

REVISED REPORT

**THE ECONOMIC IMPORTANCE
OF THE LIFE SCIENCES SECTOR
IN BRITISH COLUMBIA**

Updated to reflect data available in 2012

D.E. Park & Associates Ltd.

**THE ECONOMIC IMPORTANCE
OF THE LIFE SCIENCES SECTOR IN BRITISH COLUMBIA
RESULTS OF ANALYSIS**

- This analysis was carried out for Life Sciences British Columbia by D.E. Park & Associates Ltd.
- The definition of life sciences provided by LSBC included biopharmaceuticals, medical devices, bioproducts, bioenergy, and forest, agricultural and marine biotechnology.
- This is an update based on data for fiscal 2011-12 or calendar 2011, except for a 2012 company tally.
- With the assistance of LSBC, a listing of life sciences companies was provided to Statistics Canada, which compiled aggregate figures for the 159 companies active among a long list of 306.
- The number of active companies was 19% higher in 2011 than the 134 that were active in 2010.
- The annual payroll for all BC life sciences companies in 2011 is projected to have been \$300 million.
- On a full time equivalent basis there were approximately 4,200 employees of life sciences companies.
- The corresponding figures for 2010 were \$240 million and 3,300 employees. The payroll figure for 2011 was 25% higher and employment 27% higher than for 2010, although in part that might be because of more complete identification of companies engaged in life sciences research.
- Total expenditures in BC in 2011 by life sciences research and development companies were about \$570 million, 24 % higher than the estimated \$458 million in 2010.
- In addition to life sciences companies, in BC there are numerous universities/hospitals and other research institutions that conduct life sciences research.
- In fiscal 2011-12 or near 12 month period, they attracted at least \$264 million in funding for life sciences research, and added to that a further \$160 million internally for a total of \$424 million.
- Of that amount, an estimated \$332 million was spent in BC, which was 12% more than 2010-11.
- These estimates of amounts spent on life sciences research are conservative, since there are other known sources for which data is not immediately available.
- It is estimated that total life sciences research spending in BC in 2011-12 was about \$900 million, or 19% more than the \$755 million spent in 2010-11.
- Total impact of life sciences research spending in BC in 2011-12 is estimated to have been just over \$1 billion on provincial Gross Domestic Product (GDP) through direct and indirect effects. This is approximately 19% higher than for 2010-11.
- The total impact of the life sciences sector on employment in BC in 2011-12 is projected to have been 14,000 jobs on a full time equivalent basis, 20% higher than in the previous year.
- Although in 2012 there were prominent setbacks affecting key life sciences companies in BC, the numerical indicators presented here show that the sector as a whole has grown relatively strongly. It remains to be seen whether that momentum has outweighed the more visible negative events.

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THE ECONOMIC IMPORTANCE OF THE LIFE SCIENCES SECTOR IN BRITISH COLUMBIA

1. SUMMARY

1.1 Background

Life Sciences are an important part of research and development in British Columbia. Over the past decade the field has grown very substantially, in part paralleling the remarkable progress of genomics research in this province.

For purposes of this analysis the life sciences sector has been defined to have four parts, as laid out by LifeSciences British Columbia. Those parts are Biopharmaceuticals; Medical Devices; BioProducts; and BioEnergy. Forest, agricultural and marine biotech are also aspects of life sciences in the province.

The active cooperation of LifeSciences British Columbia (LSBC) has been a key part of this project, including the provision of comprehensive lists of life sciences organizations in the province, and surveying members to obtain data on their expenditures and employment as part of the basis for estimating the economic importance of life sciences in the province.

To supplement that data, the consultants contracted with Statistics Canada for that agency to review in confidence the mandatory statistical submissions to Statistics Canada of the life sciences companies in British Columbia. This provided aggregate figures for employment as well as data from which an overall estimate was made of wages, salaries and benefits (payroll) for the sector in this province.

As the study progressed it became increasingly evident that life sciences research plays a major role in the economic importance of life sciences. We therefore have identified sources of life science research funding and the amounts that they have contributed to this research in British Columbia. However, we believe that there are additional sources that we have not identified, and that the estimate of the economic importance of the life sciences cluster therefore is somewhat conservative.

