interviews were tabulated and analyzed to address the key study issues. The logic model developed in Phase I of the study provided the basis for the data analysis. The immediate project outcomes were summarized based on the performance indicators specified for each project. The primary performance indicators are those specified under WD's Program Activity Architecture (PAA) for each of the two sub-activities, Technology Adoption and Commercialization and Knowledge Infrastructure. These are known as the PAA indicators. The reported performance on PAA indicators were first summarized based on the date available in the progress reports provided by WD for each projects. The intermediate sub-activity outcomes were summarized by updating these results with the data collected through the interviews. Performance on unique indicators was reviewed through the interview. However, it was not possible to summarize unique indicators as they were specific to the project, not comparable, and usually defined in various units of measurement even when they related to the same objective. For example, indicators relating to the objective of training may have been defined as: number of training courses over a specified time period; number of people attending training courses; number of students in a program; number of workshops held; number of hours of training provided; the number of users (either people or organizations) using a facility; number of hours the equipment was used; revenues from training; etc.

Qualitative data on accomplishment of project objectives, project impacts, cluster development, the role of WD were analyzed using typologies. Based on a review of the data, categories or themes were identified, e.g., types of notable impacts, and then these types of impacts were summarized across the sample of projects. Perceptual data on the project success, contribution to cluster development and a few other variables were collected via a five point Likert scale where respondents indicated their level of agreement with a particular statement.

Data collected through interviews with users and stakeholders were reviewed to see if they generally corroborated with the project outcomes as described by the proponents. Higher level outcomes have been described based on perceptual data and enumeration of new technological developments and commercialization.

The role of the projects in strengthening the innovation system in Western Canada by was assessed by:

- Reviewing the results of the case studies and the interviews with proponents;
- Reviewing the results of the interviews with stakeholders including users;
- Reviewing the available documentation regarding the Technology Adoption and Commercialization and Knowledge Infrastructure projects funded by the Innovation component of the Western Diversification Program from April 1, 2002 to March 31, 2007; and
- Mapping the projects supported under the two sub-activities within the innovation support system based on the prior review of the available secondary data on the characteristics on the innovation system; and the characteristics of the innovation support system in Western Canada.

D. VALIDITY AND LIMITATIONS OF THE STUDY

Key factors that contribute to the validity of this research include:

- Extensive input was obtained from representatives associated with almost all of the projects. A project proponent was interviewed from all 122 projects (out of the 129) for which a contact was available. For 3 projects, 3 further interviews were conducted with a second proponent as the initial contact proponent specified was not the person most familiar with the project.

- Most representatives were directly involved and very familiar with the projects. The majority of proponents interviewed were familiar or very familiar with the projects; the average rating was 4.4 on a scale of 1 to 5, where 1 is not at all familiar, 3 is somewhat familiar and 5 is very familiar.

- The sample of projects covered in this study is representative of all approved projects as it includes all projects except those for which less than 70% of approved funds have been paid out to date, projects under $100,000 (except in some cases to improve regional representation), projects for feasibility studies or proposal development, and those funded under certain sub-programs.

While the representativeness of the sample and the high response rate combined with the high level of familiarity of proponents with the projects enhance the validity of this study, there are some limitations associated with the study as described below:

- Wide variation in the use of PAA Indicators as Performance Indicators: The performance indicators were the primary data source to measure project outcomes. A more formal set of PAA indicators was introduced by WD only in the last two years of the five year period covered by this study, from April 1, 2005 to March 30, 2007. Therefore projects in the first three years of the study did not use PAA indicators intensively. Even when they were used, they were not necessarily defined in a standardized way. Often, a PAA indicator might be defined as unique indicator, with a slight variation in definition or unit of measurement.

- Incomplete data on indicators: For some projects, reporting was not complete on indicators, because the reports were not filed, there was turnover in project staff, or the projects were still in progress. As a result of a few large projects in the last year covered by this study (2006-2007) almost 44% of WD project outputs (i.e. dollars disbursed) related to projects still in progress; therefore the proponents are not yet obliged to report final outcomes on performance indicators. Even when the project was finished, complete data on indicators was not always available. For example, while some indicators relied on data being collected from other entities (e.g. corporate clients within an incubator), no mechanism may have been established or agreed upon for collecting this data.

- Variability in definition of performance indicators: Quite often there was ambiguity in the definition of an indicator; proponents were sometimes unsure what exactly an indicator meant. Ambiguity in definition of indicators or reliance on indicators that are not commonly understood outside of WD inhibits the reporting of longer-term impacts and outcomes. This limitation cannot be emphasized enough. Proponents were able to report on standardized indicators such as patents, licenses or spinoff companies even if these indicators had not necessarily been established for the project as they are commonly understood. However for an indicator such as “technologies adopted”, even the proponents for whose projects the indicator had been established had difficulties in quantitatively measuring this during the project and subsequent to its completion. Proponents for whose projects this indicator had not been established could report only report anecdotally on this indicator. Another example is “technologies to market”. A new product on the market could incorporate many different technologies, and new technologies can be incorporated as incremental improvement to an existing product.

- Project Diversity: The sample of approved projects is extremely diverse in nature, ranging from feasibility studies under $80,000 to $15,000,000 towards the construction of an incubation facility. Given that projects vary so widely in their intended outcomes, it was challenging to construct a standardized template for evaluation of impact and to summarize the results in a meaningful way. Some projects had over 15 performance indicators while others had just one or two.

- Time frame for evaluation: One of the primary limitations of this study relates to the short time frame for evaluation of impact, particularly in the area of technology commercialization. Many proponents emphasized that technology commercialization is a long term process, which is somewhat spontaneous and unpredictable in nature. For example, it can take up to five years for a patent to be issued. In life sciences, it can take several years to conduct the clinical trials needed for regulatory approval of a drug. Thus it is particularly challenging to summarize the technology commercialization impact of projects which were approved in the latter half of the period covered by this study. Approximately 40% of WD investments in the sample projects occurred in the last two years (from 2005 to 2007).

E. STRUCTURE OF THE REPORT

The report is divided into five chapters. Chapters II and III provide an overview of the two target sub-activities of the Innovation Component of the WDP - Technology Adoption and Commercialization and Knowledge Infrastructure - in terms of the project outputs, characteristics of projects supported, the outcomes and impacts of the projects, importance of the support provided by WD, and a summary of the results by province for each sub-activity. Chapter IV provides an overview of the innovation system and outlines the impact of the projects on it. Projects selected for case studies are described in further detail and the impact of projects on the development of clusters is presented. Chapter V summarizes the impact on the projects by sector and summarizes the major findings and conclusions of the study.

II. THE TECHNOLOGY ADOPTION AND COMMERCIALIZATION SUB-ACTIVITY

This chapter first presents a profile of the Technology Adoption and Commercialization sub-activities in terms of the characteristics of projects supported. We then provide an overview of project outcomes, the role of WD in supporting the projects, and a summary of the results by province.

A. OVERVIEW OF THE SUB-ACTIVITY

1. Objectives

The Technology Adoption and Commercialization sub-activity provides support to increase the commercialization and adoption of technologies, products, processes and services in the marketplace. Over time, by generating an increase in the number of technologies developed in research institutions that have commercialization potential as well as an increase in technologies adopted by existing firms, it is anticipated that the sub-activity will help to diversify the economy of Western Canada, improve productivity, and increase competitiveness.

2. Total Funding Provided – Number and Value of Projects

A summary of the number and value of projects approved under the Technology Adoption and Commercialization sub-activity by fiscal years is provided in the table on the following page. As indicated, 75 projects were selected for potential review totaling nearly $73 million in funding. The number and value of projects approved by region can vary widely from year to year.

PROJECT NUMBER AND VALUE BY TYPE OF INSTITUTION APPROVED UNDER THE TECHNOLOGY ADOPTION AND COMMERCIALIZATION SUB-ACTIVITY, 2002-03 TO 2006-07

Type of Organization	Number of Projects	WD Funding	Total Project Cost
Economic Development Organization	2	$2,730,699	$11,032,019
Educational Institution	31	$38,342,812	$123,413,836
Hospital	1	$999,670	$1,332,229
Industry Association	9	$2,235,468	$8,286,130
Non-profit	11	$5,815,411	$11,580,417
Provincial Government	2	$5,490,000	$7,381,002
Provincial Health Authority	5	$3,668,133	$6,435,863
Public Private Partnership	5	$5,646,958	$21,348,687
R&D Consortium - Government	2	$1,481,781	$3,171,781
R&D Consortium - University	6	$5,958,273	$13,482,407
R&D Consortium University Hospital	1	$500,000	$2,130,500
Total	**75**	$**72,869,205**	$**209,594,871**

Educational institutions were the proponent for over one-half of the value of projects approved.

We conducted an analysis of the types of project approved based on the project approval documents and our interviews, which is summarized below.

TYPES OF PROJECTS APPROVED UNDER THE TECHNOLOGY ADOPTION AND COMMERCIALIZATION SUB-ACTIVITY, 2002-03 TO 2006-07

Type of Project	Number of Projects	Percent of Projects	WD Investment in Projects	Percent of Investment
Asset Purchase-Technology Commercialization Capacity	32	43%	$50,934,025	70%
Asset Purchase-Technology Demonstration	4	5%	$3,618,177	5%
Asset Purchase-Education & Training and/or Outreach	3	4%	$2,192,813	3%
Asset Purchase-Improve Research Capacity	2	3%	$1,350,000	2%
Technology Commercialization-New Product Development or Demonstration	26	35%	$12,047,000	17%
Improve Research Capacity	2	3%	$699,948	1%
Education & Training and/or Outreach	4	5%	$1,877,983	3%
Benchmarking and Evaluation	2	3%	$149,259	0%
Total	**75**	**100%**	**$72,869,205**	**100%**

The projects relate to a range of economic sectors with IT and life sciences being those most commonly identified.

SUMMARY OF PROJECTS BY SECTOR/CLUSTER AND ACTIVITY UNDER THE TECHNOLOGY ADOPTION AND COMMERCIALIZATION SUB-ACTIVITY, 2002-03 TO 2006-07

Sector/Cluster	Number of Projects	Percent of Projects	Value WD Investment	Percent of Investment	Total Project Cost
Information Technology	13	18%	$16,698,370	23%	$31,370,108
Life Sciences	26	34%	$18,457,404	25%	$46,282,234
Multi-sector	22	30%	$23,889,357	33%	$92,737,186
Other	14	19%	$13,824,074	19%	$39,205,343
Total	**75**	**100%**	**$72,869,205**	**100%**	**$209,594,871**

A summary of the distribution of these projects by fiscal year and province is provided in the table on the following page.

DISTRIBUTION BY PROVINCE AND YEAR OF INVESTMENT: PROJECTS* APPROVED FOR WD INVESTMENT UNDER THE TECHNOLOGY ADOPTION AND COMMERCIALIZATION SUB-ACTIVITY, 2002-03 TO 2006-07

Approval Year	FY 02/03		FY 03/04		FY 04/05		FY 05/06		FY 06/07		All Years	
Region	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects
AB	15	$16,184,208	5	$6,308,120	7	$10,676,417	2	$768,177	4	$17,569,482	33	$51,506,404
BC	-	-	5	$2,688,133	5	$1,201,987	13	$3,137,517	1	$996,300	24	$8,023,937
MB	2	$2,324,800	4	$1,049,259	3	$2,311,870	2	$4,501,037	-	-	11	$10,186,966
SK	1	$148,372	1	$68,727	2	$109,518	-	-	3	$2,825,281	7	$3,151,898
Total	**18**	**$18,657,380**	**15**	**$10,114,239**	**17**	**$14,299,792**	**17**	$**8,406,731**	**8**	$**21,391,063**	**75**	$**72,869,205**

* Sample projects selected for assessment

Forty-nine organizations were approved for funding under the Technology Adoption & Commercialization sub-activity, with the number of projects per proponent ranging from 1 to 9 (the University of Alberta).

LIST OF ORGANIZATIONS RECEIVING FUNDING UNDER THE TECHNOLOGY ADOPTION AND COMMERCIALIZATION SUB-ACTIVITY, 2002-03 TO 2006-07

Client Name	Organization Type	Region	Number of Projects	WD Funding	Total Funding	
Alberta Advanced Education and Technology	Provincial Government	AB	1	$990,000	$2,130,000	
Alberta Association of Colleges & Technical Institutes	Industry Association	AB	1	$249,948	$570,000	
Alberta Cancer Board	Provincial Health Authority	AB	1	$1,500,000	$1,751,851	
Alberta Health And Wellness	Provincial Government	AB	1	$4,500,000	$5,251,002	
Alberta Terrestrial Imaging Corp.	Public Private Partnership	AB	1	$933,000	$2,120,000	
Calgary Technologies Inc.	Non-profit	AB	3	$1,183,912	$4,010,350	
Canadian Environmental Technology Advancement Corporation - West	Industry Association	AB	1	$421,000	$1,517,177	
Caritas Health Group	Hospital	AB	1	$999,670	$1,332,229	
Edmonton Economic Development Corporation	Economic Development Organization	AB	1	$2,500,000	$10,492,600	
Forintek Canada Corp.	R&D Consortium Industry	AB	1	$1,879,313	$4,433,625	
Northern Alberta Institute of Technology	Educational Institution	AB	1	$950,000	$3,022,763	
Peace Region Economic Development Alliance	Economic Development Organization	AB	1	$230,699	$539,419	
PTAC Petroleum Technology Alliance Canada	R&D Consortium Industry	AB	1	$708,978	$1,772,446	
The Banff Centre for Continuing Education	Educational Institution	AB	1	$356,904	$488,910	
The Governors of the University of Alberta	Educational Institution	AB	9	$28,332,415	$104,046,541	
The Governors of the University of Calgary (Including UTI)	Educational Institution	AB	4	$2,360,200	$4,783,530	
TRLabs	R&D Consortium Industry	AB	3	$3,236,482	$6,981,336	
University of Lethbridge	Educational Institution	AB	1	$173,883	$544,970	
BC Cancer Agency (Including BC Cancer Foundation)	Provincial Health Authority	BC	3	$1,778,133	$4,244,012	

Client Name	Organization Type	Region	Number of Projects	WD Funding	Total Funding	
British Columbia Institute of Technology	Educational Institution	BC	3	$1,622,503	$2,517,459	
British Columbia Sustainable Energy Association	Industry Association	BC	1	$42,702	$210,652	
Ecosmart Foundation Inc.	Public Private Partnership	BC	2	$403,551	$859,951	
Emily Carr University of Art And Design	Educational Institution	BC	1	$90,596	$188,096	
Fraser Basin Council Society	Non-profit	BC	1	$150,000	$300,000	
Genome British Columbia	R&D Consortium Government	BC	1	$990,000	$1,100,000	
Neil Squire Society	Non-profit	BC	2	$681,101	$1,444,900	
Okanagan Research & Innovation Centre	Non-profit	BC	1	$151,671	$473,671	
Plant Biotechnologies Association	Industry Association	BC	1	$220,000	$1,120,000	
Simon Fraser University	Educational Institution	BC	1	$247,000	$494,000	
Stem Cell Network	R&D Consortium University Hospital	BC	1	$500,000	$2,130,500	
University of British Columbia	Educational Institution	BC	2	$591,080	$2,078,580	
University of Northern British Columbia	Educational Institution	BC	1	$112,500	$150,000	
University of Victoria Innovation And Development Corporation	Educational Institution	BC	2	$373,100	$1,599,100	
BC Functional Food & Nutraceutical Network	Industry Association	BC	1	$70,000	$140,000	
Biomedical Commercialization Canada Inc.	Non-profit	MB	1	$1,190,000	$1,325,269	
Canadian International Grains Institute	Industry Association	MB	1	$199,800	$326,600	
Canadian Manufacturers & Exporters	Industry Association	MB	1	$922,500	$4,034,735	
Composites Innovation Centre Manitoba Inc.	Public Private Partnership	MB	2	$4,310,407	$18,368,736	
Red River College	Educational Institution	MB	2	$2,305,000	$2,500,000	
Smart Winnipeg	Non-profit	MB	1	$190,000	$560,000	
St. Boniface General Hospital Research Center	Provincial Health Authority	MB	1	$390,000	$440,000	
University of Manitoba	Educational Institution	MB	2	$679,259	$826,515	

Client Name	Organization Type	Region	Number of Projects	WD Funding	Total Funding	
Canada - Ukraine Technologies Centre Inc.	Non-profit	SK	1	$68,727	$81,227	
Canadian Western Agribition Association	Industry Association	SK	1	$67,027	$74,475	
Forintek Canada Corp.	R&D Consortium Industry	SK	1	$133,500	$295,000	
Saskatchewan Ethanol Development Council Inc.	Industry Association	SK	1	$42,491	$292,491	
Saskatchewan Forest Centre	R&D Consortium Government	SK	1	$491,781	$2,071,781	
Springboard West Innovations Inc.	Non-profit	SK	1	$2,200,000	$3,385,000	
University of Regina	Educational Institution	SK	1	$148,372	$173,372	
Total			**75**	**$72,869,205**	**$209,594,871**	**N/A**

B. THE PROGRAM LOGIC MODEL

A program model illustrating the interrelationships between the outputs, and intended impacts is provided on the following page.

WD provides financial and other assistance towards the development of projects under the sub-activities. While the financial assistance is often the most visible type of support provided by WD, the role of WD staff in bringing together groups, formulating partnerships, nurturing champions, and assisting in the design of projects and initiatives can also be an important contribution that WD makes in promoting innovation. With respect to financial support, in some cases, WD serves as the primary source of funding for a given project. In other cases, the funding from WD acts as a catalyst to attract other funding or tops up funding from other sources to ensure that the project proceeds in timely fashion and at an appropriate scale. In some other cases, WD may fund the early-stage development of a given project which will then attract significant funding from other sources for the implementation of future stages.

Examples of common outputs from these projects include levered investment in projects, jobs created by projects, project reports, technology demonstrations, prototype development, strengthened linkages between project partners, and development of physical assets (hardware, software, buildings, and equipment) for commercialization activity (such as incubation), R&D, and training. For example, projects funded through these sub-activities are able to increase their user base, offer more courses, train additional skilled workers, support an increased number of collaborations, etc. In the short-term, these outputs can lead to further investment, use of expanded research capabilities and capacity, identification/promotion of promising new technologies and processes, adoption and commercialization of new technologies, strengthened linkages and coordination in activities between participants in the innovation system, and ongoing employment. Over the medium-term, it is intended that the activities will increase technology development, adoption and commercialization. In turn, over the longer-term, the sub-activities will contribute to further development and diversification of the Western Canadian economy.

PROGRAM LOGIC MODEL FOR THE TECHNOLOGY ADOPTION & COMMERCIALIZATION SUB-ACTIVITY: MEASURING THE IMPACT OF INNOVATION FUNDING

Element	Technology Adoption & Commercialization (TAC)	
Definition and Activities	▪ Provide financial support for projects and initiatives that support technology adoption and commercialization ▪ TAC projects aim to support the commercialization and adoption of technologies, products, processes and services in the marketplace ▪ TAC projects target organizations that generate knowledge and inventions on the commercialization pathway and facilitate technology adoption ▪ Work directly with other organizations to encourage and facilitate the development of projects and initiatives	
Outputs	▪ Number and Value of Projects Funded under the Technology Adoption & Commercialization Sub-Activity	
Immediate Outcomes	**Definition**	**To what extent did each project approved for funding produce its project outcomes as described in the "Attachment A, Statement of Work" for each project?**
	Measured By: Performance Indicators during the reporting period on a Project by Project Basis	▪ # of patents filed/issued ▪ # of technology demonstrations ▪ # of technologies adopted ▪ # of technologies to market ▪ # of spinoff companies formed ▪ # of licences executed ▪ # of prototypes developed ▪ $ in venture capital invested and levered investment in projects ▪ Unique indicators: market development, jobs created, increased reports, projects, studies, strengthened linkages between project partners, identification/promotion of promising new technologies and processes etc.
Intermediate Outcomes	**Definition**	**To what extent did the Technology Adoption & Commercialization sub-activity achieve its objectives?**
	Measured By: Aggregated Performance Indicators beyond the reporting period	▪ # of patents filed/issued ▪ # of technology demonstrations ▪ # of technologies adopted ▪ # of licences executed ▪ # of prototypes developed ▪ # of technologies to market ▪ # of spinoff companies formed ▪ $ in venture capital invested and levered investment in projects ▪ Unique indicators: in certain situations only
Intermediate Innovation Activity Outcomes	**Definition**	**To what degree have WD investments in the Technology Adoption & Commercialization sub-activity increased the level of knowledge-driven and value-added economic activity in Western Canada?**
	Measured by results from WD approved projects as well as perceptions and provincial indicators (where appropriate)	▪ Improved infrastructure for R&D, new product/process development and education and training ▪ Expenditures on R&D ▪ R&D personnel ▪ Growth of the intellectual property base: patents, trademarks, trade secrets ▪ New technology clusters are created and existing ones are strengthened ▪ Increased capacity, awareness and use of new technology ▪ Increased cooperation and collaboration among players in the innovation system
Final Entrepreneurship and Innovation Strategic Outcomes	**Definition**	**What is the impact on the western Canadian innovation system of WD investments under the Technology Adoption & Commercialization sub-activity?**
	Measured by results data from WD investments, key informant perceptions, surveys, case studies, literature and policy reviews, and results of projects and sub-activity level investments	▪ **Development and diversification of the Western Canadian economy** ▪ A strengthened innovation system in Western Canada ▪ Increased technology development, adoption and commercialization ▪ Further development of technology clusters

C. RELATIONSHIP OF INFORMANTS TO THE PROJECTS

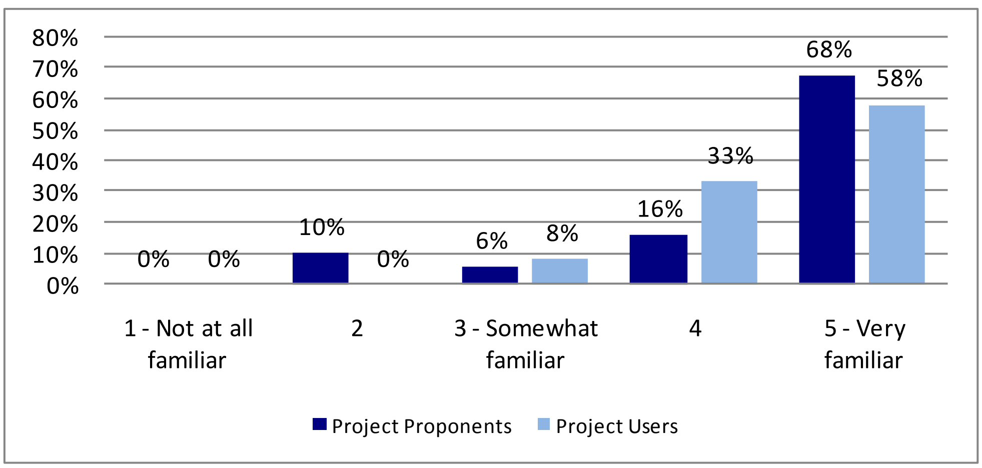
To further understand the relationship of the representatives interviewed to the projects, we asked them to rate how familiar they are with the projects and describe the roles they played in terms of the development, management, and delivery of the project. We also asked users of project outputs and other stakeholders to rate how familiar they are with the projects and explain the nature of their interaction with the projects. The results are summarized as follows.

- **Project proponents and users are generally very familiar with their project.**

  When asked to rate how familiar they are with their project on a scale of 1 to 5, where 1 is not at all familiar, 3 is somewhat and 5 is very familiar, the project proponents provided an average rating of 4.4. While most project proponents (84%) indicated that they are familiar or very familiar with the project, 6% indicated that they are somewhat familiar and 10% indicated that they are not that familiar with the project. In some cases the project lead was no longer with the organization or responsibilities had been divided amongst different people.

  Similarly, when asked to rate how familiar they are with the project(s) and/or its output(s) on a scale of 1 to 5, where 1 is not at all familiar, 3 is somewhat and 5 is very familiar, the users and stakeholders provided an average rating of 4.5. Ninety percent of the users and stakeholders indicated that they are familiar or very familiar with the project and/or its output(s), and the rest (10%) indicated that they are somewhat familiar.

LEVEL OF FAMILIARITY WITH TECHNOLOGY ADAPTATION AND COMMERCIALIZATION PROJECTS BY PROJECT PROPONENTS AND USERS AND STAKEHOLDERS



- **Project proponents played various roles in the development, management, and delivery of the project.**

  Projects proponents identified various roles that they played in the development, management, and delivery of the projects, as summarized in the following table. In some cases, their roles evolved as the projects moved into different development stages; for example, proponents might first become involved with the project to conduct background research or develop proposals and later on take on more responsibilities in managing and delivering the project.

Type of Role	Examples of Responsibilities	Examples of Positions
Development	▪ Write initial proposals or work plans ▪ Secure funding and manage budget ▪ Hire staff to run project ▪ Provide knowledge and experience for project team	(Executive or Scientific) Director, Proposal Writer, Chief Financial Officer, Dean, Vice President, Chief Executive Officer
Management	▪ Oversee project development, scheduling, delivery and organization at the top level ▪ Involve in day-to-day operations ▪ Report outcomes	Executive Director, Project Manager, Vice President Operations, Principal Investigator, Program Manager or Director, Manager
Delivery	▪ Help with site installation or facilities-preparing ▪ Teach students or train staff ▪ Background research	Scientific Leader, Technical Leader

- **The nature of interactions between the users and the projects varies widely.**

  The table below summarizes the ways in which users and stakeholders interacted with the projects. The highest proportion of users interviewed were tenants in incubator facilities. In addition to the interactions in the table, for a couple of the projects, users and stakeholders mentioned that they had also employed some skilled personnel through their interaction with a project. For two incubator facilities in particular, the facility at ORIC and the Eureka project at the Smartpark facility at the University of Manitoba, mentorship was mentioned as a significant intangible component of the interaction in addition to physical tenancy (specifically the opportunities provided for networking, fundraising, and personal contributions to business plans and strategy by the Directors of these two facilities).

Nature of Interaction	Number of Users	Number of Projects
Incubator Tenant	8	6
Recipient of technology transfer or commercialization partner	6	6
Fund research at the facility	5	3
Industrial User of Facility for product/process/parts development	3	1
Project Partner/Subscriber	2	2
Professional Development/ Mentorship/Learning	2	2
Cluster representative or tangential interest	2	2
Collaborative Research Partner	1	1
Total	29	23

D. IMPACTS OF THE PROJECTS

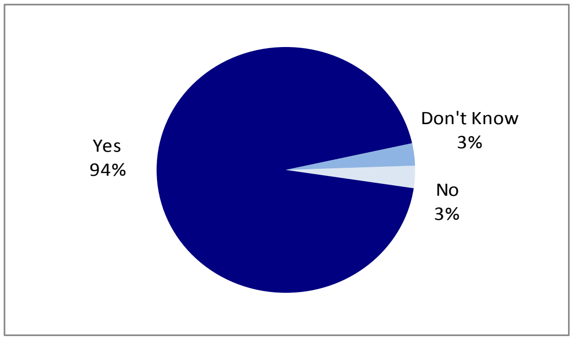
Project proponents and users and stakeholders were asked to rate various impacts generated by the projects in terms of project implementation, objective achievement, achievement of standard performance indicators and other impacts. The major findings arising from our interviews are summarized below.