1.2 Results – Life Sciences Organizations

Employment of these life sciences organizations (very largely private sector companies) in British Columbia in 2011 is estimated to have been approximately 4,200 full time equivalent positions. On an annualized basis, the corresponding payroll is projected to have been about \$300 million.

In addition to wages, salaries and benefits paid by life sciences organizations in BC, it is estimated that they made \$270 million in other expenditures in the province. Total expenditures in British Columbia by the full population of life sciences organizations thus would have been approximately \$570 million in that year (before provincial or federal sales taxes).

The size of an economy is usually reported in terms of gross domestic product (GDP), which is a measure of the value added to the economy by the current productive activities within its borders.

The importance of an entity to the economy cannot be gauged just by its direct economic impact. To produce a product or service, an organization purchases goods and services from other organizations. The impact of this is the *indirect* effect of the entity.

An organization pays its employees to produce products or services. The spending of these wages and salaries generates more economic activity in other organizations, resulting in the *induced* effect.

The total economic effects therefore include the *direct, indirect and induced* effects outlined above.

However, there are also other economic effects that can be attributed to an organization. These include investment in machinery, equipment and construction, and the impact of tax payments made by the organization.

The direct impact in terms of Gross Domestic Product from the group of companies analyzed by Statistics Canada is estimated to have been \$330 million on an annualized basis. The indirect GDP impact is estimated to have been \$120 million, the induced GDP impact \$150 million, and the total GDP impact \$600 million.

1.3 Life Sciences Research in British Columbia

The figures cited above are for true life sciences businesses according to the categories noted earlier, which include biopharmaceuticals, medical devices, bioproducts and aspects of bioenergy. However, there are numerous academic and other institutions that conduct life sciences research but are not included in these definitions of life sciences. That research should be considered as a part of the life sciences cluster; it is that activity that to a large extent provides the impetus for the establishment and operations of the listed life sciences companies.

We have identified life sciences research funding sources for British Columbia of \$264 million based upon fiscal years for 2011-12 or nearest year to this. A substantial majority of this funding is from senior government sources. The list may not be complete, so that the resulting estimate of economic impact would be conservative.

In addition to external funding attracted by universities to support the research they perform, universities allocate substantial internal and other funding to research activities. In 2007, Canadian universities on average funded approximately 45.6 per cent of their research from internal sources. This funding originated primarily through Provincial operating contributions and tuition, although the Indirect Costs Program of the federal government is another substantial source. The estimate is based on the estimated dollar value of faculty time spent on research (approximately 40 per cent), unfunded institutional costs and some costs associated with research conducted in affiliated hospitals.¹

The total estimated internal funding allocated by British Columbia universities and hospitals to life sciences research in fiscal 2011-12 is \$160 million. Adding this to the \$264 million cited

¹ *Momentum: The 2008 report on university research and knowledge momentum*, Association of Universities and Colleges of Canada, Ottawa, 2008.

earlier yields a total of \$424 million. It is estimated that of this, \$332 million was spent in British Columbia. The estimated total annual impact on Gross Domestic Product in the province was roughly \$430 million, and the employment impact 6,500 person-years.

1.4 Combined Impacts

The total expenditures in this province by BC life sciences businesses are estimated to have been \$570 million on an annual basis in 2011-2012, and like expenditures from life sciences research \$332 million. Thus the combined annual total of these expenditures would be about \$900 million.

Similarly the total annualized GDP impact for life sciences organizations in British Columbia is estimated to have been \$600 million and for life sciences research \$430 million, for a total of approximately \$1 billion.

Direct employment in British Columbia by life sciences organizations in 2011-2012 was roughly 4,200 (full time equivalents), and direct employment in life sciences research in the province about 4,300, for a total of 8,500. Indirect and induced employment impacts from life sciences in British Columbia were approximately 3,300 for life sciences businesses and 2,200 for life sciences research. Including these, the total employment impact in the province from life sciences was roughly 7,500 and for life sciences research 6,500, for a total of about 14,000.