1. Implementation and Achievement of Project Objectives

- **The Technology Adoption and Commercialization projects were implemented largely as planned.**

Most project proponents (94%) believe that their projects were implemented largely as planned. Only two of the proponents (3%) stated otherwise while two (3%) chose not to comment on the matter.

In your experience, was the project implemented largely as planned?



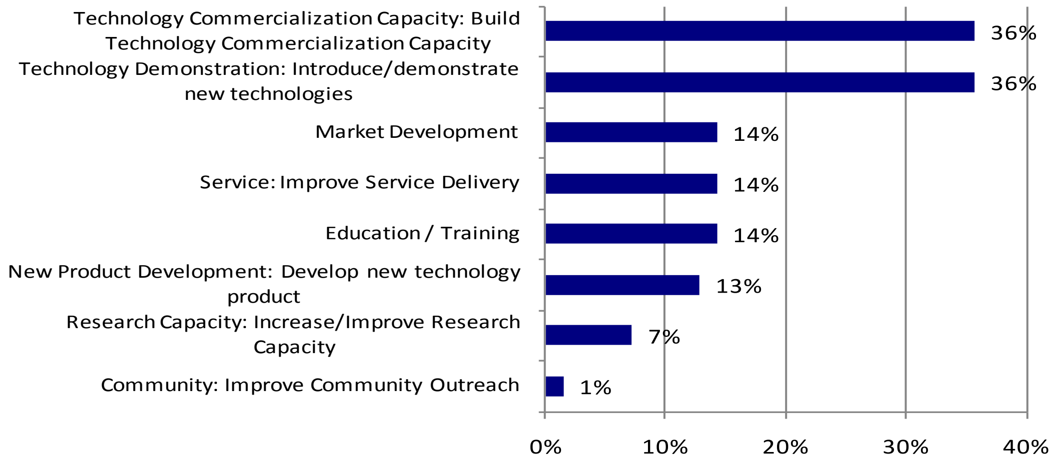
Some proponents who believed that the projects were mostly implemented as planned noted that even though there were some adjustments made as they were moving forward (e.g. broadened project scopes, refinements to the work plan, and project revisions), most adjustments created positive impacts and timing delays were not substantial.

Two proponents who responded that their projects were not implemented as planned were asked what major changes were made. In one situation, the project proponent noted that after project funding was approved, municipalities offered to fund their own participation in the project, thereby freeing up some funds for reallocation. This funding was then used to further encourage industry participation. The overall impact of this change was positive and enhanced the effectiveness of the project. The second proponent who indicated that the project was not implemented as planned stated there was a delay in preparing the facility to receive the equipment as it needed renovations. While there were delays in several other projects usually related to construction, renovation, or technical issues with equipment installation, most proponents did not consider such delays to be significant changes to project implementation plans.

- **Technology Adoption and Commercialization projects were designed to accomplish a wide range of objectives.**

Proponents were asked to specify the primary objectives of the project and what the project was designed to accomplish. A project may have had more than one primary objective so the totals add up to more than 100%. As indicated below, the two most common objectives were to build technology commercialization capacity and to introduce and demonstrate new technologies.

MAJOR OBJECTIVES OF TECHNOLOGY COMMERCIALIZATION AND ADOPTION PROJECTS AS SPECIFIED BY PROPONENTS



The first objective, "build technology commercialization capacity" refers here specifically to:

- the introduction of polices, processes and the hiring of personnel to provide guidance on technology commercialization activities such as patenting etc.; or
- the provision of physical space for new technology based companies.

Most projects in this category take the form of support for technology transfer offices or technology development offices and incubator facilities. These projects did not directly support the creation of intellectual property or new products or prototypes, but they facilitated the process of creating these, e.g. by hiring personnel to provide advice on patenting. Performance indicators for these projects often related to outcomes of technology commercialization activities, e.g. patenting, licensing, prototyping or spinoff formation activity. Projects that are incubation facilities were evaluated on performance indicators such as occupancy rates or activities by tenant companies relating to patenting, prototyping, product development, technology demonstrations, etc.

An example of a technology demonstration project that received a lot of publicity is a project at the University of Calgary where a research team of computer scientists, biologist, artists and mathematicians created the world's first complete object-oriented computer model of a human body. Known as the "CAVEman", a cube-shaped virtual reality room allows scientists to literally walk inside their experiments by translating medical and genomic data of the human body into four dimensional images.

- **The objectives of the users were moderately consistent with those of the overall project and usually depended on the nature of the interaction and how the outputs could contribute to the further development of their own organizations.**

  For example:

  - In a project where the stakeholder was tasked with development of the cluster, the objective was that the output of the project (a roadmap for commercialization of the functional foods and nutraceuticals cluster) would be used by the stakeholder's clients.
  - For stakeholders who funded research, the primary objective of their interaction was to

support the new discoveries or new product or prototype development. Xerox Corporation, which funds research at a WD supported nanotechnology incubation facility, stated that being able to fund research at that facility allowed their researchers to stay focused and proceed faster without being distracted by the daily pressures of Xerox's core business operations. Another research funder emphasized the value to them of being able to send their clients to the WD supported facility for sample testing at short notice, and to support value-added research that would ultimately enhance their clients' commercial success.

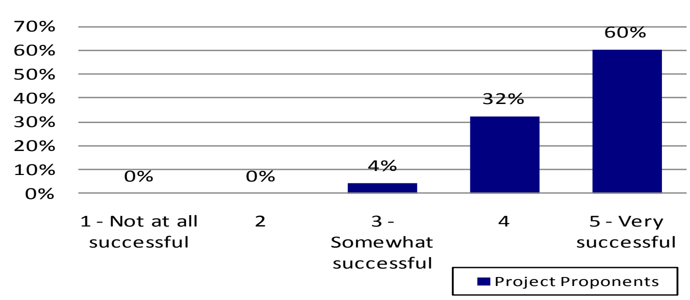
- Industrial users appreciated well-run facilities with a wide range of equipment available at reasonable cost to conduct prototype or product development activities.
- Tenants of incubator facilities stated that their primary objective was to have a functional and reasonably priced but well-equipped space to support the growth of their company. In some instances however, the tenants indicated that they were motivated to occupy the space in order to benefit from the mentorship, strategic business development advice and networking opportunities provided by the incubator.
- For a recipient of technology transfer, the objective was to receive project management and on-site technical support to facilitate the smooth transfer of technology.

Some stakeholders were quite specific about their objectives. For example, a physician, the end user of a software development project to develop an integrated pharmaceutical record for patients, stated that he needed to be able to see accurate and current pharmacological information on patients in order to provide them with the safest and highest quality healthcare. Similarly the project partner on another healthcare software project said that their ultimate aim was to use the project outputs for surgeon training, pre-surgery planning and patient education. In some instances, projects provided stakeholders with professional development or mentorship/learning opportunities, either for themselves or for their clients.

- **Technology Adoption and Commercialization projects have generally been successful in achieving their objectives.**

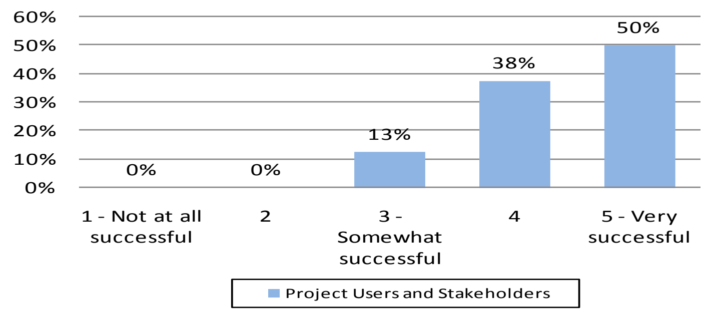
When asked to rate how successful the project has been in achieving the objectives on a scale of 1 to 5, where 1 is not at all successful, 3 is somewhat and 5 is very successful, the proponents provided an average rating of 4.6. All proponents who responded to the question believe that the projects have been at least somewhat successful in achieving their objectives; 60% indicated that the projects were very successful, 32% indicated that they were successful and 4% indicated that they were somewhat successful in achieving the objectives.

SUCCESS OF PROJECTS IN ACHIEVING OBJECTIVES AS RATED BY PROPONENTS



Similarly, the users and stakeholders were positive regarding how successful they had been in achieving their objectives through their interaction with the projects, providing an average rating of 4.3 on the same 1 to 5 scale. About 85% of the users and stakeholders indicated that they were successful or very successful in achieving their objectives and 15% indicated that they were somewhat successful.

SUCCESS OF USERS AND STAKEHOLDERS IN ACHIEVING PRIMARY OBJECTIVES



2. Achievement of Standard Performance Indicators

The expected result of WD's investments in Technology Adoption and Commercialization is accelerated technology commercialization and adoption. The eight standard performance indicators defined for this sub-activity in WD's Program Activity Architecture (PAA Indicators) are summarized in the table below. The table summarizes:

- The number of projects for which this was defined as indicator;
- The aggregate target for the indicator as established in the statement of work;
- Previously reported outcomes from Project Progress Reports, Res Reports and Final Outcome Summaries (Immediate Outcomes);
- Adjustment based on interviews generally referring to additional impacts that have occurred since the reporting period (Intermediate Outcomes); and
- The combined impact of previously reported outcomes and adjustments based on the interviews

As indicated, no more than 19 of 75 projects used any one indicator.

PAA INDICATORS IN TECHNOLOGY ADOPTION & COMMERCIALIZATION SUB-ACTIVITY

Indicator Name	Number of projects using as indicator	Target	Previously Reported Outcome	Adjustment Based on Interviews	Combined Impact
(WD42) Number of patents filed/issued (Baseline 26)	19	145	158	69	227
(WD45) Number of technology demonstrations	10	198	164	N/A	164
(WD49) Number of technologies adopted (Baseline 16)	4	39	29	23	52
(WD43) Number of licences executed (Baseline 168)	8	273	226	25	251
(WD44) Number of prototypes developed (Baseline 92)	15	217	266	77	343

Indicator Name	Number of projects using as indicator	Target	Previously Reported Outcome	Adjustment Based on Interviews	Combined Impact
(WD46) Number of technologies to market (Baseline 4)	5	131	32	5	37
(WD47) Number of spinoff companies formed (Baseline 1)	12	45	27	3	30
(WD48) Value in venture capital invested and levered investment in projects (Baseline $116,000)	2	$30,600,000	$6,000,000	$3,000,000	at least $9,000,000

Since April 1, 2005 at least one of these performance indicators has been utilized in project approval documents to gauge project performance. No more than 19 of 75 projects used more than any one indicator. Prior to that date, performance indicators were not standardized; therefore, results against those indicators cannot all necessarily be aggregated. A description of performance against each type of indicator is provided below.

- **Patents**

Of the 75 technology commercialization projects, 19 established patents as a performance indicator including:

- 8 projects used the indicator in its standardized form as a PAA indicator. These 8 projects had a target of 45 patents and a total outcome of 78 patents.
- 11 projects used a variation on patents as a unique indicator. These 11 had a target of 100 patents and an outcome of 134 patents.

Eight of the 19 projects did not meet their patent targets. One project has not yet reported its results.

In addition, 4 projects which had not established patents as an indicator reported 15 unexpected patents. In total, therefore, 23 projects reported 227 patents. The most significant contributor to this total is the BC Cancer Agency which reported 81 patent applications. WD provided support for the BC Cancer Agency's Technology Development Office, which manages the Agency's patenting activities. The project aimed to increase the activity of this office in evaluating, developing and patenting intellectual property through direct contact with researchers.

Some of the reporting challenges found to be associated with the use of the patents as an indicator include:

- This indicator does not distinguish between applications and patents issued and the numbers for each of these can be very different; for example, the BC Cancer Agency, which has made 89 applications since 2002, has been issued 6 patents to date.
- Many respondents mentioned other alternatives to protection as a route to commercialize intellectual property. For example one respondent mentioned moving towards trade secrets in biological sciences and added that sometimes the regulatory approval process provided longer exclusivity than patents. To be successful as an IP commercialization strategy, the timing of patent applications is critical. In a report relating to one project which conducted a national intellectual property review, it was revealed that what is being patented is very early with little subsequent data developed to make the patent stronger. The report included the quote, "we patent science in Canada, in the U.S. they patent technology."

- The cost of a patent application was found to be prohibitive for some smaller non-profit organizations which had intellectual property that could be patented but they did not have the resources or budgets for patent applications. While targets for patents filed/issued were set as performance indicators, there was not necessarily a strategy or budget established for the financial resources required for this intellectual property protection strategy.

- The trajectory of technology commercialization can often be unpredictable: in the course of one project the patent goal was abandoned as the patents would not be defendable.

- **Technology Demonstrations**

Of the 75 technology commercialization projects, 10 established technology demonstrations as a performance indicator including:

- 8 projects used the indicator in its standardized form as a PAA indicator. These 8 projects had a target of 184 technology demonstrations and a total outcome of 146 technology demonstrations.

- 2 projects used technology demonstrations as a unique indicator. These 2 had a target of 14 technology demonstrations and an outcome of 18 technology demonstrations.

Two of the 10 projects did not meet their targets. The outcomes were influenced by one project which had a target of 100 demonstrations (accounting for almost 50% of the target). During the course of the project Natural Resources Canada discontinued its rebate for solar hot water (a key component in meeting this indicator). The project was amended to reflect discontinuation of the rebate. Due to the early success of the project before the rebate was discontinued, the proponent subsequently received support of $6.6 million from Natural Resources Canada and the BC provincial government for a comprehensive program to provide incentives, training and facilitate the installation of solar hot water systems in BC communities. Solar BC now has fourteen installers registered with their program, it provides rebates and is successfully leading the demonstration and adoption of solar hot water in BC.

The primary reporting challenge associated with the technology demonstrations indicator is that many respondents had trouble interpreting this indicator. The definitions of "technology" and "demonstration" are open to a wide range of interpretation. This is probably one reason that no further outcomes were reported on this indicator. Definitions of this indicator varied widely from project to project: in one project it referred to the number of companies participating in an exhibit, while in another project it referred to assisting in implementation of technologies at plant level. Apart from a project which is still in progress and had installed and demonstrated one part of its equipment purchases; it was difficult for proponents to provide precise numbers of demonstrations. One proponent said they were ongoing as needed while for two projects it was stated that there had been "many more" or "more" than the reported number. Because of these difficulties we have not added to the figures defined initially by the projects.

- **Technologies Adopted**

Of the 75 technology commercialization projects, 4 established technologies adopted as a performance indicator:

- All four projects which established this indicator established it as a PAA indicator. These 4 projects had a target of 39 technologies adopted and an outcome of 52 technologies adopted.
- No projects established this as a unique indicator. Some projects did use performance indicators which reflected technology adoption as a general goal but those are not included here due to variability in definition and unit of measurement.

One project with a target of 10 did not report on this indicator as it was found to be too difficult to track; the other three projects exceeded their targets.

An example of a technology commercialization project that used indicators that could be interpreted as aimed at achieving the general goal of technology adoption is a Market Development project which set targets for the adoption of biodiesel. Indicators included the amount of biodiesel (in litres) used by municipal and other fleets. While this project and others like it were very successful in facilitating the uptake of new technologies, the indicators cannot be added together as the units are not in any standardized form. Two other examples both had as an objective the development and adoption of healthcare software. In one project; the effectiveness of the technology adoption was limited in impact because though most of the pharmacists adopted the software; uptake by physicians was slow. To be maximally effective in providing better patient care, the software needed to be adopted by both physicians and pharmacists. But for physicians, the barrier to the adoption was that the system was not integrated with a patient's provincial electronic medical record and it takes significant time for physicians to cut and paste information from one program to another. For such a project, the proponent indicated that the most important indicators of effectiveness of "technology adoption" were the # of prescriptions and # of allergic reactions (with the goal being to minimize the # of allergic reactions experienced).

As with the previous indicators, the reporting challenges associated with this indicator related to ambiguity in definition. Proponents found the indicator ambiguous since neither "technology" nor adoption" were defined. Only four projects used this indicator, of which 1 found it too difficult to track. As with the previous indicator, the definition is ambiguous. One Project reported that the indicator referred to 19 drug compounds that have been chosen for further development. In one Project which had the objective of increasing investment in value-added products for the forestry sector, the indicator referred to various research projects, e.g., the use of X-ray fluorescence to sort trees. In another, this indicator was said to refer to a licensing deal or prototype development.

- **Licences Executed**

Of the 75 technology commercialization projects, 8 established licenses as a performance indicator including:

- 3 projects used the indicator in its standardized form as a PAA indicator. These 3 projects had a target of 245 licenses executed and a total outcome of 216 licenses executed.
- 5 projects made mention of a licence agreement as part of a unique indicator. These 5 had a target of 28 licenses executed and an outcome of 35 licenses executed.

Four of the 8 projects did not meet their licensing targets. However, one of these projects is still the most significant contributor to licenses executed. Two projects accounted for 237 of the 251 licences executed. As mentioned earlier, WD supported the BC Cancer Agency's Technology Development Office which reported 28 licensing deals, well over the target of 8. The TEC Centre Incubation facility at the University of Alberta, which started with a baseline of 168 licences, and established a target of

240 licences executed, currently has a total of 209 licences (exclusive and non-exclusive licenses combined).

- **Prototypes Developed**

Of the 75 technology commercialization projects, 15 established prototypes as a performance indicator including:

  - 11 projects used the indicator in its standardized form as a PAA indicator. These 11 projects had a target of 76 prototypes and a total outcome of 63 prototypes.
  - 4 projects used a variation on prototypes as a unique indicator. These 4 had a target of 141 prototypes and an outcome of 280 prototypes.

Of 13 projects due to report on prototype targets, 6 did not meet their prototype targets. Two projects establishing prototypes as a PAA indicator with a combined target of 12 prototypes are still in progress and not yet obliged to report on final outcomes. For one of these, the prototyping outcomes will be contingent to a degree on the patent application process.

The most significant contributor to the prototype target is a project which, starting with a baseline of 82, a target of 120 and a reported outcome of 198, has since completed a total of 257 prototypes to date. The prototypes refer to clinical and research models for various types of surgery. In 3 projects, which did not meet their prototype targets, the reasons varied. Other Projects had fewer invention disclosures suitable for prototyping activity. A Project to commercialize Green Roof Technologies made a decision to sign contracts for use of its Roof Evaluation Module instead of developing prototypes. In another instance, the project is progressing towards the target and is likely to meet it eventually.

The primary reporting challenges associated with the use of this indicator is the wide variation in definition of "prototype". For example, in one project, a prototype refers to the application of rapid translation of digital images to physical models using three-dimensional prototyping technologies. These models are subsequently used to aid in surgeon training and patient education. For this project, it appears that the models or prototypes produced refer to the application of a unique process and it is not clear if they fit the “classic” prototype definition of a product which will eventually be sold as a product in the market. However, of the 12 prototypes developed under another project, 9 fit the "classic" definition while 3 refer to flavours of a beverage. For another, which was very successful in prototype development, prototypes referred to market-ready products (assistive devices).

- **Technologies to Market**

Of the 75 technology commercialization projects, 5 established technologies to market as a performance indicator including:

  - 3 projects used the indicator in its standardized form as a PAA indicator. These 3 projects had a target of 23 technologies to market and a total outcome of 10 technologies to market.
  - 2 projects used technologies to market as a unique indicator. These 2 projects had a target of 108 technologies to market and an outcome of 27 technologies to market.

Four of the 5 projects which established technologies to market as an indicator did not meet their market targets. One of these projects, with a target of 10 technologies to market was one of the four projects excluded from the field research and there is also no reported data on this target.

These outcomes have been influenced by one project which had a target of 100 technologies to market. The indicator referred to selling 100 units of the same product. After delivery of 10 units, due to changes in the operating system by the manufacturer, the product required a new driver leading to a delay. The final outcome is that the product has been licensed. The product in question is an assistive device. As it serves a limited commercial market, it has been challenging in the absence of regulation to find industry partners willing to invest resources in production and marketing. However the licensing outcome attests to the commercial viability of the product.

Another project defined technologies to market as a product in the market that "behaves like a real product" (i.e. with salespersons, sales targets, budgets, promotional materials) and is actively supported in the market with a range of sales and marketing functions. Of the 6 reported technologies to market, 2 are already in the market and 4 are being prepared for a summer of 2009 launch.

This indicator was not used for a project supporting an incubation program. However this project led to a follow-on project also supported by WD which is not part of the sample of approved projects covered in this report. This follow-on project supported a Go-To-Market program and at 9 months after the completion of the first session of the new program offered in 2007/08 with 7 entrepreneur participants, it had already recorded 6 new products launched, 2 new markets entered, and 2 products significantly re-positioned subsequent to the program completion.

The reporting challenge of this indicator also relate to the definition, and variation in usage: for one project the indicator was used to quantify many units of the same product; while for another it was used to quantify distinct products. Hence, there was a wide range in the target values: 100 for the former and 10 for the latter.

- **Spinoff Companies Formed**

Of the 75 technology commercialization projects, 12 established spinoff companies formed as a performance indicator including:

- 8 projects established spinoff companies formed as a PAA indicator. Seven of these projects had a target of 37 spinoff companies formed and a total outcome of 24 spinoff companies formed.. One project is not yet obliged to report on meeting its final target but reported that discussions are already underway for a potential spinoff.

- 4 projects established spinoff companies formed as a unique indicator. These 4 had a target of 8 spinoff companies formed and an outcome of 4 spinoff companies formed. One of these 4 projects is not yet obliged to report on its final targets as it is still in progress. One example of a project referring to spinoffs as a unique indicator which is not included here is as follows; "Academic projects generating licenses, spin-off companies, and/or industry contracts". Its target was not included since it does not refer exclusively to spinoffs and the proponent was not sure what it referred to since the facility was already used by industrial users who relied on it heavily.

Five of these 12 projects did not meet their spinoff formation targets. One of these was a project for whom no contact could be found and which had established a target of forming one spinoff company. Three projects with a combined target of 18 spinoff companies formed are not yet obliged to report final outcomes till March 2010.

In addition, 2 projects which had not established spinoff companies as an indicator each reported one spinoff company formed. In total, therefore, 14 projects reported 30 spinoff companies formed.

The use of this indicator in incubator facilities was found to be a little ambiguous. By definition, incubator facilities house new companies; the facilities themselves do not necessarily play a role in the spinoff process. For example, one incubator had a target and outcome of 3; due to staff turnover, the proponent who was not part of the original grant application could not provide an update and stated he was not sure what the indicator could refer to as it was before his time. The project continues to function successfully and effectively. An incubation facility at a university, with a target of 9 companies per year, had reported 4 in its first progress report in April 2008. The updated total provided as per the field research is 83. This refers to the incubator's clients or portfolio companies, which include the university's spin off companies and non-University technology companies in the region that were assisted. The large change in numbers suggests some inconsistency in definition and use of the indicator.

- **Venture Capital invested**

Of the 75 technology commercialization projects, 3 established venture capital invested as a performance indicator including:

- 2 projects established this indicator in its standardized form as a PAA indicator. These 2 projects had a target of $30.6 million in venture capital invested and a total outcome of at least $9 million in venture capital invested.

- 1 project established a unique indicator referring to venture capital invested: Total investment from outside sources in tenant companies including seed capital, venture capital, grants, equity investment of $0.5 to $1 million per company for between 5-10 companies. The reporting deadline for that project is too recent for the outcomes to be included in this report.

Of the 2 projects which did use this indicator, one with a target of $25 million had not reported on outcomes and was one of the four projects excluded from field research for this report (i.e. no interview was conducted with the project proponent). One with a reported outcome of $6 million exceeded its target of $5.6 million. More recently, in the past year, the amount of money raised by portfolio companies that have been assisted by Executives in Residence at one incubator was in excess of $3 million.

In addition, some proponents were able to report on capital invested or levered. For example:

- One project which assisted British Columbia's Simon Fraser University in expanding commercialization initiatives for the technology sector led to a follow-on project for a mentoring program (which is not part of the sample of 129 in this report). Early evidence suggests that synergy between the expansion of the Angel Network from the earlier project with the new mentorship program has been very successful. Fifty per cent of companies going through the Angel Network get funding. In the previous 2 years, 14 of 20 companies that went through the program were funded.

- Another project reported that it had levered $297,834 from industry for applied research projects to be conducted at the various colleges which form its membership. The proponent provided one-third of the funding and two-thirds was levered from industry, government and participating colleges.

The challenges of reporting on this indicator, or on other unique indicators based on calculating investment capital raised, particularly by incubator clients is that private companies are not obliged to provide this information and there are no formal mechanisms in place to collect it. Any reported figures are only available on an ad hoc basis, e.g., for one, the indicator is not specifically tracked but an excerpt from a February 2009 report prepared by an independent consultant to this project provides some figures for companies offered investment deals.

3. Other Indicators Used

Some TC projects established indicators similar to those used as PAA indicators in the Knowledge Infrastructure sub-activity as seen in the table below.

Other Indicators Established in Technology Adoption and Commercialization Sub-Activity

Indicator Name	# of Projects Using as Indicator	Target	Previously Reported Outcome	Adjustment Based on Interviews	Combined Impact
Physical Space: similar to (WD68) # of square metres dedicated to R&D and skills training	1	4366 Square metres	4366 square metres	13 projects reported an additional 175,065 square feet (16,263 square metres)	20,629 square metres
Value of research: similar to (WD 69) Value of R&D undertaken in the new facility or using new equipment supported under the WD project(s) (Baseline $24,000,000)	5	$29,550,000	$35,500,000	Project continues to generate research revenues from $300,000 to $500,000 per year	NA

Findings regarding these and other indicators are highlighted below.

- **Square metres dedicated to R&D and skills training**

  Of the 75 technology commercialization projects, several projects did establish space as an indicator, however, the unit of measurement was more often expressed as an occupancy rate over varying periods of time. No projects used physical space as a PAA indicator, but one incubator facility did establish it as a unique target (square feet occupied by TEC Centre--47,000 square feet). Of the 13 other projects reporting additional space for TC activities (including but not limited to R&D and skills training), two projects accounted for over 100,000 square feet (the development of Smartpark Parcel Q at the University of Manitoba, and the Edmonton Biotechnology Business Development Centre).

- **Value of R&D undertaken**

  Of the 75 technology commercialization projects, 5 projects established a unique indicator relating to the value of research work similar to the PAA indicator used in the Knowledge Infrastructure sub-activity. Examples are: "value of work provided to tenants"; "new R&D expenditures", “Research funding” and “Value of projects supported that required use of advanced prototyping platforms”. Of these 5 projects, only one reported an adjustment to outcomes beyond the project reporting period.