As indicated earlier, the estimates for the impact of life sciences research and hence the total impacts likely are conservative.

The numbers cited have been rounded to avoid any undue impression of accuracy.

1.5 Other Life Sciences Impacts

There are limitations to the extent that funding and expenditure data can describe the total economic effects of life sciences organizations. These organizations impact the economy in other ways, some of which are mentioned below.

1.6 Life Sciences and British Columbia Research Universities

Life sciences companies play an important role with respect to the research universities in the province, and vice-versa. These businesses provide a means for university researchers to pursue the development of drugs and equipment, based on university work. Well-established researchers are attracted to teach and do research here while also pursuing commercialization of their research. Life sciences organizations also provide employment for university graduates and post-graduates.

The economic impact and potential economic impact of other fruits of life sciences research can only be speculated upon. For example, life sciences researchers at the University of British Columbia discovered a way to block the communication between brain cells that triggers drug cravings. This finding might have the potential to lead to new therapies to treat addiction and relapse as well as compulsive behaviours associated with schizophrenia.

THE ECONOMIC IMPORTANCE OF THE LIFE SCIENCES SECTOR IN BRITISH COLUMBIA

2. BACKGROUND

2.1 Introduction

Life Sciences are an important part of research and development in British Columbia. Over the past decade the field has grown very substantially, in part paralleling the remarkable progress of genomics research in this province.

LifeSciences British Columbia “--- is an industry-funded association that supports and represents the life sciences community of British Columbia through leadership, facilitation of investment and partnering, advocacy, and promotion of our world-class science and industry.”² The Association has sponsored this study to identify the importance of life sciences to the economy of the province.

2.2 Components of the Life Sciences Sector in British Columbia

For purposes of this analysis the life sciences sector has been taken to have four parts, as defined by LifeSciences British Columbia.³ Those parts are:

1. Biopharmaceuticals;
2. Medical Devices;
3. BioProducts; and
4. BioEnergy.

These sub-sectors have been described by LifeSciences British Columbia as follows:

Biopharmaceuticals represent an emerging, new class of medical drugs produced using biotechnology. Biopharmaceuticals are typically proteins, including antibodies, or nucleic acids (DNA, RNA or antisense oligonucleotides) used for therapeutic or diagnostic purposes, and are produced by means other than direct extraction from a native biological source. Biopharmaceuticals can refer to small compound pharmaceuticals developed using biotechnology methods.⁴

Biotechnology is loosely defined by the United Nations as "any technological application that uses biological systems, or derivatives thereof, to make or modify products or processes for specific use." This definition of biotechnology includes small molecule and biopharmaceutical drugs, as well as some medical implants and instruments, derived from or developed from an understanding of biological systems.⁵

² LifeSciences British Columbia, *About Life Sciences British Columbia*, http://www.lifesciencesbc.ca/About_Us/, accessed January 31, 2011.

³ In other jurisdictions the definition of life sciences may vary. For example, a key source of statistics concerning life sciences in the United States includes only biopharmaceuticals and medical devices in the definition of life sciences.

⁴ LifeSciences British Columbia, *Industry Sectors – Biopharmaceuticals*, <http://www.lifesciencesbc.ca/Sub-Sectors/Biopharmaceuticals.asp>, accessed January 21, 2011.

⁵ LifeSciences British Columbia, *Industry Sectors – Biopharmaceuticals*, <http://www.lifesciencesbc.ca/Sub-Sectors/Biopharmaceuticals.asp>, accessed January 21, 2011.

While historical drugs have often been serendipitously discovered and developed by trial and error, biotechnology products leverage our superior understanding of genomics, proteomics, physiology and systems biology to design and engineer products to specifically modify or exploit known biochemical or physiological processes.