2 of the 5 projects are not due to report on this indicator yet. Of the two projects within the reporting time frames for this report that actively used and reported on the indicator, both exceeded their targets in the previously reported outcomes.

The largest contributor to the impact of this indicator is a project for animal housing at one Research Agency. The project started with a baseline of $24 million, and exceeded its target of $26.4 million by reporting $34.9 million in its final report. While there are obviously many factors contributing to the growth of research funding, the efficacy of this animal housing is estimated to have had a strong positive impact on research efficiency and productivity by housing far more animals at lower cost and in better health, while being ergonomically easier for animal care employees at the facility.

Another Research Office which reported an outcome of $600,000 (double the target) from May 2003 to March 2006 has been very successful in generating ongoing research revenues every year since 2006.
There are some reporting challenges associated with this indicator. Of the two projects that are not yet due to report on this indicator, one has suggested that it will be difficult to calculate and will need qualifiers. One project is not sure what the indicator refers to as the real time control of computers at high speed was demonstrated, the equipment is still in use and it attracted 2 further projects, which have been included in follow-in investments.

- **Physical Assets**

  Examples of some physical assets installed in this sub-activity include:

  - Support for technology transfer offices (e.g. office equipment) or construction of incubation facilities;
  - Web-based online entry system;
  - Product prototyping facility;
  - Animal housing;
  - MRI system;
  - Nanofabrication equipment;
  - Phosphoric acid fuel cell; and
  - Biomedical engineering lab equipment.

- **Unique Indicators**

  Some other commonly used indicators for this sub-activity include:

  - Number of users (organizations or individuals) or other indicator relating to use of facilities
  - Funds leveraged specifically from industry
  - Increased revenues
  - Number trained: could refer to number or people trained, number of clients in programs, number of training courses, or number of hours of training. Sometimes, this could be really specific, for example, number of fleet managers with sufficient knowledge to use biodiesel
  - Number of alliances, partnerships, collaborations,
  - Number of events
  - Number of reports, number of research or other types of projects

The main reporting challenge associated with aggregating these indicators is a lack of standardization in definition and in the unit of measurement. Sometimes a proponent indicated that an inappropriate indicator had been mandated, e.g. using revenues for early-stage companies in an incubator facility; or that an indicator had been set for the project which did not support the recipient organization's mandate. Occasionally, two indicators might refer to the same activity or the same participants in an activity, making it difficult for proponents to distinguish between indicators. For example, two indicators for a project, "# of BC companies involved in the partnership and cluster development activities of this project" and "# of BC products, services and technologies involved with the branding portion of this project" both referred to the same set of companies.

Other types of unique indicators used occasionally are for example: # of enquiries for a new system or media hits; companies participating in export or market development; making an asset or equipment or facility operational; or attracting new life sciences venture capital firms or a raw material supplier to the province. Many indicators were defined specifically for the technical aspects of projects, for example: 3 composite technologies commercialized in Manitoba companies and 2 new composite technological processes developed; decrease in mask production time, increase number of research mice created; Flexseal - % decrease with leakage, increase in data transfer, tests for cancer developed; Manitoba Curriculum Developed for lean education in high schools and higher learning institutions.

4. Other Impacts

Intermediate innovation activity outcomes are summarized below. These illustrate the level of knowledge-driven and value-added economic activity in Western Canada. The funding provided by WD for TC projects has been levered to expand operations and physical assets, add personnel to assist with TC, and contribute to the development of clusters and innovation systems.

- **Technology Adoption and Commercialization projects led to a number of major accomplishments.**

  Proponents were asked to identify the major accomplishments of the projects; these accomplishments generally related to the project objectives. Examples of the major accomplishments highlighted by proponents include:

  - **Building Technology Commercialization Capacity**: One of the most notable collective accomplishments of WD support provided to applied research offices, university-industry liaison offices, technology transfer offices at community colleges, technical institutes and newly accredited universities is the levered growth that occurred in technology commercialization capacity. Some specific accomplishments include:
    - One UILO received under $100,000 in WD support. Under the leadership of a noted local entrepreneur the office now has $700,000 funding for continued operations. Companies that hired students for applied research projects return for subsequent projects, testifying to the success of the office.
    - The success of the applied research office at Red River College.
    - Another College has a long history of applied research and innovation but even so, WD support came at a very timely point for it, five years after the College made a decision to formalize its applied research activities. It supplied the foundation for the momentum that the research team needed. The College now has 4 major assets (valued at over $12 million) that make up its applied research capacity: The College's School of Innovation and its laboratories; a composting and biofuel technologies centre; a biofuel pilot plant; and 2,000 acres of agricultural research land. The WD investment of approximately $0.5 million is calculated to have produced a leverage factor of 10 to 1 as the College has since procured over $5 in significant strategic support from other investors. This does not include research funding from industry and service revenues. The School of

Innovation has a special competence in biofuels, until recently, it was the only processor of biodiesel in its province. The College's ability to engage industry in all its initiatives is enhanced by a long standing culture of accessibility.

- At the British Columbia Institute of Technology (BCIT), WD provided early support for an office to commercialize medical and other assistive devices. This was the seed from which BC's technology commercialization activities developed into a formal office, now a successful fully-fledged applied research and industry liaison office. Currently BCIT is implementing plans to expand its applied research activities into a new Centre for Applied Research and Innovation.

- WD support for a pilot innovation network and fund with the Alberta Association of Colleges and Technical Institutes (AACTI) to support applied research at the college level was very successful in engaging industry, levering funding from industry, and demonstrating new technologies. By helping faculty and industry to become aware of these opportunities, the project was successful in enabling colleges to move from ad-hoc applied research projects to *continued* increased capacity through platform-level investments--building continuously operational applied research programs at the college level (applied research offices with dedicated infrastructure, facilities, staff and budgets). At the time the project was first approved, the applied research and innovation portfolio was not part of the core business of AACTI's membership (with the exception of Old's College). The project supported by WD was credited as the spark to get things going across the system, particularly in approximately 8-10 of the 17 colleges involved in the project which demonstrated a stronger interest in technology commercialization.

- At the University of Northern British Columbia, technology commercialization and outreach activities at the UILO are off to a promising start. The project has exceeded its patent targets (an outcome of 10 versus a target of 3). Of the patents in its portfolio, four are being actively pursued and three are being developed into prototypes. One of these patents, based on the properties of terahertz radiation to is likely to be commercialized through a spinoff company with the initial application being for the oriented strand board (OSB) industry. Funds have been raised (for commercialization of this intellectual property and 3 industrial partnerships are being developed with potential clients in the forest industry.

- **Successful Technology Demonstrations**: As a result of two WD projects for new healthcare software in Alberta, proponents perceived that Alberta is leading Canada in implementation of a single province-wide electronic health record. Now the province is trying to integrate other types of data: pharmaceutical prescriptions, and lab and imaging results to the original software. Proponents for projects relating to environmentally sustainable technologies felt that their projects had been successful in demonstrating opportunities to industry for emission reductions and cost-saving opportunities and in providing performance data to validate the efficacy of a technology (e.g. the project for demonstrating Green Roofs at BCIT).

- **Improved Service Delivery**: Proponents of projects whose primary objective was to improve service delivery reported on accomplishments in terms of increased numbers of user and/or revenues and being able to provide a wider range of services than previously. An example of this is the Nanofabrication facility at the University of Alberta.

- **There were some areas that Technology Adoption and Commercialization project proponents identified as being less successful than originally intended.**

These included:

- Barriers to technology adoption or demonstration: some proponents identified barriers to technology demonstration or adoption that had resulted in a lower uptake of a technology than anticipated through performance indicator targets, e.g. integration of software product with other databases or other programs that were part of the core business operations of the target users.

- Engaging industry, usually due to the time and cost or investment commitments required of industry.

- For projects whose performance targets include very specific niches, e.g. biotechnology, wireless or nanotechnology, the accomplishment of targets was limited by the supply of companies in the catchment area of the project

- Construction delays or installation challenges (e.g. technical problems, particularly in a clean room environment).

- Delays due to regulatory approvals and permits for operation of equipment.

- Challenges in synchronizing expenditure outlays with the disbursement deadlines of various funding sources, including WD.

The projects themselves had been very successful in some instances but, when technologies are far ahead of the market or changing rapidly, the path ahead when the project reaches its conclusion is not always clear. For example, the equipment purchased as part of one project was very successful as a technology demonstration project. It now needs to be replaced but, since the manufacturer no longer manufactures the samemodel, it is unlikely that it can be replaced at a reasonable cost.

The technology commercialization process is unpredictable and proponents sometimes found it challenging to be flexible in employing different strategies to meet the ultimate aim of technology commercialization while still trying to meet the specific performance indicators established at the project approval stage.

Most users and stakeholders did not identify specific areas in which their expectations of interactions with projects were not met, although some did mention that their interactions were still in early stages and the results would be known over time. This is partly an artifact of self-selection: most users and stakeholders who responded to requests for interviews had enjoyed positive interactions with projects.

- **Technology Adoption and Commercialization projects also generated other notable impacts.**

Proponents were asked to specify some of the other notable impacts generated by their projects to date, i.e. beyond the reporting period if the project was completed. Some of the impacts that were identified are described below.

- Incubation facilities supported by WD demonstrated notable impacts such as retaining the operations of local companies that might otherwise have moved away. Having a specialized facility for biotechnology firms has enabled the region to attract the attention of international firms with great depth and resources. The University of Alberta's research commercialization activities have received successive support from WD. The new TEC Edmonton Centre provides the university with a presence in downtown Edmonton, the location is used to host many technology events and tenants have easy to access to professional service providers such as accounting and legal firms.

- WD provided support for the ORIC incubator facility located within a National Research Council facility in Penticton, a project which has been very successful. By allowing the NRC to demonstrate that their projects have commercial applications, ORIC can be used as a business model across Canada by the NRC. Thanks to the entrepreneurial attitude and work ethic of its President, ORIC is now a sustainable and self-sufficient business operation. In November 2008, ORIC expanded its operations to Kelowna, opening a 7,500 square feet facility with support from the BC provincial government, in-kind support from NRC and additional support from the Southern Interior Development Initiative Trust. Two of ORIC's tenants have raised over $3 million in funding.

- The Eureka project located in the University of Manitoba's Smartpark records $2million in non-government investment in its client companies over 2 years from 2007-2009, proof of the viability of knowledge based businesses in Manitoba. One client has a major project with NASA. Another of its clients has licensed an agricultural technology to a multinational company. If operating funding for the Eureka project is continued and it can focus on long term plans for its clients, it expects to raise significant funds for 4 clients in the coming year. WD has provided support for this project in successive stages, nurturing the project through a difficult time when there was staff turnover and a lack of leadership. Under new leadership the project has been very beneficial to its tenant companies and has enabled their growth.

- A virtual incubation project also located in Winnipeg, SMART Winnipeg, estimated that at the conclusion of the WD supported project, 84% of startups supported were still in business after 3 years. It is also the only program to serve the aboriginal market, since it is able to provide services to remote communities. In Alberta's Peace Region, WD's early support for an innovation network was the seed which put the Peace Region Economic Development Alliance on a trajectory which culminated in a new Centre for Research and Innovation in partnership with Grande Prairie College. The Centre has been awarded funding from the Rural Alberta Development Fund for applied research and service delivery. According to the proponent, there is an acceptance of innovation, competitiveness and productivity as the language of the region.

Some of the notable impacts of WD's technology demonstration and technology adoption projects include:

- WD provided support for the first installation in Canada of a 200 kilowatt phosphoric acid fuel cell. The fuel cell was successfully integrated with NAIT's own energy supply and heating systems, enabling NAIT to win awards from the Alberta Foundation for Environmental Excellence and the Alberta Emerald Award. The Interpretive Centre built around the fuel cell has had thousands of visitors including tours by engineering associations as professional development activities for their membership. The energy efficiency and performance of the PAFC were documented to evaluate the business case for these fuel cells. NAIT used the fuel cell to teach its power engineering students and is now developing a new alternative energy program. Taken together, these impacts have been invaluable in marketing NAIT as a premier post-secondary educational institution.

- At the Magnetic Resonance Diagnostics Centre at the University of Alberta, WD support was said to be instrumental in positioning the Centre as the focal point for metabolomics within

Canada.

- At BCIT support from WD provided the foundation for most of the demonstrations for green roofs to date; establishing BCIT as the centre for green roofs in the region, and possibly in Canada.

- The Biodiesel Market development project supported by WD counts as a notable impact the introduction of a new provincial regulation. In 2010, 5% of diesel must be from renewable sources.

- Technical assistance provided by Forintek to Alberta's lumber industry led to approximately substantial new private sector mill investments and cost savings.

- WD's support as major sponsor in the first phase of a project to increase awareness of emission reduction technologies for the oil and gas industry (TEREE or Technology for Emission Reduction & Eco-Efficiency) led to the identification of five greenhouse gas reduction opportunities that were further explored in a second phase. WD's early support facilitated collaboration between 3 NGO stakeholders, 11 oil and gas companies and 9 government stakeholders to cooperate on emission reduction and eco-efficiency, allowing the project to expand successfully to a second stage which also received WD support.

- Some of the technologies demonstrated through the first phase are now being successfully commercialized; since 2000, application of venting technologies is estimated to have conserved 5 megatons of greenhouse gas emissions. There have been 7 installations of a proprietary technology that reduces captures vented methane vented and uses combustible hydrocarbons as a supplementary fuel source for natural gas engines. One startup company evolved from this project.

- The Alberta Cancer Board successfully developed with WD support a Oncology query software tool that allows end users to extract data from medical records. The users are clinical leads within the Cancer Board and the tool has been rolled out to all major clinical tumour groups and to outcomes, surveillance, and performance measurement departments of the Cancer Board.

While few TC projects had education and training as a primary objective, WD's support for the Centre for Media and Digital Entertainment at Red River College in Winnipeg allowed the Centre to: (1) increase intake into its communication program which is in very high demand; (2) develop a new program in digital multimedia; and (3) develop new majors in broadcast production within its communication program. Ultimately this is critical to technology commercialization as the graduates from these programs provide the talent base supporting the growth of Manitoba's new media companies—all of the programs graduates are employed and are in high demand.
For a WD project which supported the Canadian Manufacturers and Exporters Association in providing lean manufacturing training to Manitoba's SMEs, it is estimated that for 24-25 companies over 3 years, the average increase in sales per employee was 30%. The CME has increased awareness and improved the image of manufacturing careers.

- **Users and stakeholders also indicated other notable impacts of the interactions they had with WD projects and outputs generated by the projects.**

One ORIC tenant stated that although the ideas underlying the company were his own, ORIC should be credited with doing all the work to develop the technology. ORIC also helped the company with levering funding opportunities from NRC-IRAP and provided mentorship. The company has some patents pending and the Director of the company is emphatic that the company could not have developed without the high level of technical support provided by ORIC. Another tenant spoke about the mentorship and advice received regarding business structure and financing options. The company now has 14 employees, developed a new technology and attributes its revenue growth directly to the support it received from ORIC.

A tenant at the Eureka project in Smartpark stated that when they entered the facility as a tenant, the company had 3 employees but has since grown to eight employees and 2 contractors. Being located at the facility has improved the company's access to potential clients. It is very pleased with the professional image it is able to present to clients by being located at the facility and by the talent base at the University of Manitoba which it utilizes by offering internships to students. The client emphasized that the intangible mentorship benefits which provided focus to its business plan were as valuable as the tangible growth in the company's revenues since it was a tenant. For a company with few capital resources, the combination of physical space, a support structure and the mentorship have been invaluable. Another tenant which has developed proprietary educational and training software has projects with the Canadian Space Agency and NASA. The company is expected to grow shortly to as many as 20 employees. This stakeholder believes that the professional environment of the facility has contributed significantly to his company's success.

Other users and stakeholders stated that the outcomes of applied research and technology transfer projects had been successful for them in enabling smooth transitions of technology, increasing knowhow, and ultimately supporting corporate growth.

- **A number of Technology Adoption and Commercialization projects directly led to other projects, investments, and developments.**

Thirty-two proponents said that their projects lead directly to other projects, investments or developments worth approximately $125.6 million.
The projects, investments or developments identified by proponents as resulting from Technology Adoption and Commercialization projects include:

- $6 million for a SOFC fuel cell network across Canada
- $1.95 million for phase II of the Technologies for Emission Reduction and Eco-Efficiency (TEREE) project
- $4 million from CANARIE for 2 projects relating to grid computing at the University of Alberta
- $5 million grant to the Alberta Cancer Diagnostic Consortium from the Heritage Foundation for further develop its devices for cancer testing by incorporating multiple devices on one chip to make the devices more useful in a clinical setting
- $5 million from Genome Canada to the University of Calgary for four-dimensional modeling of human disease and developmental patterns

Organizations which provided funding for all the projects, investments and developments identified by proponents as resulting from Technology Adoption and Commercialization projects are: ARDA, private companies, NRC-IRAP, provincial governments, industry associations, BCIC, SSHRC, NRCan, CIHR, BCKDF, Michael Smith Foundation, NSERC, Health Canada Office of Disability, Crohn's and Colitis Foundation, Terry Fox Foundation, Cancer Legacy Fund, Genome Canada, Chinese Academy of Sciences, Heritage Foundation, CANARIE, Environment Canada, municipal governments, universities or internal funding, WD. Industry and industry associations played an important role in supporting follow on projects, investments and developments to TC projects.

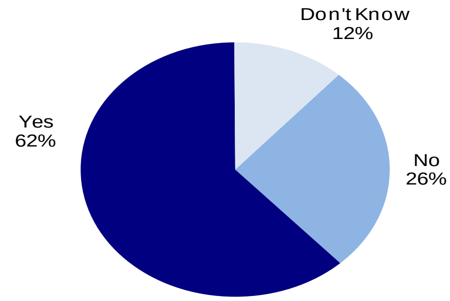
E. IMPORTANCE OF THE SUPPORT PROVIDED BY WD

The major findings of our review regarding the role of WD in the development of the projects are summarized as follows:

- **Apart from providing funding, representatives of WD also commonly play an important role in the design, development or implementation of Technology Adoption and Commercialization projects.**

  Of the 68 project proponents interviewed, 62% reported that representatives of WD played an important role in the design, development or implementation of their projects while 26% reported that WD's primary role was simply to fund the project. This was more common in highly technical projects.

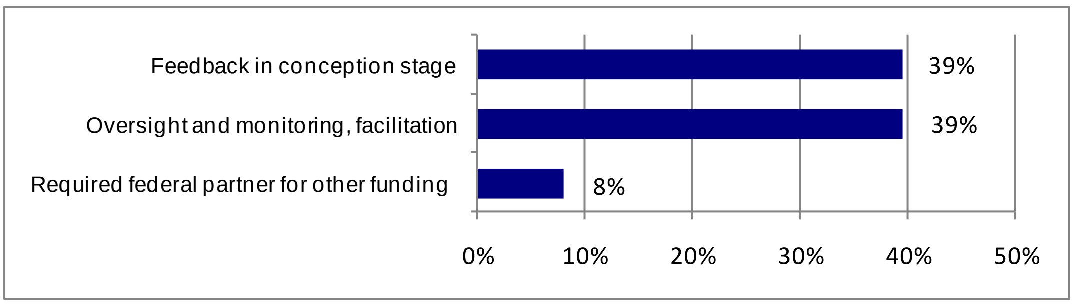
Apart from providing funding, did representatives of WD play an important role in the design, development or implementation of your projects?



We further asked those who believe that representatives of WD also played an important role in the design, development or implementation of projects what role these representatives play.
In the Technology Adoption and Commercialization sub-activity, the major roles played by WD in the development, design and implementation of projects included:

- Feedback on design / conception stage
- Oversight and monitoring, project facilitation or participation in steering committees during project implementation
- Being the required federal partner to secure other (e.g. provincial) funding

MAJOR ROLES PLAYED BY REPRESENTATIVES OF WD



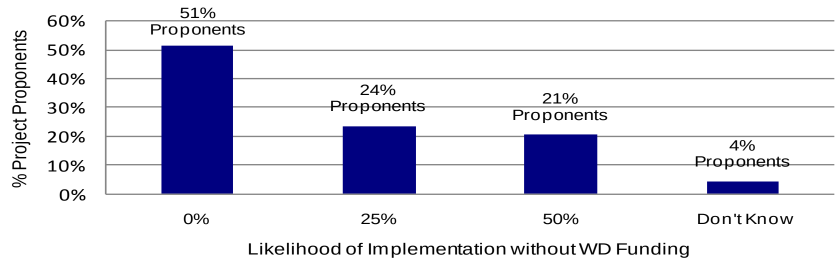
Some proponents stated that WD representatives also provided advice on levering funding or provided introductions to other funding sources; assisted in publicity and media relations; and helped create collaborations with industry partners.

In projects in which WD was perceived to have played a role besides providing funding, proponents emphasize that WD made an important contribution by keeping proponents focused on broader commercialization, innovation and economic development goals. WD was perceived to have brought structure and financial discipline to the administrative process, while allowing strategic flexibility in meeting project objectives.

- **The impacts generated by the funding and assistance WD provided are generally incremental in that projects would not have been implemented in the absence of the support from WD.**

On average, the project proponents estimated that there was only a 17% likelihood that their projects would have been implemented regardless of assistance from WD. As indicated below, more than one-half (51%) of the proponents felt that there was no chance that their projects would have been implemented without the support from WD.

ESTIMATES OF PROJECT PROPONENTS REGARDING THE LIKELIHOOD OF PROJECT IMPLEMENTATION WITHOUT ASSISTANCE FROM WD



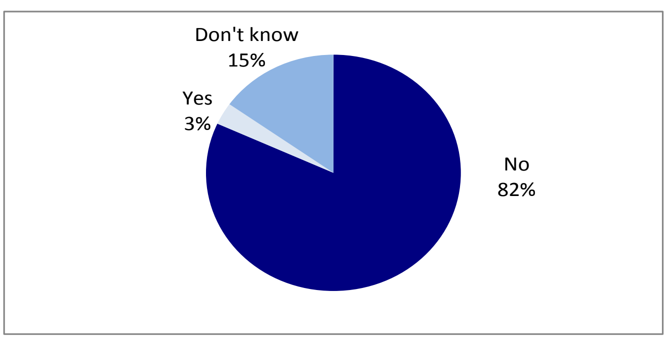
Proponents who believe that there was no chance that their project would have been implemented rationalized that the funding from WD was critical, that there was no other sources for the development of higher-risk technology commercialization projects, that they would not have proper equipment/space for the project, and that they would not have been able to attract other funding partners. The funding and support from WD not only helped project proponents in enhancing competitiveness and credibility to engage in industries, but also allowed them to bridge their relationships with provincial funders and leverage other funding.

Those who were more optimistic of the likelihood of project implementation without assistance from WD generally felt that they might have been able to obtain other sources of funding or that the project would still have proceeded with difficulties.

- **Anticipation of timing delays and a limited project scope is high among those who believe that the projects may have still proceeded without assistance from WD.**

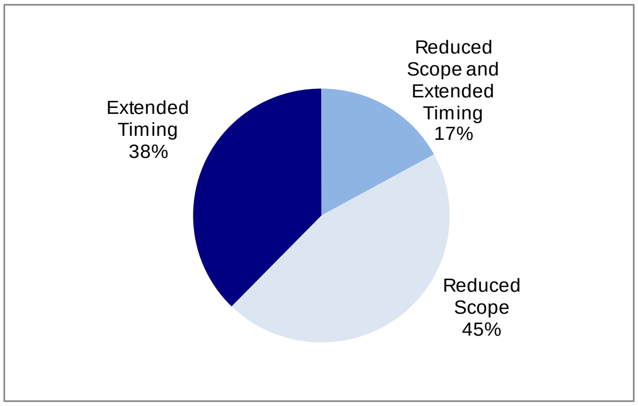
Project proponents who indicated some possibility of implementation without WD funding were asked whether they anticipated that the project would have proceeded within the same time frame and within the same scope. Not surprisingly, most of these proponents (82%) anticipated that they would not have proceeded within the same time frame and within the same scope.

If the projects may have proceeded without assistance from WD, do you anticipate that they would have proceeded within the same time frame and within the same scope?



When we further asked these people how the timing or scope of the projects would have changed, 45% felt that the scope of the projects would be reduced, 38% felt that the time frame would have been extended, and 17% felt that the projects would have undergone both delays in timing and reduced project scopes.

How would the timing or scope of the projects have changed?



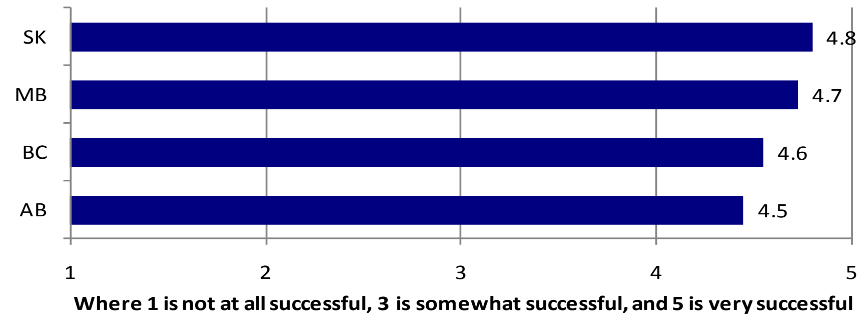
F. SUMMARY OF RESULTS BY PROVINCE

To develop a deeper understanding of the interview results, we cross-tabulated the results regarding objective achievement and achievement of standard performance indicators by the four provinces. The results are presented as follows.

1. Objective Achievement and Incrementality

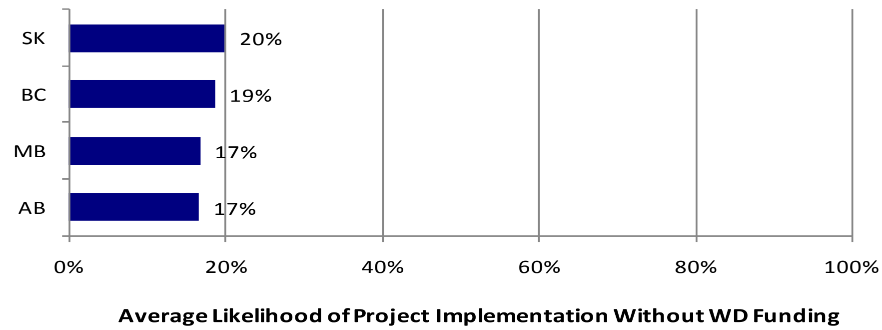
The projects across all four provinces were generally successful in achieving their objectives.

SUCCESS OF PROJECTS IN ACHIEVING OBJECTIVES AS RATED BY PROPONENTS BY PROVINCE



The provinces did not differ significantly in terms of the likelihood of project implementation without WD funding.