Medical devices are diagnostic or therapeutic articles that do not achieve any of their principal intended purposes through chemical action within or on the body. Such devices can be interventional & implantable cardiology, diagnostic & therapeutic ultrasound, diagnostic testing and analyzing, vital sign monitoring, MRI, point-of-care instruments, crutches, electrodes, pacemakers, arterial grafts, intraocular lenses, and orthopedic equipment.⁶

Bioproducts are products made from renewable resources (Biomass) and/or biological processes primarily from Agriculture, Forestry, Marine, and Municipal Waste to provide biofuels, bioenergy, biomaterials, and everyday household or industrial products.⁷

BioProducts and BioEnergy are sub-sectors within an emerging field of industrial biotechnology. The sectors provide familiar products that can be manufactured using biomass and/or novel processes to replace or complement conventional manufacturing that uses fossil fuels and petrochemicals. Biomass is any type of organic material that is available on a renewable or recurring basis. It may come in the form of raw material or primary crops, by-products left over from a variety of activities and industrial processes, and waste material.⁸

Forest, agricultural and marine biotech are also aspects of the life sciences in British Columbia.

In the bioenergy field there is a significant overlap between the life sciences and other economic sectors. For example, life sciences research and techniques may be used in industrial processes that are clearly part of the forest industry. It has been estimated that in 2010, 1.2 million tonnes of wood pellets were produced in British Columbia from waste wood, with gross sales revenues of \$185 million.⁹ This use of biomass falls within the definition of bioenergy outlined above, but essentially is a function of the forest industry. For purposes of this analysis and to avoid potential double counting, that industrial activity is not attributed to the life sciences sector.

2.3 Project Scope

This study has had three main components:

1. Inventorying BC-based life sciences companies and research institutions from a variety of sources;
2. Benchmarking their current state in terms of basic measurables such as number of employees, expenditures by type, etc.; and

⁶ LifeSciences British Columbia, *Industry Sectors – Medical Devices*, <http://www.lifesciencesbc.ca/Sub-Sectors/Medical-Devices/>, accessed January 21, 2011.

⁷ LifeSciences British Columbia, *Industry Sectors – BioProducts*, <http://www.lifesciencesbc.ca/Sub-Sectors/BioProducts/>, accessed January 21, 2011.

⁸ LifeSciences British Columbia, *Industry Sectors – BioProducts*, <http://www.lifesciencesbc.ca/Sub-Sectors/BioProducts/>, accessed January 21, 2011.

⁹ Hamilton, G. “Europe’s carbon policies bolster a B.C. bioenergy industry,” *The Vancouver Sun*, May 4, 2011, p.C7, and Murray, G. executive director, Wood Pellet Association of Canada, personal communication, May 4, 2011.

3. Assessing the overall economic impact of these organizations on the province, including direct, indirect and induced effects, as discussed below.

In addition, some other relevant economic subject matter has been added.

3 ECONOMIC IMPACTS

3.1 Active Cooperation with LifeSciences British Columbia

The active cooperation of LifeSciences British Columbia (LSBC) has been a key part of this project to assess the economic importance of the life sciences sector in the province. The association has significant information needed for this analysis, particularly concerning the identity of life science companies in the province. The consultants reviewed that information in detail, and identified those firms that fit the definitions of those engaged in biopharmaceuticals, medical devices, bioproducts and bioenergy, with a few additional firms in forest, agriculture and marine biotechnology.

3.2 Life Sciences Companies in British Columbia

In the report sections below, results stated are from the analysis carried out in 2012 and generally reflect data for the fiscal year ending March 31, 2012 or calendar 2011. A key exception to this is that the identification of life sciences companies was carried out in mid-2012.

For comparison, a few corresponding figures are also shown from the previous version of this report based on data from fiscal year 2009-10 or nearest year to that for which data is available. The differences from the earlier version of this report are based on more current information and a more complete identification of life sciences companies in British Columbia.

From the list provided by LSBC, directory information provided by LSBC and Internet search, in 2012 the consultants in conjunction with Statistics Canada identified 306 life sciences companies in British Columbia that fit one of the defined types. In comparison, in 2011 through a similar process 233 companies were identified. In both cases these companies do not include supporting organizations such as accounting firms whose impact is reflected through indirect impact assessment.