AVERAGE ESTIMATES OF PROJECT PROPONENTS REGARDING THE LIKELIHOOD OF PROJECT IMPLEMENTATION WITHOUT ASSISTANCE FROM WD BY PROVINCE



2. Achievement of Standard Performance Indicators

The table below summarizes achievement of standard performance indicators in this sub-activity by province. The use of indicators is reflective of the allocation of projects by province as seen in the first section of this chapter. Saskatchewan only had 7 projects in this sub-activity (of which 2 were excluded from the field research), compared to 11 for Manitoba, 33 for Alberta and 24 for British Columbia. There is variation in the use of standard performance indicators among provinces, and this has a corresponding impact on outcomes of these indicators. The column titled "# Projects Reporting" includes projects which reported on the indicator as a formal indicator and as an unexpected outcome.

This chapter has examined the impacts of the sample of 75 projects in the TC sub-activity, based on the program logic model which illustrates the interrelationships between project outputs and intended impacts. The majority of TC projects (94%) were implemented as planned. Among the many objectives of TC projects, were two major ones: building technology commercialization capacity and introducing or demonstrating new technologies. The achievement of TC projects on the eight standard performance indicators for this sub-activity were summarized to assess the first two levels of outcomes specified by the program logic model. Technology adoption and commercialization projects generated many other notable impacts in terms of intermediate innovation activity outcomes, such as building technology commercialization capacity, demonstrating new technologies and improving service delivery. The support provided by WD was considered instrumental to the design, development and implementation of TC projects with proponents specifying the roles played by WD and the likelihood of project implementation without WD assistance. The results by province have been summarized but as project distribution among the provinces varied widely, this limits the degree to which specific conclusions can be drawn about provincial performance.

TECHNOLOGY ADOPTION AND COMMERCIALIZATION: ACHIEVEMENT OF STANDARD PERFORMANCE INDICATORS BY PROVINCE

	British Columbia			Alberta			Saskatchewan			Manitoba		
	# Projects Reporting	Target	Impact	# Projects Reporting	Target	Impact	# Projects Reporting	Target	Impact	# Projects Reporting	Target	Impact
(WD42) Number of patents filed/issued PAA (Baseline 26)	13	110	187	8	21	30	0	NA	NA	2	14	10
(WD45) Number of technology demonstrations	4	158	128	4	30	20	2	10	16	0	NA	NA
(WD49) Number of technologies adopted (Baseline 16)	3	18	27	0	NA	NA	1	21	25	0	NA	NA
(WD43) Number of licences executed (Baseline 168)	4	16	40	3	255	210	0	NA	NA	1	2	1
(WD44) Number of prototypes developed (Baseline 92)	11	68	65	3	135	266	0	NA	NA	1	14	12
(WD46) Number of technologies to market (Baseline 4)	4	121	31	0	NA	NA	0	NA	NA	1	10	6
(WD47) Number of spinoff companies formed (Baseline 1)	5	22	11	6*	3	7	1	15	9	2	5	3
(WD48) Value in venture capital invested and levered investment in projects (Baseline $116,000)	1	$25m	NA	1	$5.6 m	$9m	0	NA	NA	0	NA	NA

*not including the project which defined its target in terms of spinoffs per year

III. THE KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITY

This chapter first presents a profile of the Knowledge Infrastructure sub-activities in terms of the characteristics of projects supported. We then provide an overview of project outcomes, the role of WD in supporting the projects, and a summary of the results by province.

A. OVERVIEW OF THE SUB-ACTIVITY

1. Objective

The Knowledge Infrastructure sub-activity supports knowledge infrastructure such as research equipment or buildings, which are key to research and development or specialized training. It is expected that this knowledge infrastructure will lead to the development of new technologies which have commercial potential and to the training of HQP who have a direct economic impact on academic institutions (universities and colleges) research institutions and research hospitals. In turn, the development of technology and related human resources will facilitate the development of the knowledge economy in Western Canada.

2. Characteristics of Projects Supported

A summary of the number and value of projects approved under the Knowledge Infrastructure sub-activity by fiscal years is provided in the table on the following page. As indicated, 54 projects were selected for potential review totaling nearly $54 million in funding. The number and value of projects approved by region can vary widely from year to year.

Educational institutions were the proponent for two-thirds of the projects approved.

PROJECT NUMBER AND VALUE BY TYPE OF INSTITUTION APPROVED UNDER THE KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITY, 2002-03 TO 2006-07

Type of Organization	Number of Projects	WD Funding	Total Project Cost
Educational Institution	36	$26,146,282	$97,142,486
Industry Association	1	$437,400	$487,400
Non-profit	2	$871,436	$1,353,286
Provincial Government	2	$655,970	$1,311,940
Provincial Health Authority	6	$17,203,323	$82,878,323
R&D Consortium - Government	4	$6,802,650	$41,376,749
R&D Consortium - University	3	$1,502,000	$11,108,500
Total	**54**	**$53,619,061**	**$235,658,684**

We conducted an analysis based on the types of projects approved based on project approval documents and interviews, which is summarized below.

TYPES OF PROJECTS APPROVED UNDER THE KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITY, 2002-03 TO 2006-07*

Type of Project	Number of Projects	Percent of Projects	WD Investment in Projects	Percent of Investment
Asset Purchase-Improve Service Delivery	17	31%	$26,314,211	49%
Asset Purchase-Improve Research Capacity	32	59%	$24,797,730	46%
Asset Purchase-Community Outreach	2	4%	$871,436	2%
Asset Purchase-Technology Demonstration	4	7%	$2,225,684	4%
Asset Purchase-Technology Commercialization Capacity	6	11%	$7,795,000	15%
Total	**54**	**100%**	**$53,619,061**	**100%**

*All 54 Knowledge Infrastructure Projects involved Asset Purchases as a key component of the project and categories are not mutually exclusive

The projects relate to a range of economic sectors with life sciences being the most commonly identified.

SUMMARY OF PROJECTS BY SECTOR/CLUSTER AND ACTIVITY UNDER THE KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITY, 2002-03 TO 2006-07

Sector/Cluster	Number of Projects	Percent of Projects	Value WD Investment	Percent of Investment	Total Project Cost
Information Technology	7	13%	$4,823,870	9%	$43,307,232
Life Sciences	33	61%	$36,857,671	69%	$139,031,414
Multi-sector	3	6%	$1,471,611	3%	$2,467,611
Other	11	20%	$10,465,909	20%	$50,852,427
Total	**54**	**100%**	**$53,619,061**	**100%**	**$235,658,684**

A summary of the distribution of these projects by fiscal year and province is provided in the table on the following page.

DISTRIBUTION BY PROVINCE AND YEAR OF INVESTMENT: PROJECTS* APPROVED FOR WD INVESTMENT UNDER THE THE KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITY, 2002-03 TO 2006-07

Approval Year	FY 02/03		FY 03/04		FY 04/05		FY 05/06		FY 06/07		All Years	
Region	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects	Number of Projects	WD Investment in Projects
AB	1	$550,000	1	$590,000	3	$3,404,044	-	-	-	-	5	$4,544,044
BC	14	$5,834,305	11	$5,495,634	2	$656,884	7	$2,788,393	-	-	34	$14,775,216
MB	2	$1,550,000	1	$9,500,000	1	$1,927,750	4	$11,240,000	2	$1,106,000	10	$25,323,750
SK	1	$2,500,000	1	$474,456	2	$1,001,595	1	$5,000,000	-	-	5	$8,976,051
Total	**18**	**$10,434,305**	**14**	**$16,060,090**	**8**	**$6,990,273**	**12**	**$19,028,393**	**2**	**$1,106,000**	**54**	**$53,619,061**

*Sample projects selected for assessment

Twenty-nine organizations were approved for funding under the Knowledge Infrastructure sub-activity, with the number of projects per proponent ranging from 1 to 6 (the University of Manitoba).

LIST OF UNIQUE ORGANIZATIONS RECEIVING FUNDING UNDER THE KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITY, 2002-03 TO 2006-07

Client Name	Organization Type	Region	Number of Projects	WD Funding	Total Funding	
Alberta Agriculture, Food and Rural Development	Provincial Government	AB	1	$404,375	$808,750	
Northern Alberta Institute of Technology	Educational Institution	AB	1	$499,669	$560,034	
Olds College Centre for Innovation Inc.	Educational Institution	AB	1	$550,000	$616,554	
The Governors of the University of Alberta	Educational Institution	AB	1	$2,500,000	$10,926,600	
The Governors of the University of Calgary	Educational Institution	AB	1	$590,000	$2,293,460	
A.S.T.C. Science World Society	Non-profit	BC	1	$500,000	$925,000	
BC Cancer Foundation	Provincial Health Authority	BC	3	$1,703,323	$2,378,323	
British Columbia Institute of Technology	Educational Institution	BC	2	$690,000	$772,466	
Fuel Cells Canada	Industry Association	BC	1	$437,400	$487,400	
Genome British Columbia	R&D Consortium Government	BC	3	$1,802,650	$3,367,150	
H. R. MacMillan Space Centre Society	Non-profit	BC	1	$371,436	$428,286	
Kwantlen Polytechnic University	Educational Institution	BC	1	$489,034	$546,284	
Malaspina University-College	Educational Institution	BC	1	$542,825	$4,237,186	
NewMic Foundation	R&D Consortium University	BC	1	$352,000	$393,500	
Okanagan University College	Educational Institution	BC	2	$1,078,471	$1,350,914	
Simon Fraser University	Educational Institution	BC	3	$1,579,664	$2,806,298	
University College of the Cariboo	Educational Institution	BC	2	$543,355	$925,059	
University of British Columbia	Educational Institution	BC	5	$1,475,830	$2,284,630	
University of Northern British Columbia	Educational Institution	BC	2	$676,779	$873,779	
University of Victoria	Educational Institution	BC	4	$1,382,449	$2,590,049	
Western Canadian Universities Marine Biological Society	R&D Consortium University	BC	2	$1,150,000	$10,715,000	
Red River College	Educational Institution	MB	1	$551,000	$909,000	

Client Name	Organization Type	Region	Number of Projects	WD Funding	Total Funding	
St. Boniface General Hospital	Provincial Health Authority	MB	1	$2,500,000	$7,500,000	
University of Manitoba	Educational Institution	MB	6	$9,272,750	$58,923,000	
Winnipeg Regional Health Authority	Provincial Health Authority	MB	2	$13,000,000	$73,000,000	
Canadian Light Source Inc.	R&D Consortium Government	SK	1	$5,000,000	$38,009,599	
Saskatchewan Research Council	Provincial Government	SK	1	$251,595	$503,190	
University of Regina	Educational Institution	SK	1	$474,456	$527,173	
University of Saskatchewan	Educational Institution	SK	2	$3,250,000	$6,000,000	
Total			**54**	**$53,619,061**	**$235,658,684**	

B. THE PROGRAM LOGIC MODEL

A program logic model illustrating the interrelationships between the outputs, and intended impacts is provided on the following page.

WD provides financial and other assistance towards the development of projects under the sub-activities. While the financial assistance is often the most visible type of support provided by WD, the role of WD staff in bringing together groups, formulating partnerships, nurturing champions, and assisting in the design of projects and initiatives can also be an important contribution that WD makes in promoting innovation. With respect to financial support, in some cases, WD serves as the primary source of funding for a given project. In other cases, the funding from WD acts as a catalyst to attract other funding or tops up funding from other sources to ensure that the project proceeds in timely fashion and at an appropriate scale. In some other cases, WD may fund the early-stage development of a given project which will then attract significant funding from other sources for the implementation of future stages.

Examples of common outputs from these projects include levered investment in projects, jobs created by projects, project reports, technology demonstrations, prototype development, strengthened linkages between project partners, and development of physical assets (hardware, software, buildings, equipment) for R&D or training. For example, projects funded through these sub-activities are able to increase their user base, offer more courses, train additional skilled workers, support an increased number of collaborations, etc. In the short-term, these outputs can lead to further investment, use of expanded research capabilities and capacity, identification/promotion of promising new technologies and processes, adoption and commercialization of new technologies, strengthened linkages and coordination in activities between participants in the innovation system, and ongoing employment. Over the medium-term, it is intended that the activities will increase technology development, adoption and commercialization. In turn, over the longer-term, the sub-activities will contribute to further development and diversification of the Western Canadian economy.

PROGRAM LOGIC MODEL FOR THE AND KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITY: MEASURING THE IMPACT OF INNOVATION FUNDING

Element	Knowledge Infrastructure (KI)	
Definition	▪ Knowledge Infrastructure is defined to include research equipment or buildings necessary for R&D and specialized training ▪ KI projects target academic institutions (universities and colleges), research institutions and hospitals which support the knowledge economy	
WD Activities	▪ Provide financial support for projects and initiatives that strengthen the knowledge infrastructure ▪ Work directly with other organizations to encourage and facilitate the development of projects and initiatives	
Outputs	▪ Number and Value of Projects Funded Under the Knowledge Infrastructure Sub-Activity	
Immediate Outcomes	**Definition**	▪ **To what extent did each project approved for funding produce its project outcomes as described in the "Attachment A, Statement of Work" for each project?**
	Measured by: Performance Indicators during the reporting period on a Project by Project Basis	▪ # of square metres dedicated to R&D and skills training (WD68) ▪ Value of R&D undertaken in the new facility or using new equipment supported under the WD project(s) (WD69) ▪ # of Physical Assets (WD 70) ▪ Various unique indicators: improved research capacity, research projects, collaborations and partnerships, training of skilled personnel, increased research publication and reports, improved quantity and quality of data etc.
Intermediate Outcomes	**Definition**	▪ **To what extent did the Knowledge Infrastructure sub-activity achieve its objectives?**
	Measured by: Aggregated Performance Indicators beyond the reporting period	▪ # of square metres dedicated to R&D and skills training (WD68) ▪ Value of R&D undertaken in the new facility or using new equipment supported under the WD project(s) (WD69) ▪ # of Physical Assets (WD 70) ▪ Various unique indicators: in certain situations only
	Definition	▪ **To what degree have WD investments in the Knowledge Infrastructure sub-activity increased the level of knowledge-driven and value-added economic activity in Western Canada?**
Intermediate Innovation Activity Outcomes	**Measured by results from WD approved projects as well as perceptions and provincial indicators (where appropriate)**	▪ Improved infrastructure for R&D, new product/process development and education and training ▪ Expenditures on R&D ▪ R&D personnel ▪ Growth of the intellectual property base: patents, trademarks, trade secrets ▪ New technology clusters are created and existing ones are strengthened ▪ Increased capacity, awareness and use of new technology ▪ Increased cooperation and collaboration among players in the innovation system
	Definition	▪ **What is the impact on the western Canadian innovation system of WD investments under the Knowledge Infrastructure sub-activity?**
Final Entrepreneurship and Innovation Strategic Outcomes	**Measured by results data from WD investments, key informant perceptions, surveys, case studies, literature and policy reviews, and results of projects and sub-activity level investments**	▪ **Development and diversification of the Western Canadian economy** ▪ A strengthened innovation system in Western Canada ▪ Increased technology development, adoption and commercialization ▪ Further development of technology clusters

C. RELATIONSHIP OF INFORMANTS TO THE PROJECTS

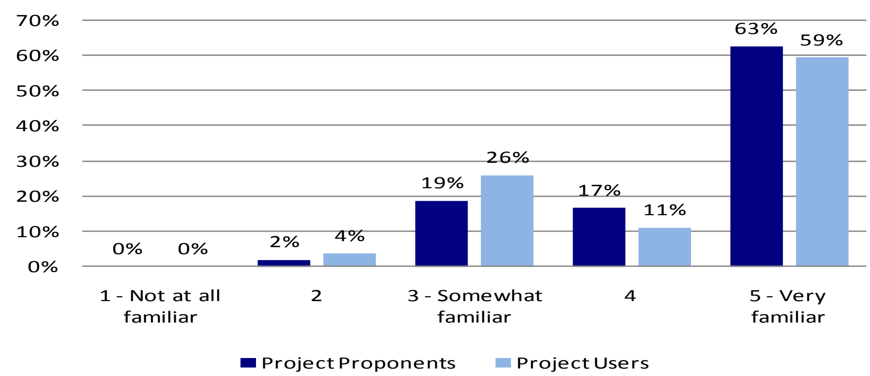
To further understand the relationship of the representatives interviewed to the projects, we asked them to rate how familiar they are with the projects and describe the roles they played in terms of the development, management, and delivery of the project. We also asked users of project outputs and other stakeholders to rate how familiar they are with the projects and explain the nature of their interaction with the projects. The results are summarized as follows.

- **Project proponents are generally very familiar with their project.**

  When asked to rate how familiar they are with their project on a scale of 1 to 5, where 1 is not at all familiar, 3 is somewhat and 5 is very familiar, the proponents provided an average rating of 4.4. Eighty percent of the proponents indicated that they are familiar or very familiar with the project, 19% indicated that they are somewhat familiar while only 2% indicated that they are not familiar with the project. In some instances the project lead was no longer with the organization or responsibilities had been divided across a variety of people.

  Similarly, when asked to rate how familiar they are with the project(s) and/or its output(s) on the same 1 to 5 scale, the users and stakeholders provided an average rating of 4.2. About two-thirds (66%) of the users and stakeholders indicated that they are familiar or very familiar with the project, 29% indicated that they are somewhat familiar and 4% indicated that they are not familiar with the project.

LEVEL OF FAMILIARITY WITH KNOWLEDGE INFRASTRUCTURE PROJECTS BY PROJECT PROPONENTS AND USERS AND STAKEHOLDERS



- **Project proponents were involved in many ways in the development, management, and delivery of the projects.**

  Proponents of Knowledge Infrastructure projects provided a list of examples of responsibilities and positions they held in terms of the development, management, and delivery of the projects. As summarized in the table below, a majority of project proponents were involved in the development and management activities while about a third were involved in delivery activities.

Type of Role	Examples of Responsibilities	Examples of Positions
Development	▪ Write initial proposals or work plans ▪ Secure funding and manage budget ▪ Oversee construction, equipment installation, lab start-up ▪ Conceive and design infrastructure	Director of Innovation, Proposal Writer, Chief Financial Officer, Principal Investigator, Vice President, Controller, Dean
Management	▪ Oversee project development, scheduling, delivery and organization at the top level ▪ Involve in day-to-day operations ▪ Report outcomes ▪ Manage purchasing of equipment	(Executive or Scientific) Director, Project Manager, Program Manager, Chief Executive Officer
Delivery	▪ Help with site installation or facilities-preparing ▪ Perform research and delivery related tasks ▪ Manage relationships with vendor	Technical Lead, Operations Leader

- **The nature of interactions between the users and the projects varies moderately.**

Nature of Interaction	Number of Users	Number of Projects
Industrial User of Facility for product/process/parts development	6	4
Recipient of technology transfer or commercialization partner	4	4
Supplier to project	4	4
Academic User of Facility for Research	3	3
Collaborative Research Partner	2	2
Fund research at the facility	1	1
Professional Development/ Mentorship/Learning	1	1
Total	**21**	**19**

In addition to the specific primary interactions mentioned above, there were occasionally other secondary interactions, e.g. the user/stakeholder hired staff through their association with the project, e.g. students from a research laboratory. In one case, a commercialization partner funded a joint scholarship at the WD supported facility with which they had had a positive interaction.

D. IMPACTS OF THE PROJECTS

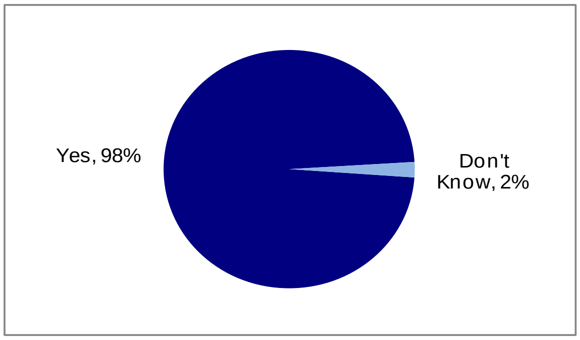
Project proponents and users and stakeholders were asked to rate various impacts generated by the projects in terms of project implementation, objective achievement, achievement of standard performance indicators and other impacts. The major findings arising from our interviews are summarized below.

1. Implementation and Achievement of Project Objectives

- **The Knowledge Infrastructure projects were implemented largely as planned.**

Nearly all (98%) proponents believe that their Knowledge Infrastructure projects were implemented as planned, except for one proponent who did not know enough to comment on the matter due to several changes of staff.

In your experience, was the project implemented largely as planned?

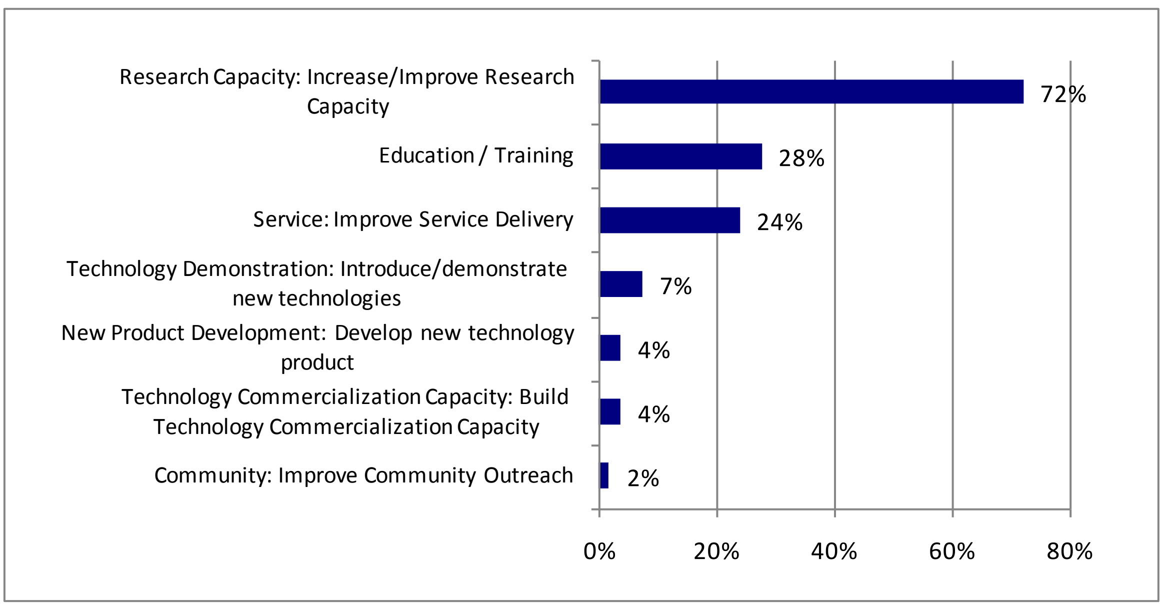


Three of the proponents indicated that there were relatively minor changes in timing, construction, or organization structure; however, they believe these changes did not impact the projects and the projects were implemented largely as planned.

- **Knowledge Infrastructure projects were designed to accomplish a wide range of objectives.**

Proponents were asked to specify the primary objectives of the project and what it was designed to accomplish. As indicated below, the most common objective amongst Knowledge Infrastructure projects was to increase or improve research capacity.

MAJOR OBJECTIVES OF KNOWLEDGE INFRASTRUCTURE PROJECTS AS SPECIFIED BY PROPONENTS



A project may have had more than one primary objective so the totals add up to more than 100%. The primary objectives of Knowledge Infrastructure projects were to increase or improve research capacity and provided education and training. In some instances, particularly at technical institutes such as BCIT or NAIT or colleges such as Okanagan University College and University College of the Cariboo, Knowledge Infrastructure projects also had service delivery objectives (e.g. at NAIT to provide metrology and inspection services to the manufacturing industry to improve productivity and at BCIT to provide food processing services to industry clients). Some of these institutions were subsequently restructured so UCC became TRU while Okanagan University College became part of UBC; in the latter case this led to some changes in the project (and subsequent project outcomes) to better reflect the mandate of UBC.

- **The objectives of the users and stakeholders were moderately consistent with those of the overall project and usually depended on the nature of the interaction and how the output could contribute to the further development of their own organizations.**

  For example:

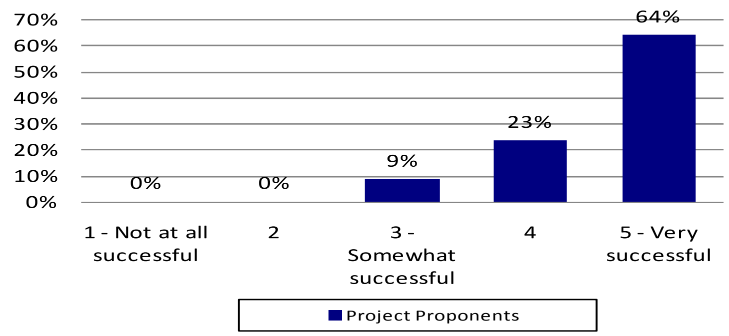
  - Academic research users aimed to develop new areas of expertise, e.g. immunology, depression research.
  - Industrial users, particularly in very specialized facilities were quite specific about their objectives. For one project, two stakeholders suggested that the facility was the only one in Canada that could provide data accuracy at the level it was needed, e.g. for measurement of ethane spectra to facilitate the detection of ethane in gas leaks.
  - Commercialization partners set their sights on actual commercial transactions as in the case of one stakeholder who licensed patents based on research from a WD supported research facility.
  - Collaborative research partners hoped to conduct evaluations of their technology and advance research in specific areas, e.g. molecular imaging. Industrial users of facilities had objectives such as decreasing their cost and processing times and being able to use the equipment at the time they need it (as opposed to waiting or having to ship samples elsewhere).
  - Suppliers to projects hoped to achieve either increased market acceptance for their products, diversify their customer base or develop it by adding to their product line. The fact these suppliers were able to access what one stakeholder termed as the “braintrust” available at the university was also a motivating factor.
  - Some stakeholders who funded research were really engaged with the project proponents and were proactive in supporting the proponents in acquiring funding to support the expansion of space available for research. Industrial partners who funded research facilities hoped to be able to commercialize new products.

- **Both project proponents and users and stakeholders interviewed believe that the projects have been successful in achieving their objectives.**

  When asked to rate how successful the project has been in achieving the objectives on a scale of 1 to 5, where 1 is not at all successful, 3 is somewhat and 5 is very successful, the proponents provided an average rating of 4.6. Most of the proponents (87%) indicated that the projects were successful or very successful in achieving the objectives while 9% indicated that the projects are somewhat successful.

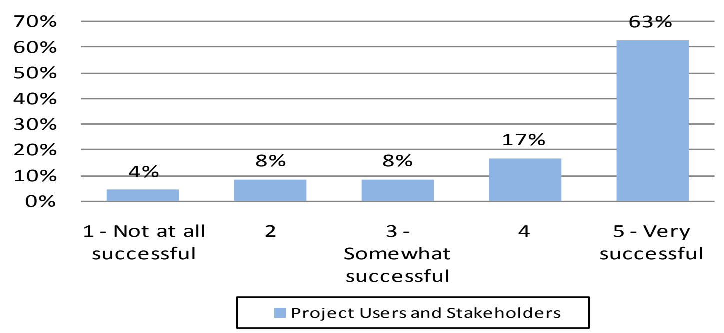
SUCCESS OF PROJECTS IN ACHIEVING OBJECTIVES

AS RATED BY PROJECT PROPONENTS



The users and stakeholders provided an average rating of 4.3 when asked to rate how successful they were in achieving the objectives of their interaction with the project on the same 1 to 5 scale. About 80% of the users and stakeholders indicated that they were successful or very successful in achieving the objectives, while 8% indicated that they were somewhat successful and 12% indicated that they were not very successful in achieving their objectives.

SUCCESS OF USERS AND STAKEHOLERS IN ACHIEVING PRIMARY OBJECTIVES



2. Achievement of Standard Performance Indicators

The expected result of WD's investments in Knowledge Infrastructure is enhanced knowledge infrastructure and capacity. The standard performance indicators defined for this sub-activity in WD's Program Activity Architecture are shown in the table below. The table summarizes:

- The number of projects for which this was defined as indicator;
- The aggregate target for the indicator as established in the statement of work;
- Previously reported outcomes from Project Progress Reports, Res Reports and Final Outcome Summaries (Immediate Outcomes); and
- Adjustment based on interviews generally referring to additional impacts that have occurred since the reporting period (Intermediate Outcomes).

As indicated no more than 6 of the 54 projects used more than any one indicator.

Knowledge Infrastructure: Indicator Name	Number of Projects Using as Indicator	Target	Previously Reported Outcome	Adjustment Based on Interviews
(WD68) Number of square metres dedicated to R&D and skills training	6	13,442 -9,300 =4,142	4,592	19 other projects reported additional space of 191,947 sq ft; approximately 17,832 square metres
(WD69) Value of R&D undertaken in the new facility or using new equipment supported under the WD project(s)	7	45,650,000 -30,000,000 = **15,650,000**	8,600,898	16,419,000*
(WD 70) Number of Physical Assets Baseline 8	7	26	26	N/A

*This figure includes the previously reported outcome. Note that for indicator WD69 it is difficult to distinguish the previously reported outcome from the adjustment based on interviews. Respondents were not always certain to which grants the previously reported outcome might have referred to, especially as research grants are often over a number of years. They usually provided a total to date.

Since April 1, 2005 at least one of these performance indicators has been utilized in project approval documents to gauge project performance. Prior to that date, performance indicators were not standardized; therefore, results against those indicators cannot all necessarily be aggregated. A description of performance against each type of indicator is provided below.

- **Square metres dedicated to R&D and skills training**

  Of the 54 Knowledge Infrastructure projects, 6 established the number of square metres dedicated to R&D and skills training as a PAA indicator including:

  - 6 projects used this indicator in its standardized form as a PAA indicator. These 6 projects had a reported outcome of 4,592 square metres. 9,300 square metres for the Institute for Advanced Medicine is still under construction with the building expected to open in May 2009. One project did not use this indicator in its statement of work, but it was reported on in the progress report therefore there is no target associated with physical space for the project, but there is an outcome. Another project, the Centre for Depression Research, reported a space almost double the size of the original target.

  - 19 other proponents who were able to provide an estimate of the physical space associated with their projects for R&D and/or skills training reported an additional 17,832 square metres.

- **Value of R&D undertaken in the new facility or using new equipment**

  Of the 54 Knowledge Infrastructure projects, 9 established the value of R&D undertaken in the new facility or using new equipment supported under the WD project(s) as a performance indicator including:

  - 6 projects used this indicator in its standardized form as a PAA indicator. Five of these projects (excluding the Institute of Advanced Medicine which is still under construction) reported a combined impact (based on the interviews and previously reported figures) of $16.4 million in the table above. Only one of these projects did not meet its target in reported outcomes, but the proponent reported a very large training contract worth $70 million as a follow-on development during the field research.
  - 3 projects established a unique indicator relating to value of research funding. Of these 3 projects, 2 are related: one is a direct follow-on to other and the target for the first project appears to have been superseded by the second project, which is still in progress. This

project has established a unique indicator "value of grants and research contracts" in addition to establishing the standardized PAA indicator above, therefore the difference between value of R&D and value of grants and research contracts proponent was too ambiguous for the proponent to distinguish between. One early project which predated the use of PAA indicators established as a unique indicator: “The …Research Scientist will generate 60,000 in research grants per year”. The long term outcome for this project has been $137,000 with an additional $500,000 over 5 years.

Several reporting challenges were found to be associated with the use of the indicator: value of R&D undertaken in the new facility or using new equipment supported under the WD project:

- Attribution; Many proponents emphasized that their research uses other equipment and infrastructure in addition to WD supported equipment, and that it was challenging to attribute the total amount of research funding solely to the WD supported portion of equipment or facilities used.

- Time Frames: It was often challenging for proponents to clearly specify the time frames covered by research funding. Since many proponents have several grants at the same time for varying lengths of time, they were not always able to identify total research funding over a specified time period.

- Recording: In many instances, a piece of equipment might be used by various research groups from different faculties and there is no one person whose job is it to track grants per research instrument or per piece of equipment. Grant totals are usually only available at the research group or department level.

- With the exception of 1 BC project, this indicator was used as a PAA indicator only in Manitoba

- **Physical Assets**

Of the 54 Knowledge Infrastructure projects, 7 established physical assets as a performance indicator including:

- 7 projects used the indicator in its standardized form as a PAA indicator. These 7 projects had a target of 16 physical assets. The outcome was also 26 physical assets although the 26 reported assets are not the same specified as the 26 target assets. In a couple of projects an extra asset was installed within the same budget while for another project 2 new assets (beam-lines) are fully operational for a total of 9, while 3 are going to commissioning. All of the projects met or are in the process of meeting their targets for installing physical assets.

- Several projects referred to the installation of a physical asset as a milestone or as a unique indicator. Examples include: Centre for Shellfish Research and field site; completion of building construction for Agri-Food Discovery Place Phase II, NMR spectrometer, large scale cabled ocean observatories, marine sciences equipment, pilot plant equipment at a food processing resource centre, hydrogen safe environmental test chamber; and a composites model factory.

The reporting challenge associated with this indicator lies in trying to aggregate the physical assets which are so diverse in scale and cost.

3. Other Indicators Used

Some Knowledge Infrastructure projects established standardized indicators from the Technology Adoption and Commercialization sub-activity. The use of these indicators is shown below.

USE OF TECHNOLOGY ADOPTION AND COMMERCIALIZATION PAA INDICATORS IN KNOWLEDGE INFRASTRUCTURE PROJECTS

Indicator Name	# of Projects Using as Indicator	Target	Previously Reported Outcome	Adjustment Based on Interviews	Combined Impact
(WD42) # of patents filed/issued (Baseline 4)	5	30	24	11	35
(WD45) # of technology demonstrations	2	23	NA	NA	NA
(WD43) # of licences executed	2	8	In progress		In progress
(WD47) # of spinoff companies formed (Baseline 0)	3	17	0	6	6

- **Patents**

Of the 54 Knowledge Infrastructure projects, 5 projects established patents as a unique performance indicator. Examples are: “Patents issued for innovative products” and “'# of Patents filed”. One project specified patent targets for 4 different industry sectors. These 5 projects which established patents as a unique indicator reported 28 patents filed or issued towards a target of 30 patents.

Of these 5 projects, one is still in progress and there is only one project that did not meet its patent targets. This project had a target of 14 patents and a reported outcome of zero. There was a lot of staff turnover on this project (there were 5 directors in 4 years and one of the previous proponents died). Still it is not clear as to how this outcome would have been achieved as the project was for construction of a building which was in effect a "science hotel" where different scientists stay to conduct their research. The facility is fully booked during the research season and operates successfully but it is not clear who or how the patents were to have been generated.

In addition to these 5 projects, 3 projects which had not established patents as an indicator, reported a total of 7 patents. Of these 7 patents, 5 (4 approved and 1 pending) were reported from the Wine Research Centre. The Centre has been very successful in commercializing the results of its research with its commercialization partner which funded three years of research at labs which were renovated with WD support. The Centre has patents on the first 2 GRAS (Generally Accepted As Safe) genetically engineered wine yeasts. The malolactic yeast ML01 is the first genetically improved yeast to receive approval from the FDA and Health Canada and Environment Canada for commercial application. Notifications are being prepared to request permission for commercial application in major wine producing regions around the world. A yeast commercialization project has been announced for urea degrading yeasts which was also developed and patented by the Centre.

Another of the unexpected patents has received a lot of publicity in the past—the BC Cancer Agency applied for a patent on the SARS genome, not in order to protect their intellectual property, but in order to make it publicly available. WD supported the purchase of DNA sequencing equipment for the BC Cancer Agency. The type of sequencer that was bought proved to be very successful. The Agency subsequently purchased seven more of those machines for itself and now has a world renowned sequencing platform.

A significant contributor to the patent outcome is Genome BC which reported an outcome of 15 patents and/or invention disclosures. In general, invention disclosures were not included in indicators relating to patents.

- **Technology Demonstrations**

Of the 54 Knowledge Infrastructure projects, 2 projects established technology demonstrations as a unique performance indicator (“demonstration of the viability of new technologies” and “# of technology demonstrations”. One of these, with a target of 15, is not due to report on the target until March 2010 but good progress is being made with respect to the experimental research that will eventually form the basis for technology demonstrations. The proponent for the project which established "demonstration of the viability of new technologies" as an indicator was not clear what the target of 8 referred to.

- **Licenses Executed**

Of the 54 Knowledge Infrastructure projects, 2 projects established licenses executed as a unique performance indicator but both are in progress and have not reported yet on this indicator.

- **Spinoff Companies Formed**

Of the 54 Knowledge Infrastructure projects, 3 projects established spinoff companies formed as performance indicator including:

  - 1 project which used this indicator in its standardized form as a PAA indicator. The final reporting date for this project is March 2010 so it has not reported yet on this target; in general it seems that while some technologies have been licensed, the trend has been towards publishing rather than capitalization.

  - 2 projects which established spinoff companies formed as a unique indicator. One of these is the “science research facility” for which the ambitious patent target had been set. It is not clear how this target for spinoff companies would be met or is relevant to this project. There is one corporate community project in place for abalone aquaculture but the purpose of this project is to rebuild stocks of an endangered species; it does not have commercial objectives at this time. The second project, which established a target of 7 spinoffs, is the first of two related projects so it is not clear if this target is still valid or had been superseded by the targets for the newer follow-on project which is still in progress.

  - In addition to the 3 projects which established spinoff companies formed as a performance indicator, 3 projects which had not established this as a performance indicator reported six spinoff companies. In fact, all the 6 spinoffs currently reported under this sub-activity were reported during the interviews as unexpected outcomes. This speaks to the unpredictable nature of the innovation and technology commercialization process.

  - 5 spinoff companies were formed at 2 WD supported projects at Simon Fraser University. Two spinoff companies from research at a wireless lab for which WD supported the purchase of equipment have been successful to date. One raised significant capital and relocated to Austin while another which continues to have an office in BC also successfully raised investment capital.

- One spinoff company was reported at the University of Manitoba where WD supported a suite of research laboratories at the computer science department. The new labs made a strong contribution to the recruitment of distinguished academics who might not have accepted the offers without the new facilities. Since the new labs were operational almost all of the department's offers to new faculty candidates have been accepted whereas previously, few were filled. The department is now able to recruit high-calibre faculty. As well, there is a much better sense of team spirit, there is increased collaboration, and graduate students are more productive now that they are not scattered around the university in ad hoc facilities. These intangible benefits may have contributed to the formation of a spinoff company.

- **Unique Indicators**

  Some other commonly used indicators for this sub-activity include:

  - Number of users (organizations or individuals) or other indicator relating to use of facilities
  - Research publications
  - Increased revenues
  - Number trained: could refer to number or people trained, number of clients in programs, number of training courses, or number of hours of training. Sometimes, this could be really specific, for example, number of fleet managers with sufficient knowledge to use biodiesel
  - Number of reports: number of research or other types of projects
  - Number of alliances, partnerships, collaborations
  - Number of events.

As with the technology commercialization sub-activity, the main reporting challenge associated with aggregating these indicators was a lack of standardization in definition and in the unit of measurement. Sometimes a proponent indicated that an inappropriate indicator had been mandated, an unrealistic target had been set or that an indicator had been set for the project which did not support the recipient organization's mandate. In some instances, an indicator is difficult to measure because it is so commonplace. Since many of the principal investigators in these projects are university professors, research publication activity is usually quite prolific since it is a primary basis for performance evaluation of these principal investigators within their own institutions.

Some examples of very unique project specific indicators are: provision of metrology and inspection services; # of horticulture sectors involved; synthesize three isotope aroma precursors; increased sequencing capacity and quality of read lengths for DNA.

4. Other Impacts

These projects also contribute towards the intermediate innovation activity outcomes, which illustrate the level of knowledge-driven and value-added economic activity in Western Canada. The funding provided by WD for KI projects has been levered to expand operations and physical assets, add personnel to assist with inventions, discoveries and other forms of innovation research and contribute to the development of clusters and innovation systems.

- **Knowledge Infrastructure projects led to a number of major accomplishments.**

  Proponents were asked to identify the major accomplishments of their projects; many of which were related to the project objectives summarized in the previous section. Major accomplishments include:

- **Improved Research Capacity**: The majority of Knowledge Infrastructure projects were aimed at improving research capacity. In order to measure accomplishment of this objective, unique indicators were widely established to measure improvement in research capacity. Proponents mentioned several ways in which research capacity had been improved, either by increasing research capacity or by improving the quality of research capacity. For example, a project at Genome BC for DNA sequencing infrastructure acquisition established a performance indicator relating to increasing sequencing throughput. A different project also for DNA sequencing established performance indicators for increasing sequencing capacity and also increasing the quality of DNA read lengths.

- **Education and Training**: Proponents reported accomplishments relating to the numbers of students going through programs or using certain types of equipment or facilities; increasing co-op placements, improving curriculum delivery or even retaining accreditation. For example a project supporting the purchase of food processing equipment at UBC allowed the department to retain its accreditation with the Institute of Food Technologists, which it might otherwise have lost.

- **Improved Service Delivery**: Proponents reported being able to improve service delivery to industrial and academic clients. Equipment upgrades or purchase of new equipment allowed proponents to provide cost effective services with faster turnaround times.

- **Collaboration:** In many instances, Knowledge Infrastructure projects enabled proponents to engage in collaborative research. The construction of new facilities often provided proponents with the ability to integrate activities in one physical space, improving research efficiency and enhancing networking and collaboration.

- **Recruitment of faculty/and or increased success with grant applications:** An important accomplishment of Knowledge Infrastructure projects was the role they played in being able to recruit distinguished faculty, many of whom bring large research grants with them. In other instances, especially for newly accredited universities, the equipment purchases supported by WD projects enabled proponents to apply for research grants that they would not previously have been able to apply for.

- **Stabilized operating funding**: In many instances, the seed capital funding provided by WD allowed proponents to stabilize their operating funding, continue operations, and often in doing so, to lever their funding and expand operations. Some examples such as the Centre for Shellfish Research at Vancouver Island University and the Institute of Sustainable Horticulture at Kwantlen are discussed in further detail elsewhere.

- **Publication productivity and discoveries:** Knowledge Infrastructure projects led an increase in publication productivity and scientific discoveries.

- **There were some areas that Knowledge Infrastructure project proponents identified as being less successful than originally intended.**

  These included:

  - Delays in installation associated with technical problems
  - Construction/renovation delays: trying to claim expenses while meeting WD disbursement deadlines. During the last few years, an economic boom across Western Canada led to

increased construction and delays for many projects.
- Diversifying funding sources
- Industry engagement: investment costs, time
- Aggressive performance indicators
- Marketing of facilities to improve industry awareness of the availability of facilities

Most users and stakeholders did not identify specific areas in which their expectations of interactions with projects were not met, although some did mention that their interactions were still in early stages and the results would be known over time. This is partly an artifact of self-selection: most users and stakeholders who responded to requests for interviews had enjoyed positive interactions with projects.

- **Knowledge Infrastructure projects also generated other notable impacts.**

Proponents were asked to specify some of the other notable impacts generated by their projects to date, i.e. beyond the reporting period if the project was completed. Since life sciences projects dominated the Knowledge Infrastructure sub-activity, accounting for 61% of the number of projects and 69% of the WD investment in this sub-activity, many of the notable impacts related to the life sciences sector including:

- At BC's Kwantlen Polytechnic University, WD's support for equipment purchases for applied horticulture research was the first important recognition of the Institute for Sustainable Horticulture. The Institute is now a very successful organization and credits this early support from WD for many of its subsequent projects and the growth it has achieved. Research from the Institute provided the impetus for Kwantlen to develop an intellectual property policy. The Institute has received support from CFI and BCKDF for a to build research labs and a greenhouse to enable development of three research programs: (1) development and commercialization of new biocontrol products; (2) "green" integrated energy systems for closed, geothermal horticulture greenhouses; and (3) new crop production opportunities for closed, geothermal, climate-controlled horticulture greenhouses. The new Centre for Developing Biocontrols will be the first of its kind in Canada and will have the production capacity to take early commercialization research all the way to product registration. In addition 4 new degree programs will be developed at Kwantlen.

- Protection of worker and animal health: WD provided support for research equipment in a level 3 biocontainment lab which does testing on BSE,[5] soon to be classified as a level 3 pathogen. Without the facility, worker's health would be endangered.

- Olds College in Alberta has been very successful in engaging industry and supporting the development of Alberta as a province for the production of biofuels. It has established a Biofuel Technology Centre and there is $1.3 million 4,000 square foot biofuel pilot plant renovation funded by AB Energy that is attached to the Biofuel Technology Centre.

- Science World in Vancouver was one of the few projects with the objective of community outreach. Traditionally its primary audience has been young children but its Bodyworks exhibit supported by WD and with in-kind contributions by local biotechnology companies has been successful in reaching out to secondary school students and encouraging them to consider careers in science and technology.

- Increasing the public profile and improving treatment of depressive illnesses through support

5 Bovine spongiform encephalopathy (BSE), commonly known as mad-cow disease.

of the Centre for Depression Research at UBC.

- UBC's program for Food Nutrition and Health where WD provided support for food processing equipment now is the only lab in Western Canada with high pressure hydraulic pasteurization allowing for cold pasteurization (e.g. of fruit juice and meats). The improved capacity of the program in training and retaining HQP had been notable, of the most recent graduates from its M.Sc. program, 25 of 26 students found employment within Western Canada last year.

- WD support of several related investments in Winnipeg have established the city as a centre for functional foods and nutraceuticals research, in Canada and globally.

- Early support from WD for Neptune Canada has evolved into a large project for building underwater cable ocean observatories which represents a revolution in technology to conduct research in the ocean. High bandwidth underwater cables will allow instruments to be controlled from anywhere.

- Software adopted by international community as global standard for grid computing.

Some notable impacts in other sectors include:

- WD supported the Innovative Structures Research Centre at the University of Manitoba. The new testing laboratory is a showpiece of the ISIS facility and is thought to be one of the most active structures labs in Canada, responsible for all design standards in Canadian civil infrastructure that use composites in place of steel for reinforcing. After ISIS winds down it has a 2 year extension to commercialize and develop design standards.

- WD support for a Chemistry Centre of Excellence at the University of Manitoba has enabled new programs such as a new forensic science interdisciplinary degree.

- WD has supported additional beamlines at the synchrotron operated by Canadian Light Source in Saskatoon. The facility does a lot of outreach for community and high school students—thousands of people tour the facility which considers it important to have an open door policy. There are 587 registered users and 135 scientific publications were generated from 2005-2008.

One proponent mentioned a significant benefit for their organization. The upgrade of a nuclear magnetic resonance facility at SFU in BC resulted in the vendor who sold the equipment using that facility as a showcase. The vendor now brings their potential clients to tour the facility at SFU, and is committed to future investments in SFU.

At smaller colleges and newly accredited universities such as Thompson Rivers University (TRU) in the Central Interior region of BC, WD's early investments in biochemical research equipment was essential for building the foundation from which professors at this university are able to conduct their research in order to apply for grants, which they have been successfully doing as a result of having access to the equipment. Not only does this seed for capacity building enable TRU to demonstrate "what we can do now that we have equipment", it allows TRU to recruit faculty who come with their own Tri-Council and NSERC grants. Another WD project at TRU for the upgrading of advanced manufacturing systems led to a very successful industry project with a company which has subsequently installed a multi-million dollar addition to their line. Since this company's order was considered too small by the supplier which normally fills large orders for the automotive industry, the company recruited TRU for technical assistance. The project was also successful in decreasing the company's worker compensation claims and the company has since donated equipment for use by TRU.

- **Users and stakeholders were also asked about other notable impacts of the interactions they had with WD projects and outputs generated by the projects.**

  A user of a beamline at the synchrotron facility talked about the indirect benefits of having advanced experimental research facilities available which generated notable economic impacts. In the mining industry which is heavily regulated, the holding costs of proposed mining projects can be as much as $1.5 million per month. Therefore a two-year delay in the environmental assessment process can result in holding costs of as much as $36 million. A key issue in the uranium mining industry for example, is the safe disposal of uranium tailings which contain arsenic. The accuracy of data generated with the help of the beamlines enables validation of the structure of iron-arsenic precipitates with a degree of precision not possible through traditional techniques such as diffraction crystallography (which labels these compounds as "amorphous"). Using older techniques requires a 5-10% concentration for proper structural analysis but the powerful excitation provided by the beamline, which is akin to have a "ten million watt lightbulb", analysis can be done at a level of parts per million. Using the beamline has enabled the company to become a world leader in technology for preparing uranium tailings for safe long term disposal. By removing the uncertainties around minerals presumed to be formed through precipitation, the environment assessment process is shortened and the reduced holding costs have a direct impact on the company's profitability. The continued profitable operation of companies which have benefited from projects contributes to the economic development impact of projects.

  WD provided support for an expansion of facilities for genome research at the Vaccine and Infectious Disease Organization (VIDO) at the University of Saskatchewan. An academic user of the facilities stated that many patents have been generated in this area, the marginal increase in grant funding that can be attributed to expansion of the facility is over $1 million annually, and a new technology on host pathogen interaction (a new way of looking at signaling pathways in cells to identify targets for disrupting or enhancing pathways) was published in *Science* magazine. The value of the infrastructure has been optimized partly due to the open collaborative culture at VIDO and it has been very beneficial to have a facility where users are in close physical proximity and can continuously exchange ideas. From this user's perspective, it is these interactions of scientists from many disciplines and with different areas of expertise (e.g. nanotechnology, molecular biology) working on common problems that is the springboard for generating new technologies.

- **A number of Knowledge Infrastructure projects directly led to other projects, investments, and developments.**

  Twenty-seven proponents indicated that approximately $138.7 million was invested in other projects, investments or developments. Some of these projects, investments or developments include:

  - The most significant of these follow on projects was a $70 million training contract from Agriculture and Agri-Food Canada for the Agriculture & Agri-food Collaborative Initiative project at the St. Boniface General Hospital Research Centre
  - $3 million for the Shell Manufacturing Centre of Excellence at NAIT from WD, the province of Alberta and in-kind support from Microsoft and Matricon
  - $3 million towards the Hewlett Packard Grid Research at the University of Calgary from CANARIE and Cybera
  - $5 million for a new lab at Kwantlen's Institute for Sustainable Horticulture

- $15 million Centre for Shellfish Research at Vancouver Island University (formerly Malaspina University College)
- $15 million for the Wine Research Centre at UBC-- $14 million in research grants that would not be possible to apply for without the renovated labs and $1 million in contract R&D with industry
- $2 million over 4 years from Sanofi-Aventis for the Centre for Depression Research at UBC.
- $3 million from CFI for facilities and equipment at the Marine Centre of the Western Canadian Universities Marine Biological Society

Funding for projects in the Knowledge Infrastructure and Technology Adoption and Commercialization sib-activity was provided by: Agriculture and Agri-food Canada, CANARIE, the university, CIHR, NSERC, CFI, NRC, Genome Canada, provincial governments, MITACS, Auto 21, NRCan, Advanced Food and Materials Network, BCKDF, Cybera, approximately 10 corporations. Government organizations accounted for the majority of the funding.

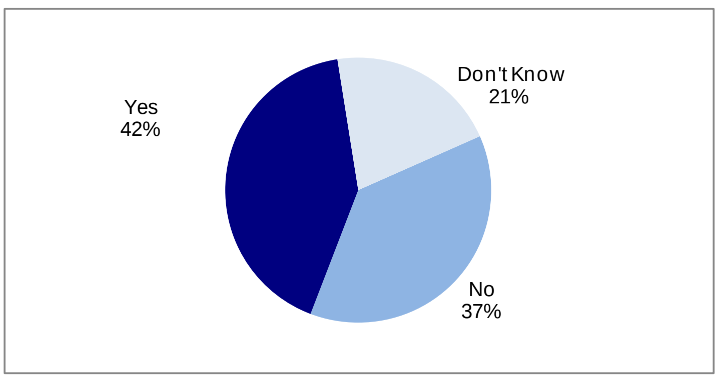
E. IMPORTANCE OF THE SUPPORT PROVIDED BY WD

The major findings of our review regarding the role of WD in the development and implementation of the projects are summarized as follows:

- **The involvement of WD representatives varies in the design, development or implementation of Knowledge Infrastructure projects.**

Of the 48 project proponents interviewed, 42% reported that representatives of WD played an important role in the design, development or implementation of their projects while 38% reported the opposite and 21% did not know enough to comment on the matter.

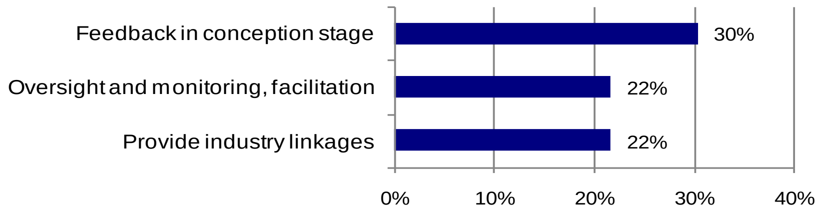
Apart from providing funding, did representatives of WD play an important role in the design, development or implementation of your projects?



We further asked those who believe that representatives of WD also play an important role in the design, development or implementation of projects regarding the role these representatives play. In the Knowledge Infrastructure sub-activity, the major roles played by WD in the development, design and implementation of projects included:

- Feedback on design / conception stage
- Oversight and monitoring, project facilitation or participation in steering committees during project implementation
- Providing industry linkages

MAJOR ROLES PLAYED BY REPRESENTATIVES OF WD

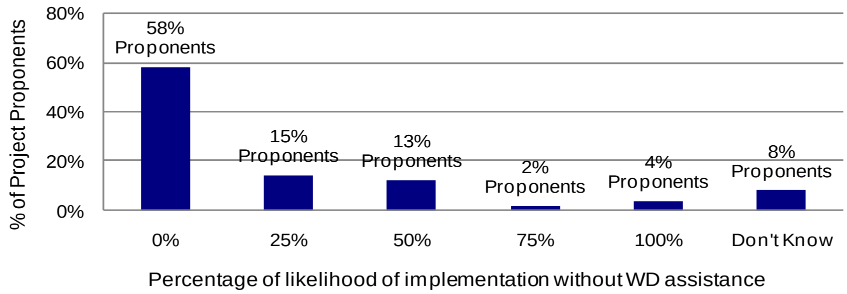


A few proponents mentioned that WD had provided advice on levering funding or provided introductions to other funding sources; assisted with publicity and media relations; and participated as the required federal partner to secure funding from other sources. In very scientifically specialized or technical projects, particularly within the Knowledge Infrastructure sub-activity, WD's role was perceived by proponents as being limited primarily to providing funding support. In Knowledge Infrastructure projects, funding support from WD was especially appreciated as having flexibility of choice in the specific brand of equipment to be purchased allowed proponents to negotiate better prices for the equipment.

- **The impacts generated by the funding and assistance WD provided are incremental in that projects would not have been implemented in the absence of the support from WD.**

On average, the Knowledge Infrastructure project proponents, like those proponents of Technology Adoption and Commercialization projects, estimated that there was a 17% likelihood that their projects would have been implemented regardless of assistance from WD. As indicated below, more than one-half (58%) of the proponents felt that there was no chance that their projects would have been implemented without the support from WD.

ESTIMATES OF PROJECT PROPONENTS REGARDING THE LIKELIHOOD OF PROJECT IMPLEMENTATION WITHOUT ASSISTANCE FROM WD



Proponents who believe that there was no chance that their project would have been implemented described the impact created as a result of the funding and support from WD as "a catalyst to get equipment to produce results that companies would be interested in", "tied to direct support for diploma/degree/certification programs", and "provided a strong jump-start" for their projects. A few proponents felt that the funding from WD was crucial because universities usually work on a smaller budget and could only provide partial resources for their projects instead of the whole amount.

Those who were more optimistic of the likelihood of project implementation without assistance from WD generally felt that they might have been able to obtain other sources of funding from industry, federal or provincial governments, or that the project would still have proceeded with an extended time frame. Two proponents claimed that their projects had secured major funding sources prior to assistance from WD therefore would have been implemented regardless.

Project proponents who indicated some possibility of project implementation without WD funding were asked whether they anticipated that the projects would have proceeded within the same time frame and within the same scope. Forty-seven per cent of these proponents indicated that the project would have been delayed, 41% believed that the scope or the scale of the project would have been reduced and 12% believed that the timing would have been delayed and the scope would have been reduced.

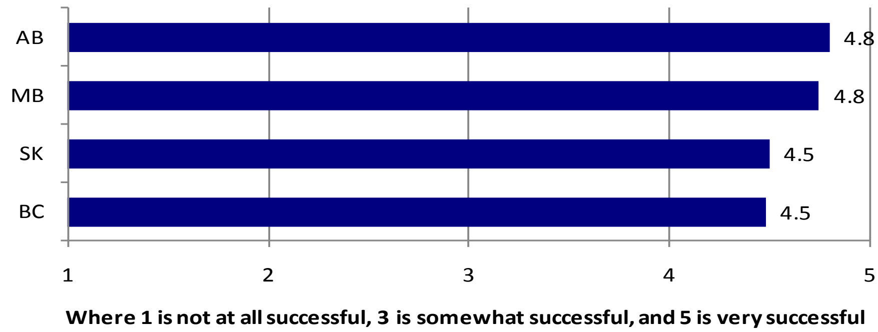
D. SUMMARY OF RESULTS BY PROVINCE

To develop a deeper understanding of the interview results, we cross-tabulated the results regarding objective achievement and achievement of standard performance indicators by the four provinces. The results are presented as follows.

1. Objective Achievement and Incrementality

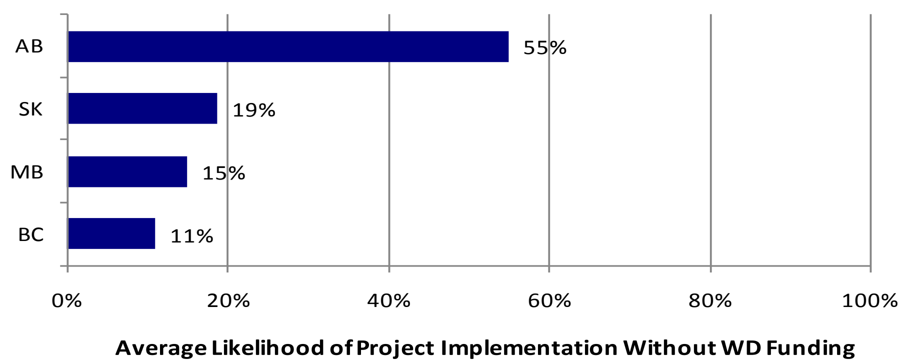
The provinces did not differ significantly in terms of the achievement of project objectives across the four provinces.

SUCCESS OF PROJECTS IN ACHIEVING OBJECTIVES AS RATED BY PROJECT PROPONENTS BY PROVINCE



Alberta stood out from other provinces in terms of the likelihood of project implementation without WD funding; over half the proponents believed that the likelihood of the project proceeding without WD assistance was higher than zero. This could partly be because Alberta had only 5 KI projects; the majority of WD supported projects in Alberta were TC projects.

AVERAGE ESTIMATES OF PROJECT PROPONENTS REGARDING THE LIKELIHOOD OF PROJECT IMPLEMENTATION WITHOUT ASSISTANCE FROM WD BY PROVINCE



2. Achievement of Standard Performance Indicators

The table below summarizes achievement of standard performance indicators in this sub-activity by province. The use of indicators is reflective of the allocation of projects by province as seen in the first section of this chapter. There is variation in the use of standard performance indicators among provinces, and this has a corresponding impact on outcomes of these indicators.

This chapter has examined the impacts of the sample of 54 projects in the KI sub-activity, based on the program logic model which illustrates the interrelationships between project outputs and intended impacts. The majority of KI projects (98%) were implemented as planned. Among the many objectives of KI projects, were three major ones: increasing or improving research capacity; providing education and training; and improving service delivery. The achievement of KI projects on the three standard performance indicators for this sub-activity were summarized to assess the first two levels of outcomes specified by the program logic model. Knowledge infrastructure projects generated many other notable impacts in terms of intermediate innovation activity outcomes, achieving the three major objectives specified above while facilitating collaboration, faculty recruitment, publication productivity and stabilization of operating funding. The support provided by WD was considered instrumental to the design, development and implementation of KI projects with proponents specifying the roles played by WD and the likelihood of project implementation without WD assistance. The results by province have been summarized but as project distribution among the provinces varied widely, this limits the degree to which specific conclusions can be drawn about provincial performance.

KNOWLEDGE INFRASTRUCTURE: ACHIEVEMENT OF STANDARD PERFORMANCE INDICATORS BY PROVINCE

	British Columbia			Alberta*			Saskatchewan			Manitoba		
	Projects	Target	Impact	Projects	Target	Impact	Projects	Target	Impact	Projects	Target	Impact
Number of square metres dedicated to R&D and skills training (WD68)	4	692	1,142	0	NA	NA	0	NA	NA	2	12,750**	3,450
Value of R&D undertaken in the new facility or using new equipment supported under the WD project(s) (WD69)	1	$560,000	$1,389,000	0	NA	NA	0	NA	NA	5	$45.09 million***	$15.03 million
Number of Physical Assets (WD 70) Baseline 8	5	12	13	0	NA	NA	1	13	12	1	1	1

*Note that Alberta and Saskatchewan each had only five Knowledge Infrastructure projects.

**Includes 9,300 square metres under construction.

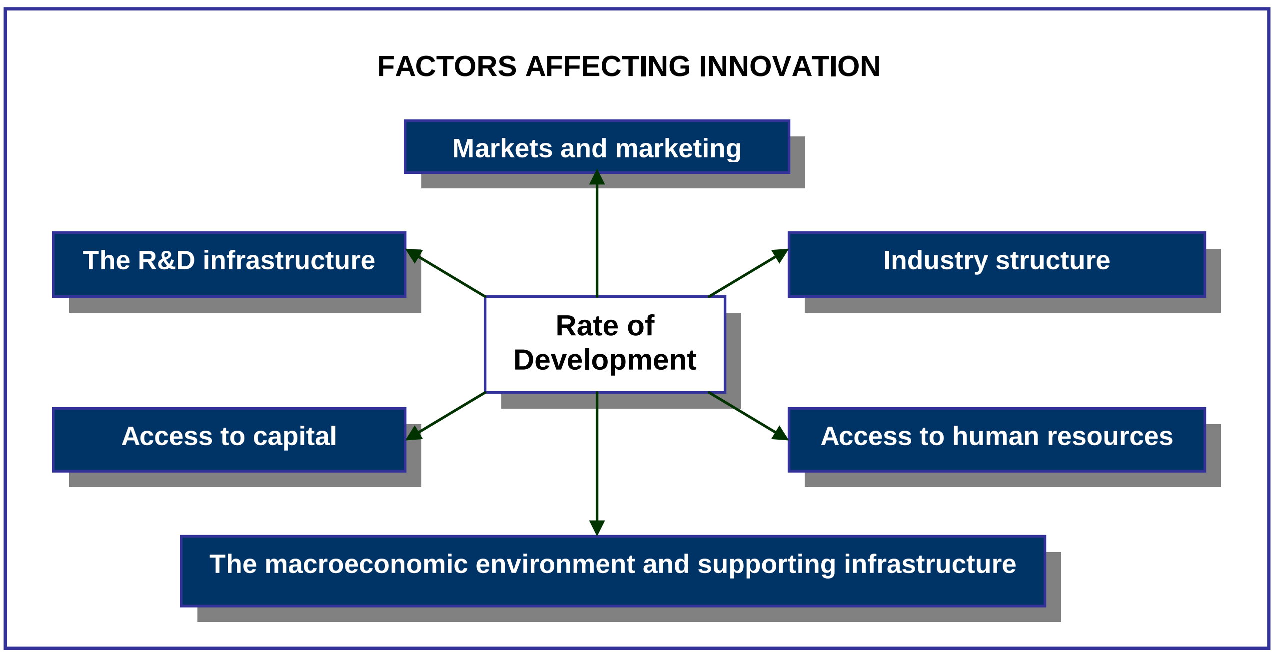
*** Includes funds for a project which is still in progress and the building is still under construction.

IV. IMPACT ON THE INNOVATION SYSTEM

This chapter summarizes some of the longer term impacts of WD's investments in technology commercialization and knowledge infrastructure on the innovation system. It addresses the final entrepreneurship and innovation strategic outcomes as described in the logic model. The first section provides an overview of the innovation system by describing the factors which affect the development of the innovation system. The second section summarizes the impact of WD projects on the innovation system. The third section includes four case studies which discuss these impacts in further detail. The final section examines the impact of WD investments on development of clusters.

A. OVERVIEW OF THE INNOVATION SYSTEM

One objective of this impact assessment is to review the role of the two sub-activities in strengthening the innovation system in Western Canada. Innovation within a region can be viewed as a function of six major factors including the R&D infrastructure, access to human resources, access to capital, markets and marketing, industry structure, and the macroeconomic environment. These factors are highlighted in the diagram below.



A brief description of how each of these factors can affect the rate of development is provided below.

FACTORS THAT AFFECT INNOVATION

Factor	Description
The R&D Infrastructure	The knowledge and R&D infrastructure has a significant impact on developing innovation within a given region. Some of the key elements of a strong knowledge and R&D infrastructure include: ▪ ***Significant levels of investment in longer-term research and development***. This investment could take the form of investments in research infrastructure (e.g. equipment and other resources), research programs, and graduate student programs. It has long been recognized that building a strong academic base with high quality R&D is key for the development of innovation within industry sectors. For example, it has been noted that 1 in 3 US biotech companies are located less than 35 miles from a University of California campus, 1 in 5 biotech companies in California were founded by a University of California scientist, 6 of the 10 best-selling biotech drugs stem from University of California research, and 85% of California biotech companies employ University of California researchers. The long gestation period, high cost, and uncertainty are factors that limit the level of private sector investment in longer-term R&D. ▪ ***Strong linkages between research institutions and industry***. Industry development can be affected by a number of factors including the extent to which the focus of primary research is consistent with emerging market opportunities and industry needs, the effectiveness of the mechanisms developed to transfer new technology to industry, the impact of intellectual property agreements, and the resources available to assist industry to commercialize new technologies (including access to required facilities, expertise, and other resources). ▪ ***Significant levels of investment in industrial R&D***. While industrial or applied research and development tends to be funded and driven primarily by the private sector, most governments provide some form of funding for applied research and development. ▪ ***Ready access to technology and technological expertise***. A wide variety of organizations and communication channels, both private and government, can play a key role in creating awareness of new technologies as well as in aiding in diffusion and implementation.
Access to Capital	Access to capital is critical to commercializing the results of research. In some sectors, it often takes seven years or longer to bring a new product to market. As such, the availability of knowledgeable and patient capital to finance and nurture the commercialization of new technologies can be the single most important factor determining the success of businesses. Important sources of external capital for commercialization can include: ▪ ***Seed capital, including angel investors*** ▪ ***Venture capital*** ▪ ***Debt financing*** ▪ ***Public equity financing***

Factor	Description
Access to Human Resources	Access to skilled managers, researchers, and workers is a critical building block for strengthening innovation. Early in the development process, the key requirement is for world-class researchers, graduate students, and technical personnel who can achieve technical breakthroughs. As work progresses towards commercialization, the focus shifts to management, production staff, and support workers. Innovation is supported by: ▪ ***A strong education and training infrastructure***, from K-12 through to graduate education programs which can facilitate the development of researchers, entrepreneurs, managers, technical staff, and other workers. ▪ ***Direct linkages between educational institutions and industry***. A common recommendation from industry is that education programs need to better prepare students for the reality of business by building stronger links to industry through co-ops, internships, and industry driven research projects. ▪ ***Attractive employment opportunities***. Sectors and companies must be able to attract, develop, and retain the managers, researchers, and workers they need to not only develop new or improved products, technologies, and processes, but also to implement those new technologies and processes in their organization. ▪ ***Strong management capabilities*****,** particularly with respect to the development, commercialization, and implementation of new or improved products, technologies, and processes.
Markets and Marketing	The characteristics of the markets and the marketing capabilities of the companies have a direct impact on the diffusion of innovation. Some of the key factors are: ▪ ***Ready access to domestic and export markets***. The markets can include public sector and private sector purchasers. ▪ ***Customers that demand innovation***. Major companies within a supply chain often drive technology development by requiring their suppliers to reduce costs, improve quality, or adopt specific supply chain management processes and systems. ▪ ***Extensive use of strategic alliances***. While industry development is frequently driven by competition, it often cannot occur without cooperation with other organizations (sometimes even with competing firms). Strategic alliances and networks are often formed because the costs, complexity, and risks associated with development are so high that firms often do not have all of the resources internally. The development of a new pharmaceutical drug, for example, may cost hundreds of millions of dollars, and only some of the drugs under development will ever reach the market. These alliances may include universities, research institutes, clients, regulatory agencies, and competing firms.
Industry Structure	The rate of innovation is also affected by the structure and competitive environment in which the technology sectors operate. Higher rates of innovation tend to be associated with: ▪ ***The presence of key technology developers.*** Key technology developers play a key role in driving the development of supporting resources, technologies, applications, and markets. ▪ ***High levels of competition***. Most organizations innovate because they have to in order to remain competitive.

Factor	Description
The Macro-economic Environment and Supporting Infrastructure	A key determinant of innovation is the extent to which a political, legal, and macroeconomic environment exists that is conducive to the adoption of innovative products, services and processes. Some of the key issues that affect the rate of innovation are: ▪ ***A positive business environment***. Conditions such as low inflation, low and stable interest rates, and taxation policy favourable to savings and investment help to encourage innovation. ▪ ***A regulatory environment that promotes competition and development***. Examples of factors than can constrain development include slow product approval processes, lack of harmonization with respect to regulatory issues, and international trade barriers. Intellectual property rights must encourage both innovation and diffusion of new technology throughout the economy. ▪ ***A strong supporting physical infrastructure***, such as strong communication networks, readily accessible sources of energy, and efficient transportation systems (highway, ports, and air).

The table in the next section summarizes some of the different types of strategies and initiatives that have been implemented with a view to increasing the rate of innovation.

B. IMPACT OF PROJECTS ON THE INNOVATION SYSTEM

1. Role in Strengthening the Innovation System

Through the sub-activities, WD has supported a range of activities designed to strengthen the innovation system in Western Canada as indicated in the table below. The table summarizes initiatives in five of the six key areas of the innovation system that are directly addressed through the sub-activities, as well as initiatives related to linkages between players in the innovation system. Initiatives supported through these two sub-activities do not have a *direct* impact on the broadest level of the innovation system, the macro-economic environment and supporting infrastructure (which includes effective business and regulatory environments and a well developed transportation, communication and utilities infrastructure).

EXAMPLES OF SUPPORT PROVIDED BY WD UNDER THE TECHNOLOGY ADOPTION & COMMERCIALIZATION AND KNOWLEDGE INFRASTRUCTURE SUB-ACTIVITIES

Elements of the Innovation System	Examples of Initiatives Supported Under Sub-activities
Markets & Marketing: Demand Conditions	▪ *Support for export and market development initiatives, facilitating participation in tradeshows and trade missions:* WD has supported 5 projects to support export and market development opportunities in specific sectors such as sustainable building technologies, wireless etc.
R&D/Technology Infrastructure	▪ *Support for investments in physical infrastructure (e.g. buildings, equipment, and labs):* Facilities supported by WD such as the Olds College School of Innovation or the Richardson Centre for Functional Foods and Nutraceuticals (amongst many others) facilitated the establishment of these institutions as centres of excellence within their respective regions. At least 31 projects reported on successful installation of various types of physical assets. Approximately 52,000 square metres (including space under construction) was reported in additional space available for R&D, skills training and

Elements of the Innovation System	Examples of Initiatives Supported Under Sub-activities
R&D/Technology Infrastructure (Continued)	activities supporting technology commercialization as a result of the projects. ▪ *Support for UILOs, innovation centres, technical support services, and pre-competitive research that helps facilitate technology transfer and commercialization:* Projects supported by WD have been the catalyst for the subsequent growth of often ad hoc activities into platform level investments in technology commercialization. Approximately 14 initiatives supported the development of technology transfer offices, applied research offices or other support for formalization of the innovation infrastructure. ▪ *Support for pilot tests and demonstrations of new technologies:* Successful pilot tests and new technology demonstrations have led to capital investments to develop these technologies further. Forty-six projects reported on accomplishments towards technology demonstrations or adoption of new technologies.
Access to Human Resources	▪ *Support related to the establishment of education and training programs for industry and students:* Education and training programs offered to industry through WD supported projects assisted industry in increasing efficiency and productivity within their own organizations. When proponents also provided training for students, it enabled proponents to tailor their own student programs to industry needs. Infrastructure and equipment purchases supported by WD enabled proponents to improve curriculum delivery, introduce new degree and diploma programs and improve co-op placements. At least 32 projects set formal targets for training. ▪ *Facilitating hiring of graduate students, postdocs and highly qualified personnel:* WD support allowed proponents to recruit distinguished faculty and improved employment prospects for graduating students. Many projects reported high graduate employment rates as proof of their success in developing a skilled workforce.
Access to Capital	▪ *Supporting clients in raising venture capital from private partners:* At least $9 million dollars was reported in venture capital invested. ▪ *Enabling funded organizations to lever WD funding to raise additional funds:* The support provided by WD was often a catalyst in enabling organizations to raise other funding, particularly because of the credibility WD brings to the project with its stringent due diligence processes. Over $16 million was reported in funding for R&D projects and $264 million was raised for follow on projects, investments or developments related to the original project.
Industry Structure	▪ *Supporting the presence of key technology developers:* At least 24 projects reported on the development of intellectual property using patents as an indicator. Several other projects reported on other types of intellectual property. WD also supported projects to encourage the growth of commercialization of technologies developed by key technology developers by supporting various types of economic and market research, technology assessment services and audits which enabled the beneficiaries to assess costs and benefits and formulate realistic strategies for commercialization. ▪ *Encouraging competition:* By encouraging the growth of startup companies through the support of 12 incubation and virtual incubation facilities or initiatives, WD supported the growth of new market players. Support has also been provided for mentoring programs targeted at improving business management capabilities to improve the survival chances of these new companies.
Linkages	▪ *Project partnerships involving public sector organizations, industry, and research institutions in its projects:* With some initial support from WD proponents were able to recruit industry, other public sector organizations and research institutions to fund and champion their projects ▪ *Assistance in developing and increasing the capacity of cluster champions and coordinating bodies:* WD support increased interactions among players in the cluster. Private companies

Elements of the Innovation System	Examples of Initiatives Supported Under Sub-activities
Linkages (Continued)	were introduced to academic partners for applied research or have funded research within public sector organizations. ▪ *Support for events, workshops, conferences, training seminars that bring together parties active in the innovation process:* Over 30 projects set targets for various types of events. Proponents reported many benefits to the increased networking and knowledge-sharing that resulted from these events. ▪ *Facilitating research collaboration and technology transfer between industry, universities, hospitals and government research labs:* At least 25 projects set formal targets relating to collaborative initiatives. As a result of collaboration and technology transfer between private companies and academic or other public research institutions, all of these institutions have become more aware of each other's respective capabilities. Successful collaborations have led to a commitment for future collaborations. As well, these collaborations have prevented the duplication of resources and capabilities, enhancing the efficiency of the innovation system.

Initiatives related to innovation can be viewed in terms of their position on a continuum which stretches from initial or basic research through the development process which can involve technology transfer, applied research, and commercialization of new products and processes. Within its mandate of promoting economic development and diversification of Western Canada, the primary focus of WD is on development (i.e. technology transfer, applied research, and commercialization). However, this has not precluded WD from supporting activities related to earlier-stage research (primarily in the form of investments in knowledge infrastructure) where it was demonstrated that:

- The activity holds significant potential to diversify and further develop the economy of Western Canada;
- Capabilities related to early-stage research are the initial constraint to further development. Support for latter-stage commercialization activities is not warranted if the technological knowledge base is not yet in place; and
- No other organizations are in a position to provide the assistance needed.

The impacts in the table above summarize WD's contributions to final entrepreneurship and innovation strategic outcomes.

- Improved infrastructure for R&D, new product/process development and education and training
- Increased expenditures on R&D conducted in the new and/or improved infrastructure
- Contribution to HQP to conduct R&D (including faculty and students) and to the skilled workforce required to support the commercialization of new technology within industry.
- Growth of the intellectual property base through various types of intellectual property: patents, trademarks, trade secrets
- Contribution to the startup, survival and growth of young companies in emerging technology clusters and enabling companies in mature technology clusters to stay competitive. Increased capacity, awareness and use of new technology
- Increased cooperation and collaboration among players in the innovation system

WD is often in a unique position to provide assistance to projects that have an effective impact on strengthening the innovation system. The factors which contributed to WD's role in promoting innovation included:

- The flexibility of WD's programming enables it to tailor its activities to reflect the specific needs of each province as well as to provide a continuum of services.

- Its availability of funding, which is considered crucial in bringing parties together and leveraging resources from other sources.
- The ability of the organization and its employees to respond quickly and make decisions.
- Its ability to match national resources and strategies with regional and provincial needs and issues.
- The presence of staff in the regions who are skilled in developing projects, building partnerships, and assessing opportunities. The experience that staff have acquired in economic development, vetting projects, and working with various parties enables WD to add significant value to the innovation system.
- Its familiarity with the local economy, clusters, and players. While WD may provide funding on a project-by-project basis, one of its major strengths is that the organization focuses on building relationships and establishing development objectives which extend beyond any one project.
- WD is generally perceived as a neutral party that does not have its own agenda apart from promoting innovation, which gives it an advantage when working to establish partnerships.

C. CASE STUDIES

Since the sample of projects in this study is very diverse, case studies are used to illustrate the impacts of WD investments that are not adequately captured by the performance indicators alone. As well, since the case studies involve related projects, they describe how the synergy among projects contributes to the overall impact of the projects. The 4 case studies in this section each involve a series of related projects (12 projects in total). One case study is described for each of the four provinces. In selecting the case studies, we considered the reported impacts, the value of making a site visit, whether case studies had been completed in the past, and the presence of related projects which effectively illustrate the impact of WD's assistance. Further detail on each of the case studies is provided in Appendix A-IV. Here we provide a short summary to illustrate the impacts.

1. Pulse Crops

This case study illustrates how two WD supported projects (a TC project in Winnipeg and a KI project in Saskatoon) contributed to the growth of the pulse crops industry in Saskatchewan. The two projects complement each other by addressing different stages in the commercialization supply chain. While the pulse crops field lab at the U of S in Saskatoon breeds new varieties of pulse crops suited to the local climate, the facility at CIGI tests the processing performance of these new varieties for international market acceptance. Saskatchewan produces over 95% of all the lentils grown in Canada each year and 75% of all peas (Pulse Canada & Statistics Canada). In 2008, Saskatchewan accounted for $1.6 billion or 80% of Canadian pulse exports (Stat Publishing). Part of the success of these projects is attributed to the choice of location for each of the two facilities. The table below highlights the major findings arising from the case study.

Saskatchewan: the growing Pulse Crops sector in Saskatchewan			
	Project Name (Sub-Activity)	**Organization, City**	**Project Details: WD Support and Fiscal Year**
Sites Visited	• Pulse Crops Field Lab (KI)	• Crop Development Centre, University of Saskatchewan, (U of S) Saskatoon	• $750,000, Fiscal Year 04/05
	• Pulse processing and milling facility (TC)	• Canadian International Grains Institute (CIGI), Winnipeg	• $199,800 Fiscal Year 02/03

Saskatchewan: the growing Pulse Crops sector in Saskatchewan	
Summary of Outcomes	• Illustration of how two WD supported projects--a TC project in Winnipeg and a KI project in Saskatoon--contributed to the growth of the pulse crops industry in Saskatchewan. The two projects complement each other by addressing different stages in the commercialization supply chain. While the pulse crops field lab at the U of S in Saskatoon breeds new varieties of pulse crops suited to the local climate and with improved processing properties, the facility at CIGI tests the processing performance of these new varieties for market acceptance.
Major Impacts	• Commercial success for Saskatchewan pulse crops in world markets: in 2008, Saskatchewan accounted for $1.6 billion or 80% of Canadian pulse exports • Growth of the domestic pulse processing industry • Intellectual property development: 64 new pulse crop varieties have been released through SPG's Variety Release Program
Factors Contributing to Success	• Proactive industry association—SPG is a catalyst bringing the players together and taking the initiative • Expertise and renown of U of S' crop breeding programs • CIGI expertise in processing and marketing • Major industry commitment and participation by individual companies • Successful business model for intellectual property commercialization • Collaborative partnerships
Future Challenges	• Encouraging growth in the domestic market for pulse crops • Opportunities for branding of Canadian pulse crops • Value-added products

The two projects are summarized below.

- **Pulse crops field lab at the University of Saskatchewan, Saskatoon:** The University of Saskatchewan's Crop Development Centre (CDC) is renowned for its expertise in breeding. Saskatchewan Pulse Growers (SPG), which represents over 18,000 pulse crop producers in Saskatchewan, uses a "1% check-off" from pulse crop sales to fund research projects at the U of S[6]. It drove the fundraising initiative behind the new lab, and also co-funds a position at the CIGI facility. Observing the acute shortage of space for pulse crops breeding research and aware of the dependency of the growing pulse industry on new varieties, SPG actively led a fundraising initiative to build a new pulse crops field lab.

  The pulse crops field lab project at the U of S, described as a "resounding success" provided an expansion capability for pulse crop breeding programs. Six scientists (with 20-30 other research and administrative staff) work at the lab, including 4 plant breeders (specializing in lentils, chickpeas, peas and dry beans), a plant pathologist and a plant physiologist. The facility is also used for education and training purposes as scientists supervise around 12-15 graduate students and 10 post-doctoral fellows. A tripling of space with the new lab led to increased efficiency and productivity of the breeding program. There has been a 10-20% increase in new varieties since the lab was completed. The market share of the lab's varieties has expanded over the last 3 or 4 years to account for over 90% of lentil production in Saskatchewan. Information collected from surveys by the SPG and by the lab's own data from the Saskatchewan Crop Insurance Corporation show that 50% of pea and chickpea varieties grown in the province were developed at the lab.

6 The annual research budget may vary from year to year. In 2007-08 SPG funded research projects amounted to approximately $4 million, of which 16 were pulse research projects at the Crop Development Centre.

- **Pulse processing and milling facility, Canadian International Grains Institute:** CIGI's facility is unique in Canada in its ability to support a new agricultural niche for western Canada and contribute to the international market growth of pulses internationally. It allows for:
  (1) Testing processing performance of new varieties of pulse crops. When working with the breeders, most of the testing is done on registered lines as larger amounts are needed for the pilot scale equipment.
  (2) Demonstration of new products in value-added applications, e.g. extruded pea snacks.
  (3) Testing production processes for value-added products at close to commercial scale so accurate cost assessments can be made including energy, water and ingredient use.

  The facility fills an important market development need for the industry. Currently SPG funds significant value-added pulse research at the CIGI facility,. The project is now in its third year and the collaboration has been fruitful for SPG. Previously there was no dedicated facility for pulses so sample testing etc. often took a backseat to other crops such as wheat.

The impacts of these two projects include intellectually property development (64 new varieties of pulse crops) and commercialization success. By addressing several stages of the supply chain simultaneously (i.e. breeding, production, processing, value-added processing and marketing) these two projects have played an important role in enabling the commercialization and growth of Canadian pulse crops internationally. Some of the success factors that have enabled these impacts include the existence of an effective proactive industry association—SPG—which functioned as a catalyst in bringing the players together. The expertise and renown of the U of S' crop breeding programs is based on an extensive network of collaborative partnerships and exploited through a unique commercialization model in partnership with SPG. Downstream in the supply chain, CIGI contributes its expertise to expanding international markets for Canadian pulse crops and facilitating domestic industry in expanding its pulse processing capabilities.

2. Composites Manufacturing

This case study describes the contribution of 4 WD supported projects to manufacturing and specifically composites manufacturing,[7] a competitive niche within Manitoba's manufacturing industry. There is an effective synergy between TC and KI projects, whereby the KI project provides education and training, developing the skilled workforce to commercialize technology transfer facilitated through the TC projects. The manufacturing and training facility at Red River College trains students and employees of local companies in composites manufacturing. The Applied Research Office (ARO) and the Composites Innovation Centre (CIC) both work on applied research projects with local industries, assisting them with new technology transfer and development. An extensive network of partnerships among related WD supported projects has contributed to the impact on the composite manufacturing industry in Manitoba. These close cooperative working relationships and investments in applied research, education and training have helped Manitoba to become a centre for advanced composite materials (ACM) in western Canada for several end user industries such as ground transportation, aviation, civil infrastructure engineering and design and agricultural equipment. The table on the following page highlights the major findings arising from the case study.

Manitoba: Composites Manufacturing in Manitoba			
Sites Visited	**Project Name (Sub-Activity)**	**Organization, City**	**Project Details: WD Support and Fiscal Year**

7 Composites are materials made of two or more substances that together offer a higher stiffness to weight ratio. When cost effective they can, e.g., be used to replace aluminum, steel, and titanium on today's aircraft.

Manitoba: Composites Manufacturing in Manitoba			
	• Phase 2 of an Applied Research Office (TC)	• Red River College, Notre Dame Campus, Winnipeg	• $180,000 Fiscal Year 03/04
	• Joint Manufacturing and Training Facility (KI)	• Composites Model Factory, Stevenson Campus, Red River College, Winnipeg	• $551,000 Fiscal Year 06/07
	• Establish operating plan; Further development (TC)	• Composites Innovation Centre, Winnipeg	• $999,370 In Fiscal Year 04/05; $3,311,037 in Fiscal Year 05/06
Additional Sites Visited	• Two projects: The eureka project, SmartPark, University of Manitoba: SMT Research • Centre for Aerospace Technology and Training, Red River College • Advanced Transportation and Energy Centre, Red River College		
Related Projects	• Innovative Structures Research Centre (University of Manitoba) (KI) • Advanced Manufacturing Initiative (Canadian Manufacturers and Exporters (TC)		
Summary of Outcomes	• This case study describes the contribution of 4 WD supported projects to manufacturing, and more specifically composites manufacturing, a competitive niche within Manitoba's manufacturing industry. There is an effective synergy between TC and KI projects, whereby the KI project provides education and training, developing the skilled workforce to enable the technology transfer facilitated through the TC projects.		
Major Impacts	• Development of new technologies and transfer of new technologies to local industry • Education and training of skilled labour force for the industry • High graduate employment rate • Encouraging growth of startup companies		
Factors Contributing to Success	• Cooperative approach among industry, educational and research institutions • Levering regional competitive strengths (e.g. in aerospace, ground transportation, civil engineering, composites • Historical competencies of Red River College in technical training		
Future Challenges	• Sustaining growth • Developing markets for new niches such as biofibres		

Each of the projects is described below:

- **Phase II of an Applied Research Office, Red River College, Winnipeg:** Established as a full-time office in June 2004 at a total project cost of $375,000, research funding at River College's Applied Research Office has increased steadily. The office has five staff and to date the ARO has raised millions in funding for applied research projects with industry,. Eligible for CFI, NSERC, SSHRC, and CIHR funding, RRC has established itself as one of Canada's leading applied research colleges. The applied research infrastructure supporting the ARO includes a new 10,000 square foot Centre for Applied Research in Sustainable Infrastructure (CARSI) focused on developing sustainable infrastructure technologies in four technical areas including ACM.
- **Joint Manufacturing and Training Facility, Department of Transportation, Aviation and Manufacturing (TAM), Red River College, Winnipeg:** Part of a joint manufacturing initiative between RRC and the University of Manitoba, the joint manufacturing and training facility factory at

Red River College's Stevenson Aviation campus [8], more commonly known as the composites model factory officially opened November 2008. Still in its early stages, the facility is heavily used, providing students from both the U of M and RRC with project-based experiential learning of advanced manufacturing processes. RRC's extensive range of manufacturing facilities provides the local operations of multinational companies and SMEs with education and training and assistance with prototyping and new process development.

- **Composites Innovation Centre, Manitoba, Inc., Winnipeg:** The Composites Innovation Centre plays a pivotal role in enabling transfer of composites technologies to local companies and in developing natural fibres for composites application. It assists industry in four sectors and functions as a catalyst for attracting new industry and encouraging startup companies.

The projects described above have made important contributions to the growth of composites manufacturing in Manitoba. The seed funding provided by WD was a catalyst for the subsequent growth of the ARO and the CIC. Both of these projects were able to successfully lever the seed funding to expand their operations and they have ambitious initiatives underway to sustain their growth. These projects have been successful in developing practical knowhow of new technologies within industry. The composites model factory plays a very important role in training students and the labour force for the new processes or new products in advanced composites manufacturing. The factors that have contributed to the success of these projects include the cooperative approach of the institutions described here including industry, educational and research institutions. An important success factor contributing to the impact of these projects is the region's competitive advantage in several end user industries such as aerospace, ground transportation and civil engineering design and construction.

3. The Nanotechnologies Cluster

With 42 companies as of May 2008 according to Cool Companies *2008-2009 Special Report on Alberta's Nanotechnology and Advanced Materials Cluster,* Alberta is home to Canada's fastest growing nanotechnology and advanced materials cluster. WD's support for the purchase of two pieces of state-of-the-art equipment for the nanofabrication facility at the University of Alberta and for the construction of the incubation facility for startup nanotechnology companies on the fourth floor of the National Institute of Nanotechnology (NINT)[9] contributed towards creating a critical mass of world renowned expertise supported by advanced infrastructure and equipment. These were instrumental in enabling the University to recruit distinguished faculty and talented students, many of whom are able to find employment with local companies, whose own operations are supported by this infrastructure. The sector has benefited from continued federal and provincial government support. In May 2007, the provincial government of Alberta announced a $130 million investment in nanotechnology with support for graduate student scholarships, building workforce skills, and other initiatives aimed at assisting the sector in applied research and ultimately achieving commercial success. The table on the following page highlights the major findings arising from the case study.

Alberta: The Nanotechnologies Cluster			
Sites Visited	Project Name (Sub-Activity)	Organization, City	Project Details: WD Support and Fiscal Year

8 In 2002, the Stevenson Aviation & Aerospace Training Centre merged with Red River College to form the Stevenson Aviation and Aerospace Training Centre at Red River College. The merger provided greater flexibility in programming, and more effective use of training staff, equipment and other resources in responding to industry demand.

9 NINT is also located on the University of Alberta campus, close to the NanoFab. Approximately 300 people work at NINT, the majority of whom are graduate students or postdocs. Twenty-four principal investigators have a cross-appointment between the NRC which operates NINT, and the University of Alberta.

Alberta: The Nanotechnologies Cluster			
	• NanoFab: Infrastructure for Microfabricating Devices (TC)	• University of Alberta, Edmonton	• $966,000 Fiscal Year 02/03
	• Nanotechnology Commercialization and Incubation Facility (TC)	• National Institute of Nanotechnology (NINT), Edmonton	• $3,800,000 Fiscal Year 04/05
Related Projects	• Alberta Cancer Diagnostic Consortium, University of Alberta (TC)		
Summary of Outcomes	• Nanofab is a very well managed and heavily used facility that has become indispensable to its industrial and academic users and is facilitating the growth and sustainability of local companies. The incubation facility at NINT provided local nanotechnology startups with well equipped facilities and proximity to the concentrated talent pool available at NINT and nearby faculties at the University of Alberta		
Major Impacts	• Attraction of Highly Qualified Personnel: Faculty, graduate students, technical staff • Local industry users rely heavily on Nanofab • Graduating students who used Nanofab facilities find local employment • Survival and growth of local nanotech start-ups • Enhancing nanotechnology research capacity and productivity		
Factors Contributing to Success	• Strength and breadth of University of Alberta's engineering programs and related programs (medicine, chemistry, etc.) • Nanofab: First mover advantage, wide range of equipment, excellent service delivery • Continued federal and provincial government support and commitment		
Future Challenges	• Moving NanoFab beyond research grade fabrication (larger scale fabrication at 6") • Improving receptor capacity in local industry and engaging AB's major traditional industrial sectors, such as oil and gas • Enhanced interaction between NanoFab users and NINT staff and incubator tenants companies		

The two projects are described below.

- **NanoFab: Infrastructure for Microfabricating Devices, University of Alberta:** Nanofab is the only nanofabrication facility in Canada which allows unrestricted access to academic, government and industry users. WD's supported the purchase of a critical instrument for the NanoFab, a Pattern Generator which has been heavily used since February 2004. Any companies who do microfabrication need the photomasks or chip designs produced by this machine. The NanoFab facility as a whole is generally considered exceptional by its users and it has provided advice to other facilities across North America with setting up their own operations. Local startup companies rely heavily on it, while the research productivity of academic users benefits from lower costs and quick turnaround times.

- **Nanotechnology Commercialization and Incubation Facility, NINT:** The incubator has had approximately 10 tenants to date. Currently there are 8 tenants and discussions are ongoing for possibly 2 more. Some of these are young pre-commercial stage companies. The facility is also home to Canada's first major public-private nanotechnology research partnership with the Xerox Research Centre of Canada. For Xerox, it was an opportunity to tap into the expertise and infrastructure of NINT. For young tenant companies, being located in a well appointed space in a prestigious institute provides them with credibility in the eyes of potential investors and has led to investment in the company.

Given the physical proximity of NanoFab (located within the University of Alberta's Electrical and Computer Engineering Research Facility) and NINT, the two facilities together form a "virtual watercooler" for nanotechnologies on a corner of the university's campus in Edmonton. NanoFab contributes to the commercial viability of local companies by operating an efficient and cost-effective service facility that offers a wide range of state-of-the-art equipment to aid in product and process development. Because the capital requirements of such facilities are so high, small start-ups would have nowhere to do their prototyping and product development without such facilities. For one established company, the critical toolsets at the NanoFab facility have been critical in allowing it to retain its largest customer which may have moved away otherwise. The critical mass of expertise and equipment in nanotechnology available through NanoFab and NINT play a vital role in luring highly qualified personnel (faculty, researchers, and technicians) to Edmonton. The strength and breadth of the University of Alberta's engineering programs and related programs (medicine, chemistry, etc.) have been an important success factor in the impact of these two projects, as has continued federal and provincial support for the facilities.

4. Therapeutic Products

This case study describes two projects in the life sciences sector that focus on two classes of therapeutic products. The Centre for Drug Research and Development, located on the UBC campus in Vancouver has only been operational for less than two years but has already been successful in levering WD's seed funding of $400,000 into over $73 million in capital investment. This funding supports its operations to develop commercially viable drugs from research conducted at BC's research institutions. At BCIT, WD supported the purchase of equipment to support the food processing industry. Numerous challenges arose with conducting applied research for this industry but over time, the equipment has successfully and increasingly been used for applied research for NHP products, a fast growing segment of the therapeutics market, and one which has the potential to lower costs to the healthcare system. The table below highlights the major findings arising from the case study.

<table>
<tr><th colspan="4">BC: Therapeutic Products: Pharmaceuticals, Natural Products, Natural Health Products (NHP)</th></tr>
<tr><th rowspan="3">Sites Visited</th><th>Project Name (Sub-Activity)</th><th>Organization, City</th><th>Project Details: WD Support and Fiscal Year</th></tr>
<tr><td>• Centre for Drug Research & Development (TC)</td><td>• University of British Columbia (UBC), Vancouver</td><td>• $400,000 Fiscal Year 05/06</td></tr>
<tr><td>• Acquisition of equipment & upgrading systems for food processing (KI)</td><td>• British Columbia Institute of Technology (BCIT), Burnaby</td><td>• $500,000 Fiscal Year 02/03</td></tr>
<tr><th>Related Projects</th><td colspan="3">• Equipment for applied research and technology commercialization (the portion relating to the bio-product safety assessment platform), BCIT
• Develop a commercialization roadmap for functional foods and nutraceuticals
• WD has supported several projects at the BC Cancer Agency (5 in the sample of 129 in this report) and at Genome BC (4 of the sample of 129). These projects support the health research infrastructure fundamental to generating the scientific discoveries that are being commercialized by the CDRD.</td></tr>
<tr><th>Summary of Outcomes</th><td colspan="3">• WD has supported innovation across a broad range of therapeutic products in BC's healthcare sector (including pharmaceuticals, NHP and medical and assistive devices). This case illustrates how two WD projects, one in each sub-activity, support commercialization in complementary classes of therapeutic products: pharmaceutical drugs and natural health products. The CDRD is a relatively new but successful TC project to develop pharmaceutical drugs from medical research at BC's universities and healthcare research organizations. At BCIT, equipment originally purchased under the Knowledge Infrastructure sub-activity for applied research and education and training for the food processing industry is being used to support applied research in BC's NHP industry. The potential for collaboration between these two types of post-secondary institutions is discussed in light of the challenges to commercialization in this sector.</td></tr>
</table>

BC: Therapeutic Products: Pharmaceuticals, Natural Products, Natural Health Products (NHP)	
Major Impacts	• Industry engagement • Collaborative partnerships and affiliation agreements • Education and training • Supporting cluster development
Factors Contributing to Success	• Focused approach to partnership development • Existing knowledge base and infrastructure in life sciences in BC research institutions • Fill gaps in local cluster capabilities
Future Challenges	• Regulation • Availability of investment capital for pharmaceutical startups given the long development cycles • Limited research budgets of SMEs in the natural health products sector

The two projects are highlighted below.

- **Acquisition of equipment & upgrading systems for food processing, BCIT**: When WD supported the upgrading of electrical systems and the purchase of equipment for a pilot plant at BCIT to support the food processing industry, it was envisioned that the new facilities would support the food processing industry. Numerous challenges arose in conducting applied research for an industry composed largely of SMEs without formal research budgets. In the meantime, the Natural Health Products[10] group at BCIT had been experiencing growth and also used the equipment to support the growth of the local industry. Companies in this sector needed pre-market licensing for their products and the average contract size for applied research was larger than for the food processing industry, making such projects financially feasible. The group currently comprises 12 staff and has established BCIT as a centre of expertise for regulatory practices and analytical methods for the NHP industry.

- **Centre for Drug Research & Development, Vancouver:** The CDRD is established as a non-profit society and is unique in that in two years it has established affiliation agreements with all the major health research institutions in British Columbia. Its core model emphasizes bridging the "proof-of-concept" gap in the drug development process; i.e. the gap between academic research and pre-clinical toxicology research. In February 2008, the CDRD was among 11 organizations to be named a Centre of Excellence for Commercialization and Research in Canada. The funds that came with this allowed it to expand its capacity to two new drug research institutes (at the BC Cancer Agency to expand animal efficacy and toxicology capabilities; and at Simon Fraser University to expand medicinal chemistry and synthesis for scale-up capabilities). The facilities at the CDRD have been operational for research projects since June 2008 so it is still too early to assess the impact of the research projects.

Though these projects cater to very different industries, both have been successful in supporting local industry, education and training, and in levering the original investment. The food processing and NHP industries are dominated by SMEs without research budgets. The NHP industry has only been specifically addressed through regulations since 2004. The pharmaceutical industry on the other hand is heavily regulated, dominated by large multinational companies, has very long product development cycles and requires extensive capital investments for product development and approval. The CDRD has calculated that they lever $5 for each $1 that they invest in a project (investments are calculated on the in-kind contribution of expertise, equipment and related expenses). The project team assembled could range from 5 to 12 people depending on the size and stage of project. Usually staff from the technology transfer office

10 NHP are a sub-category of drugs that do not require clinical trials as pharmaceutical drugs do but since 2004 must be manufactured under Good Manufacturing Practices (GMP). They include vitamins and minerals; herbal remedies; homeopathic medicines; traditional medicines such as traditional Chinese medicines; probiotics, and other products like amino acids and essential fatty acids.

of the institution where the discovery originated would be on the team. Currently, the principal investigators associated with the CDRD's 19 approved projects have received several million in grant funding.

The capabilities and respective areas of expertise of these two institutions are complementary and can support the growth of a full range of therapeutic products in BC. The two institutions are exploring the potential for collaboration for projects in the Type II diabetes field based on a natural product (i.e. a plant extract as opposed to a synthetic derivative) so the CDRD can avail of BCIT's facilities processing for large amounts of biomass. For the CDRD, it is invaluable to have a local processing facility at a reasonable cost as opposed to using a contract research lab or having to ship the material out of the province for processing. BCIT''s expertise in NHP regulation will enable the CDRD to assess whether to develop the product is developed as a pharmaceutical drug or a NHP, which have a much shorter product development cycle as they do not require extensive clinical trials. By contributing ultimately to the development and commercialization of therapeutic products in BC, these projects have the potential to make a significant contribution to economic development within the province.

D. IMPACTS ON CLUSTER DEVELOPMENT

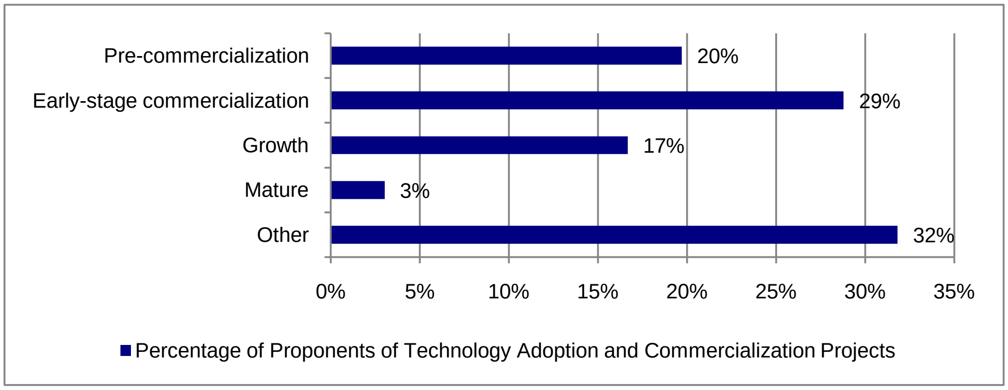
1. Technology Adoption and Commercialization Projects

Project proponents and users and stakeholders were asked about the role of projects in development of clusters. The major findings of our review regarding the role of the projects in cluster or system development are summarized as follows:

- **The Technology Adoption and Commercialization projects varied widely in terms of the level of cluster development at the time of approval.**

  Proponents were asked how they would characterize the clusters stage of development at the time of project approval (the cluster that they felt their project was most closely identified with).

PERCEIVED STAGE OF DEVELOPMENT OF CLUSTERS AT THE TIME OF PROJECT APPROVAL BY PROJECT PROPONENTS



Since many WD projects are targeted at emerging technologies, the majority of proponents (49%) characterized clusters (i.e. the cluster associated with their project) as being predominantly in pre-commercialization or early-stages of commercialization at the time their projects were approved.

"Other" typically indicates that the project is not attached to a single cluster or the question was not applicable based on the nature of the project. As shown earlier in this report, a large proportion of technology commercialization projects were aimed at building technology commercialization capacity through support for incubator facilities or technology transfer offices at universities, colleges and research institutions. The majority of these projects focused on supporting technology commercialization processes and infrastructure across many clusters. Only a couple of the incubation facilities discussed earlier focused on specific clusters such as biotechnology or nanotechnology, the other facilities did not serve a specific cluster and hosted tenants from many clusters (e.g. life sciences, software, manufacturing, etc.). Thus proponents could either not comment on specific clusters or viewed their support as being broadly spread across many clusters in varying stages of development.

- **Since the time when the projects were approved, the development of the clusters has progressed significantly.**

  Proponents were asked about the progress in cluster development since projects had been approved. Some examples of clusters which saw considerable progress are:

  - **Solar Hot Water in BC**: In BC, the growth of the solar hot water within the renewable energies cluster was seen to have progressed significantly in terms of putting "all the little pieces together". The infrastructure required has seen development, and there has been progress with building installer capacity, public awareness and the development of solar friendly regulations at all levels of government: federal, provincial and municipal.
  - **Green Roofs in BC**: Green roofs had been described as a nascent cluster at the time of project approval but over the course of the project a solid well-developed technology that included local suppliers was developed along with proof of performance data.

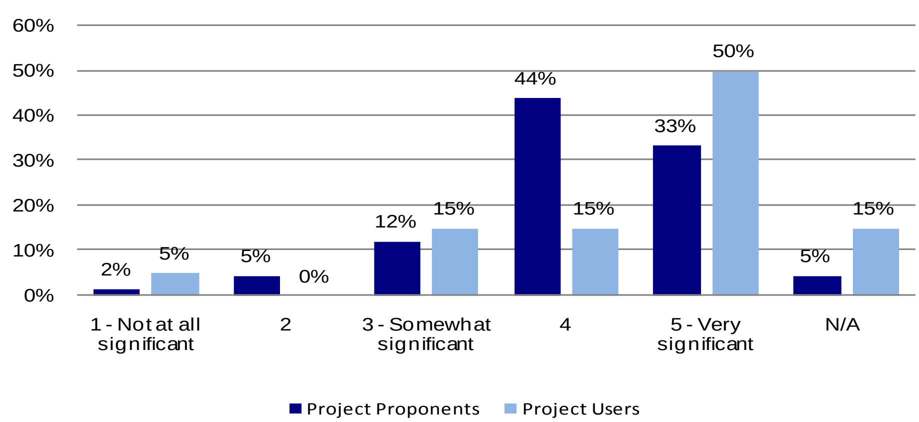
  - **Nanotechnologies in Alberta**: The nanotechnologies cluster in Edmonton was seen as having made quite some progress since 2002. It has received more investment with the result that there has been more program development, e.g. there are more prototype development programs and more specialized, dedicated resources to help startups get to market.

- **Wireless in Alberta**: Prior to WD's support of projects wireless-related projects in Calgary, there was no industry association to represent the interest of wireless companies and related institutions. The cluster also became more diverse with respect to its end user markets. While previously wireless companies in Calgary were focused on serving companies in the natural resource sector, they now also target the healthcare, environment, and mainstream ICT industry sectors as end users. The creation of another Alberta industry association, Digital Alberta was identified as contributing to the development of Alberta's new media industry.

- **Overall, proponents, users and stakeholders believe that the projects were significant in terms of promoting further development of the clusters in their region.**

Project proponents and users were asked about the significance of the project in promoting further development of the cluster in their regions.

SIGNIFICANCE OF THE PROJECT IN PROMOTING FURTHER DEVELOPMENT OF THE CLUSTER IN THEIR REGION



Within the technology commercialization sub-activity, a majority of both proponents and users/stakeholders believed that the projects had made a significant contribution to promoting the development of clusters. On a scale of 1 to 5, where 1 is not at all significant, 3 is somewhat, and 5 is very significant, the average rating provided by project proponents was 4.1 and the average rating provided by users and stakeholders was 4.2.

- **Project proponents and users believe that the projects supported by WD contributed to the progress of the development of clusters.**

Proponents and users/stakeholders were asked how the projects supported by WD had contributed to the progress they perceived in cluster development.

- **Catalyst**: Several proponents attributed WD's support as being the seed for cluster development, i.e. as the catalyst for the project's contribution to cluster development, e.g. the solar hot water project discussed earlier.

- **Formalized innovation networks and provided strategic direction**: In projects aimed at building technology commercialization capacity across clusters, proponents perceived that WD's support was instrumental in formalizing innovation networks through the creation of infrastructure and processes throughout the value chain and by establishing regional priorities for resource allocation. Within specific cluster, projects provided strategic direction to formalized innovation networks, e.g. the commercialization roadmap developed by the BC Functional Foods and Nutraceutical Network (the Western Canadian Functional Food & Natural Health Product Network since 2006) was seen as assisting companies to increase chances of success in the areas of functional foods and natural health products.

- **Increased competitiveness**: Proponents of projects aimed at mature industries such as the lumber industry stated that WD support for projects had helped to make SMEs more competitive by increasing their awareness of new technologies and technical assistance to explore opportunities in value-added products.

- **Credibility and confidence with new technologies**: Even when the WD project was relatively modest, as in the case of the project for market development of biodiesel in BC, the project made a valuable contribution by bringing confidence to users and suppliers of biodiesel and thereby improving biodiesel's credibility.

- **Marketing and branding**: WD's support was credited with contributing to the marketing and branding of Vancouver as a national centre for the Green Buildings cluster.

- **Contributed to the development of the knowledge base and HQP**: The fuel cell installations at NAIT were highly commended for their excellence as a technology demonstration and for training students who were joining the workforce with a good knowledge of fuel cell technologies. The Composites Innovation Centre in Winnipeg was credited with creating a talent and knowledge base for composites technology in the region across several industry sectors: aerospace, ground transportation, biofibres and design and construction of civil infrastructure.

- **Encouraged the introduction of favourable government regulation:** Regulations introduced by the provincial government of BC to mandate biofuels by 2010 was seen as a major contribution of the BC Biodiesel Market Development Project to cluster development.

- **Supported infrastructure development:** In Edmonton, the incubation facility for nanotechnology companies at NINT was viewed as increasing the chances of success for these companies. WD's support of the purchase of a Heidelberg Pattern Generator for the Nanofabrication facility at the University of Alberta was seen as essential to the development of young companies. As one user emphasized, any companies who do microfabrication need the photomasks produced by the Pattern Generator. Another user, commenting on the range and quality of tools provided by the whole facility stated that young companies could not exist without the facility due to the extremely high capital costs of microfabrication equipment.

- **Promoted linkages and collaboration:** Some projects were cited as having increased collaboration within provinces and sometimes across provinces. A project at the University of Calgary that has the potential to create a virtual reality space for simulation surgery (doing the surgery in virtual reality and animating the patient to assess the functional outcomes of surgery) led to a collaboration with the proponent of a separate grid computing project at the University of Alberta since large data transfers are needed for force feedback simulation surgery. The patient data used for the simulation comes from the University of British Columbia in Vancouver. In other cases proponents perceived WD support for their project as allowing them to become a central point to facilitate collaboration and as a repository for knowledge. This was seen for example within the metabolomics cluster in Edmonton and in the green roof project at BCIT.

Not all projects made a contribution to regional clusters. Here is a comparison of two projects: one with a strong regional, the other with a narrow technology and a broad geographical focus. The Centre for Drug Development and Research at UBC is viewed as making a strong contribution to regional clusters due to its affiliations with most of the province's health research institutions. However, the Stem Cell Network and the spinoff company created through it to commercialize stem cell technologies has a narrow focus on stem cells but is national in scope in terms of its objective of commercializing stem cell technologies across Canada. Another example of a national network established partly as a result of WD support is the SOFC or solid oxide fuel cell network.

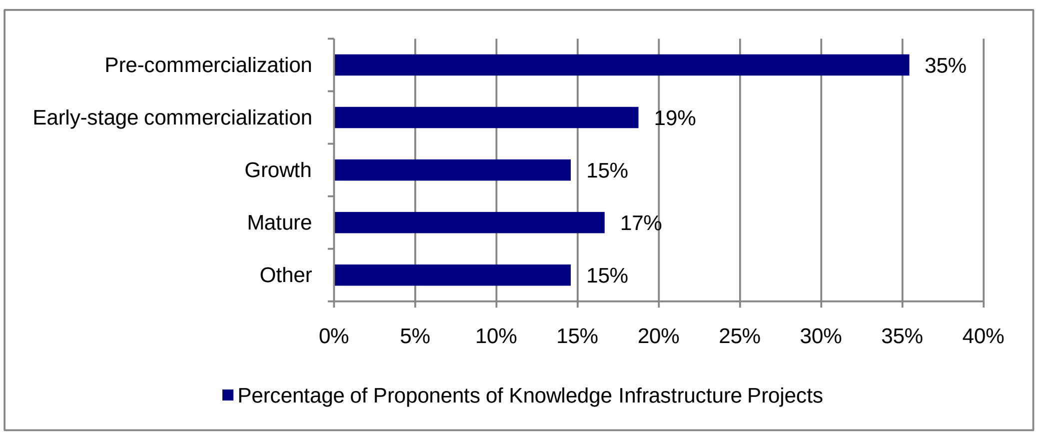
2. Knowledge Infrastructure Projects

Project proponents and users and stakeholders were asked about the role of projects in development of clusters. The major findings of our review regarding the role of the projects in cluster or system development are summarized as follows:

- **Most proponents of Knowledge Infrastructure projects characterized clusters as being predominantly in pre-commercialization or early-stages of commercialization at the time their projects were approved.**

  Proponents were asked how they would characterize the clusters stage of development at the time of project approval (the cluster that they felt their project was most closely identified with).

PERCEIVED STAGE OF DEVELOPMENT OF CLUSTERS AT THE TIME OF PROJECT APPROVAL BY PROJECT PROPONENTS



- **Since the time when the projects were approved, the development of the clusters has progressed significantly.**

  Proponents were asked about the progress in cluster development since projects had been approved. Some examples of clusters which saw progress are:

- **Biodiesel (production) in Alberta**: WD's capital and operating support for the Olds College Centre for Innovation is perceived to have contributed to the development of the biodiesel cluster in Alberta. Until recently Olds College was the only processor of biodiesel in AB and it is the only biodiesel processor in AB that had a broad-based trial of biodiesel with 12 industry partners.

- **Horticulture in BC**: Seed investments in Kwantlen's Institute for Sustainable Horticulture led to the growth of the Institute, establishing it as a focal point for the cluster in BC. The challenge that this cluster faces is that its various sectors are very diverse with different economics and different barriers to growth.

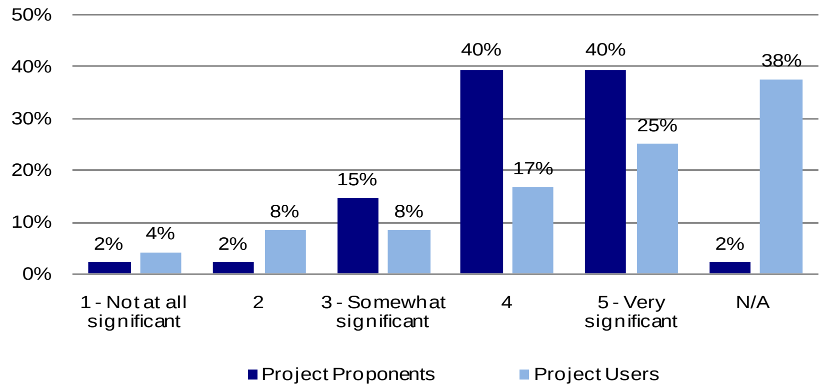
- **Functional Foods, Medical Devices & Composites Manufacturing in Manitoba**: The Smartpark research and technology park at the University of Manitoba (supported by WD in a series of investments including but not limited to the sample of projects covered in this report) focuses on 4 clusters: ICT, biotech, functional foods, and composites manufacturing. The functional foods cluster and composites manufacturing are both perceived as being relatively new to Manitoba, with the former being only a decade old. The development of the Composites Innovation Centre was seen as having a tremendous impact in establishing Winnipeg's competence in composites manufacturing. The Richardson Centre also located within Smartpark builds on the University of Manitoba's strength in food sciences. Tenants at Smartpark utilize the Richardson Centre by renting bench space, commissioning R&D from the Centre, or conducting clinical trials there. A challenged faced by the functional foods and nutraceuticals cluster is that claims are often made about products without any scientific evidence. The Richardson Centre provides the infrastructure to support expensive clinical studies with animals and humans whereas previously there was no organized approach to conducting research to validate the claims behind these products. Within the biotechnology cluster, Winnipeg is seen as realizing the fruits of cluster development in the area of medical devices which have a shorter time to commercialization.

- **Overall, proponents, users and stakeholders believe that the projects were significant in terms of promoting further development of the clusters in their region.**

  Project proponents were asked about the significance of the project in promoting further development of the cluster in their regions. Within the Knowledge Infrastructure sub-activity, a majority of proponents believed that the projects had made a significant contribution to promoting the development of clusters. Almost 40% of users and stakeholders of Knowledge Infrastructure projects did not comment on cluster development either because they operated in specialized niches and were not part of a geographical cluster, they were not familiar with developments in the cluster, or they did not feel themselves qualified to comment on developments in the cluster.

  On a scale of 1 to 5, where 1 is not at all significant, 3 is somewhat, and 5 is very significant, the average rating provided by project proponents was 4.1 and the average rating provided by users and stakeholders was 3.8.

SIGNIFICANCE OF THE PROJECT IN PROMOTING FURTHER DEVELOPMENT OF THE CLUSTER IN THEIR REGION



- **Project proponents and users believed that the projects supported by WD contributed to the development of clusters.**

  Proponents and users/stakeholders were asked how the projects supported by WD had contributed to the progress they perceived in cluster development. Some specific examples of support included:

  - **Contributed to knowledge base, development of HQP and a skilled workforce**: Knowledge Infrastructure projects were seen as contributing to the development of a skilled workforce to support the growth of technology clusters, particularly in fields such as engineering, manufacturing and various disciplines related to life sciences. Facilities supported through WD's Knowledge Infrastructure have played a critical role in educating students who then join the talent pool to supply industry. At Simon Fraser University, investments have supported projects which educated engineering students for BC's wireless cluster. For example, in the view of a stakeholder who personally experienced the benefits of the composites model factory at Red River College, the training facility enables students to "hit the ground running" when they graduate.

    WD's support of facilities for training and education were seen to have supported cluster development by directly supporting industry in its training needs (SMEs and large global companies). For example, the composites model facility at Red River College has supported local and international aerospace companies with their training needs for advanced automation. In addition when SMEs hire students who have been trained at the model factory, the students themselves facilitate technology adoption in their new workplaces; they help their employers to be open to adopting new technologies. The facility for metrology at NAIT is used by 30-50 companies per year.

  - **Infrastructure availability and consolidation of facilities for research activities**: Proponents commented on how expansion of physical infrastructure for research activities contributed to cluster development by acting as a focal point for collaboration and knowledge development. WD's contribution was especially notable for organizations such as the Centre for Shellfish Research in BC, the Forest Research Lab at the University of

Northern BC, and Kwantlen's Institute for Sustainable Horticulture since it was the seed money for these organizations. A Forest Research Lab provided space for researchers to work on the impact of the mountain pine beetle research and established the University of Northern British Columbia as the centre for this research in BC's Central Interior Region. Kwantlen now has a profile in supporting the horticulture cluster in BC's Lower Mainland region, although before the WD project it had a very narrow focus mainly on ornamental horticulture and greenhouses. Its growth is especially notable since other local institutions in the region have scaled back or shut down their horticulture programs (UBC and Capilano University).

As with the technology commercialization sub-activity, having infrastructure available for product or prototype development was invaluable to users and stakeholders of Knowledge Infrastructure projects. For example, a company involved in ethanol production finds that having a state-of-the art nuclear magnetic resonance facility (where WD supported an equipment upgrade) nearby speeds up the development process. In the previous year, the company had to send samples to the U.S. or the U.K. for analysis. Similarly the WD supported facility at ISIS was seen as a significant asset for local and national engineering consulting firms.

Another way in which the development of infrastructure was seen to be useful by stakeholders was in allowing physical proximity of scientists and researchers in a common facility. Users of many such facilities, e.g. at VIDO and at the Pulse Crops Field lab stated that having a dedicated physical space from which to conduct their research was invaluable in facilitating collaboration, improving morale and generally increasing research productivity. The nanofabrication facility at the University of Manitoba broadened its range of users to include many different disciplines after receiving support from WD whereas previously only the electrical engineering department had made use of the facility.

- **Supported development of centres of excellence**: Many research organizations institutions which received WD support contribute to cluster development because they are renowned as centres of excellence in their respective fields: these include the Wine Research Centre at UBC, ISIS at the University of Manitoba, and the Genome Sciences Centre in Vancouver.

- **Promoted linkages and collaboration:** Some users and stakeholders perceived proponents of WD projects as facilitating linkages and collaboration to support the development of clusters. For example, a supplier to Olds College perceives Olds to have become a major applied research centre for the production of biodiesel in Western Canada. The College is seen as having done tremendous work in imparting knowledge of biodiesel at the grassroots level, e.g. on crushing for feedstock crops with a high energy/oil content. The College has many partnerships with municipal and private transportation companies.

Finally, an important but less tangible way in which WD supported cluster development is by staying focused on the innovation agenda, particularly by defining industrial participation in knowledge infrastructure facilities. Proponents perceived that without WD's role in establishing this dual mandate, contribution to the growth of clusters may have been less significant.

V. SUMMARY OF IMPACTS

This chapter summarizes the major findings including the impacts generated by province and sector as well as the economic impacts of the project expenditures themselves.

A. SUMMARY OF MAJOR FINDINGS

The major findings and conclusions arising from our review are as follows:

1. WD has made significant investments in Technology Adoption & Commercialization and Knowledge Infrastructure projects.

This review has focused on 129 projects including 75 Technology Adoption & Commercialization projects and 54 Knowledge Infrastructure projects. Over the period from April 1, 2002 to March 31, 2007, WD approved funding of $126.5 million for these projects. Some of the characteristics of these projects include:

- The combined project costs for the 129 projects totaled $445.3 million. Therefore, for every dollar provided by WD, $2.52 was invested in the projects from other sources.
- The project funding was distributed to 64 organizations. Forty-nine organizations were approved for funding under the Technology Adoption & Commercialization sub-activity while 29 organizations were approved for funding under the Knowledge Infrastructure sub-activity
- Most of the proponent organizations (31%) are educational institutions. Other types of organizations include: industry associations (16%); non-profit organizations (16%); R&D consortia (16%); and provincial government and provincial health authorities (13%).
- The life sciences sector accounted for 44% of approved funding for the sample of projects. The IT sector accounted for 17% of approved project funding.
- Within both sub-activities, projects were designed to accomplish a wide range of objectives. Project types included projects aimed at: improving research capacity, building technology commercialization capacity, demonstrating new technologies, developing markets, improving service delivery, providing education and training, developing new products, and community outreach.

2. In addition to funding, WD also provided other assistance which plays a key role in the development and implementation of many projects.

Of the proponents we interviewed for the 122 projects, 54% indicated that WD representatives played an important role in design, development and implementation. More specifically, WD representatives provided important feedback on project design, oversight and monitoring, participated in steering committees during project implementation, helped to secure other sources of funding, assisted in publicity and media relations, and facilitated linkages with other organizations.

3. Most projects were implemented as planned and successful in achieving their objectives.

Of the projects which were reviewed:

- 98% of projects were implemented largely as planned. Even though there were some adjustments made as some projects were moving forward (e.g. broadened project scopes, refinements to the work plan, and project revisions), most adjustments created positive impacts and timing delays were not substantial; and

- 90% were rated by proponents as being successful or very successful in achieving their stated objectives. When asked to rate how successful the project has been in achieving the objectives on a scale of 1 to 5, where 1 is not at all successful, 3 is somewhat and 5 is very successful, the proponents provided an average rating of 4.6

4. The projects supported under the Technology Adoption and Commercialization sub-activity and Knowledge Infrastructure sub-activity have generally met or exceeded their targets related to the standard PAA (Program Activity Architecture) performance indicators.

The primary outcomes reported by the 75 Technology Adoption & Commercialization projects include:

- 227 patents filed or issued;
- 52 technologies adopted;
- 343 prototypes developed;
- 164 technology demonstrations;
- 251 licenses executed;
- 37 technologies to market;
- 30 spinoff companies; and
- at least $9 million in venture capital invested.

The outcomes reported by the 54 Knowledge Infrastructure projects include:

- The development of 22,424 square metres of space dedicated to R&D and skills training (with another 9,300 close to completion); and
- Approximately $16.4 million in R&D undertaken in the new facility or using new equipment supported under the WD project.

Other outcomes reported by these Knowledge Infrastructure projects included 35 patents filed or issued and 6 spinoff companies. Within both of the sub-activities, there are projects in progress which are not yet in a position to report on indicators.

5. The projects have also generated a range of other impacts in the form of intermediate innovation activity outcomes.

More specifically, the projects have:

- Improved research capacity (e.g. through acquisition of new equipment and development of new facilities).
- Strengthened capacity for technology commercialization (through establishment of infrastructure, processes and personnel for technology commercialization);
- Increased access to education and training (increased numbers of students going through programs, use of new equipment or facilities, increased co-op placements, improved curriculum delivery).

- Improved service delivery (e.g. improved service delivery to industrial and academic clients through equipment upgrades or purchase of new equipment which enable cost effective services with faster turnaround times).
- Attraction of funding and HQP (e.g. enabling universities to recruit distinguished faculty and better compete for research grants)
- Sustained and expand operations. For example, users of project outputs reported improved profitability through increased revenues and/or decreased costs, employment growth, and applications of new technology.
- Produced scientific discoveries and publications.
- Led to successful technology demonstrations within many industries.
- Led to follow-on projects. Twenty-seven proponents associated with Knowledge Infrastructure projects estimated approximately $138.7 million was invested in related projects, investments or developments. Thirty-two proponents indicated that their Technology Adoption & Commercialization projects led directly to other projects, investments or developments worth approximately $125.6 million.

6. Most of these impacts can be attributed to the support provided by WD.

On average, project proponents estimated that there was likelihood of only 17% that their projects would have been implemented regardless of assistance from WD. In the absence of WD support, most projects report that they would not have been successful in accessing funding from other sources. Most of those projects that could have proceeded would have been delayed or reduced in scope in the absence of WD funding.

7. Taken together the projects supported by WD in the Technology Adoption and Commercialization and Knowledge Infrastructure sub-activities have helped to strengthen the innovation system in Western Canada.

WD projects have supported the innovation system by building on it through four levels of outcomes. At the first and most immediate level, project proponents achieved or worked towards targets on performance indicators established in project approval documents. These included but were not limited to the standard performance indicators described above. The majority of projects continued to be active beyond the formal reporting period of the project. Some proponents were able to report on standard indicators beyond the reporting period of the project. These impacts were summarized as intermediate project outcomes.

Over the longer term, many proponents reported significant accomplishments and other notable impact as intermediate innovation activity outcomes. At the highest level of final entrepreneurship and innovation strategic outcomes, WD initiatives have had an effective impact on five areas of the innovation system including: enabling industry players to respond proactively to market and demand conditions; developing the R&D and technology infrastructure; contributing to the development of skilled human capital; improving access to capital, developing industry structure by encouraging competition; and supporting the development of key technology developers. They have also facilitated linkages among in the innovation system.

B. SUMMARY OF IMPACTS BY PROVINCE

The table on the following page aggregates the standard performance indicators for both sub-activities by province. As noted earlier, the reported impacts are largely reflective of the allocation of projects by province as well as some variation in the use of standard performance indicators across provinces. The column titled “# Projects Reporting” includes projects which reported on the indicator as an unexpected outcome.

ACHIEVEMENT OF COMMON STANDARD PERFORMANCE INDICATORS BY PROVINCE

	British Columbia			Alberta			Saskatchewan			Manitoba		
	# Projects Reporting	Target	Impact	# Projects Reporting	Target	Impact	# Projects Reporting	Target	Impact	# Projects Reporting	Target	Impact
(WD42) Number of patents filed/issued PAA (Baseline 26)	13	110	187	8	21	30	0	NA	NA	2	14	10
(WD45) Number of technology demonstrations	4	158	128	4	30	20	2	10	16	0	NA	NA
(WD49) Number of technologies adopted (Baseline 16)	3	18	27	0	NA	NA	1	21	25	0	NA	NA
(WD43) Number of licences executed (Baseline 168)	4	16	40	3	255	210	0	NA	NA	1	2	1
(WD44) Number of prototypes developed (Baseline 92)	11	68	65	3	135	266	0	NA	NA	1	14	12
(WD46) Number of technologies to market (Baseline 4)	4	121	31	0	NA	NA	0	NA	NA	1	10	6
(WD47) Number of spinoff companies formed (Baseline 1)	5	22	11	6*	3	7	1	15	9	2	5	3
(WD48) Value in venture capital invested and levered investment in projects (Baseline $116,000)	1	$25m	NA	1	$5.6 m	$9m	0	NA	NA	0	NA	NA
(WD68) Number of square metres dedicated to R&D and skills training	4	692	1,142	0	NA	NA	0	NA	NA	2	12,750**	3,450
(WD69) Value of R&D undertaken in the new facility or using new equipment supported under the WD project(s)	1	$560,000	$1,389,000	0	NA	NA	0	NA	NA	5	$45.1 million***	$15.03 million
(WD 70) Number of Physical Assets Baseline 8	5	12	13	0	NA	NA	1	13	12	1	1	1

*not including the project which defined its target in terms of spinoffs per year

**Includes 9,300 square metres under construction.

*** Includes a project which is still in progress and the building is still under construction.

C. SUMMARY OF IMPACTS BY SECTOR

The table on the following page illustrates the impact of WD investments by sector based on a summary of intermediate outcomes on standard performance indicators where possible. The table illustrates variations in the use of performance indictors across sector. The Knowledge Infrastructure indicator "number of square meters dedicated to R&D and skills training" was used only in the life sciences sector. The value of R&D undertaken in the new facility or using new equipment supported under this project was used primarily for projects in the life sciences sector, which registered the largest impact at $7.5 million and the "other" sector which consists various sectors. Of the standard performance indicators for the technology commercialization sub-activity, the most notable impact was also in the life sciences sector with 175 patents reported. The sector's contribution to prototype development was also notable with 286 prototypes reported. In general, the use of the standard performance indicators was most prevalent in the life sciences sector.

D. MULTIPLIER EFFECTS

WD has previously examined the impact of its investments in Western Canada's life sciences sector. The findings of this research are summarized in the report, *Impact study of WD's investments in Western Canada's life sciences cluster, September 2007.* That study reported on the qualitative and quantitative impact of investments made in life sciences by WD during the six-year period from April 1, 2000 to March 31, 2006, during which WD approved 359 projects for total funding commitments of approximately $161 million. The impact was calculated based on a sample of these projects and then extrapolated to the population of projects.

The report quantified the direct and indirect economic impacts of WD investments for output, GDP and employment based on an estimation of multipliers that reflect structural relationships in the economy. Output was defined as the sum of all expenditures or economic activity that resulted from investment in a project. GDP was defined as a measure of the value added to the economy by a project or projects, (i.e. it captures the difference between the value of output and the value of intermediate inputs, representing the net incremental value of economic activity that took place). Employment represents the number of full time jobs created as a result of the investments measured by full-time equivalents (FTEs) per million dollars of output. The direct impact of each of these measures is the initial, immediate impact that results directly from spending on the projects. Indirect impacts are the result of linkages in the economy that capture the economic impacts of iterative rounds of spending by individuals and businesses that supply goods and services to the projects. Direct and indirect impacts are often estimated through the use of economic multipliers that reflect structural relationships in the economy.

ACHIEVEMENT OF COMMON STANDARD PERFORMANCE INDICATORS BY SECTOR

	Life Sciences			Information Technology			Multi-Cluster			Other			Total		
Indicators	Projects	Target	Impact	Projects	Target	Impact	Projects	Target	Impact	Projects	Target	Impact	Projects	Target	Impact
# of square meters dedicated to R&D and skills training	6	4142	4592										6	4142	4592
# physical assets	5	12	13				1	1	1	1	13	12	7	26	26
# licenses executed	7	24	36				3	257	215				10	281	251
# patents filed/issued	15	130	175	1	1	3	6	34	73	2	10	11	24	175	262
# prototypes developed	5	144	286				8	58	48	2	15	9	15	217	343
# spin-off companies formed	8	29	12			4	5	29	19	2	4	1	15	62	36
# technologies adopted	2	23	44				1	6	8	1	10	0	4	39	52
# technologies to market	3	120	26				2	11	11				5	131	37
# technology demonstrations	3	19	11	4	31	34	2	6	12	3	165	107	12	221	164
Value of R&D ($ million) undertaken in the new facility or using new equipment supported under this project	5	$12.2 m	$7.5 m				1	$3.0 m	$4.4 m	1	$0.5 m	$4.5 m	7	$15.7 m	$16.4 m

The multipliers for the calculation of direct and indirect economic impact in this report were estimated by first categorizing funds invested by three broad types of expenditure: equipment costs, construction costs, operations costs. The Statistics Canada National Open Input-Output Model was employed to developed and applied appropriate economic impact multipliers for each category of expenditure to arrive at the economic impacts of the sampled projects. The multipliers used in that report have been used here to calculate the direct and indirect economic impacts of the sample of projects in this report. The projected economic impacts associated with the expenditures made the 129 projects which were the subject of this review are summarized in the table below.

WD Projects	**Total Expenditures**		**$ 445,253,555**
	Direct	**Indirect**	**Total**
Output $ million	445.3	198.1	643.4
GDP $ million	187.6	115.1	302.6
Employment	3,891	1,739	5,630

The estimated total output of $643.4 million is made up of $445.3 million in direct impact (the total expenditures associated with the projects we reviewed) and indirect impacts of $198.1 million. As a result, the project expenditures can be said to have generated an additional $198.1 million in impacts through the spending of the project recipients. Expressed as a ratio, each dollar invested in the project from all sources is estimated to have generated a total of $1.45 in output (each dollar invested by WD resulted in $5.08 in outputs).

The increase in GDP is estimated at $302.6 million. This consists of $187.6 million in direct impacts and $115.1 million in indirect impacts. Expressed as a ratio, each dollar invested in WD supported projects can be said to have resulted in $0.68 in increased GDP (equivalent to $2.39 in GDP for each dollar invested by WD).

The estimated 5,630 full time equivalent jobs created as a result of the projects consists of direct employment of 3,891 full time equivalent jobs, and indirect employment of 1,739 full time equivalent jobs (approximately one job for every $79,000 invested in the project or every $22,500 invested by WD).