3.3 Involvement of Statistics Canada

LSBC earlier carried out surveys of its members with the objective of securing sufficient data to gauge the economic impact of the sector. However, difficulty was experienced in obtaining a large enough sample to support the analysis.

As an alternative, the consultants contracted with Statistics Canada for that agency to review in confidence the mandatory statistical submissions to Statistics Canada of the life sciences companies in British Columbia that were identified from LSBC lists and supplementary sources. Like all organizations in every sector, they are required to submit this information to Statistics Canada, where the data for individual companies is kept confidential. Only aggregate information can be released.

Of the 306 life sciences companies identified in the current iteration, Statistics Canada found 260 of these in Statistics Canada files. Statistics Canada found active records for 159 of the 260. It appears that of the 260 companies, the 159 active ones in essence were those impacting the economy of British Columbia. In comparison, the previous update of the economic impact of life sciences in this province identified 134 active firms.

For the 159 active companies, numbers of employees and corresponding wages, salaries and benefits were aggregated by Statistics Canada for a single month (October) in 2011, and the aggregate numbers were reported to the consultants. Those figures were then extrapolated by the consultants to provide an estimate of total annual wages, salaries and benefits for the 159 firms.

3.4 Initial Results

Based on this analysis and rounding for practical purposes, employment of these life sciences organizations in British Columbia was approximately 4,400 in October, 2011, compared with 3,500 in May, 2010. The monthly payroll in October, 2011 was nearly \$25 million, versus \$20 million in May, 2010. On an annualized basis, the payroll in 2011 was about \$300 million compared with \$240 million in 2010. Thus, the average annual wages, salaries and benefits per employee in 2011 was approximately \$68,000, almost the same as in the previous year.

To facilitate comparisons, it is customary to cite employment levels in terms of full time equivalent positions. Based upon information secured from the survey of LSBC members, it is estimated that the 4,400 jobs among life sciences companies in the province were very largely full time. The equivalent number of full time positions is estimated to be 4,200.

In comparison, a past survey carried out by Statistics Canada found that in 2003, there were 91 biotechnology firms in British Columbia with 2,173 employees engaged in biotechnology-related activities.¹⁰

3.5 Other Categories of Expenditures

In addition to wages, salaries and benefits paid by life sciences organizations in BC, they have other expenditures. The principal categories of these additional expenditures include:

- consumables;
- services from fee for service providers;
- general and administrative expenses excluding wages;
- construction and renovations;
- equipment;
- software; and
- other expenses.

Based upon preliminary analysis of data provided through the member survey carried out by LSBC for 2008-2009, the ratio of the total of these other expenses to total wages, salaries and benefits has been estimated.

For the 24 organizations that responded to this survey and for which valid data were secured, total wages, salaries and benefits paid in British Columbia were reported to be \$36.4 million for the most recent fiscal year (circa 2008-2009). Consumables, services from fee-for-service

¹⁰ Statistics Canada, *Overview of the Biotechnology Use and Development Survey 2003*, Science, Innovation and Electronic Information Division Working Papers, Statistics Canada, Ottawa, Cat. No: 88F0006X1E, cited in Gertler, M and Vinodrai, T, "Life Sciences and Regional Innovation: One Path or Many?", *European Planning Studies*, vol. 17, no.2, February 2009.

providers together with general and administrative costs in the province totalled \$35.6 million, so that total annual operating expenses in British Columbia were \$58.6 million.

In addition, in British Columbia capital expenditures for construction and renovations, made by these companies together with their purchases of equipment and software, totalled \$9.2 million. A total of \$4.2 million of other expenditures were made in the province. Total annual expenditures of all types in British Columbia were \$72 million, though the size of the sample and potential for inaccuracy leave moderate uncertainty with respect to these numbers.

There also were substantial reported expenditures outside of British Columbia, totalling \$30.1 million for the sample of 24 companies. Combined annual expenditures inside and outside the province totalled \$102.1 million.

3.6 Calculation of Expenditures Other than Wages, Salaries and Benefits for Life Sciences Companies as a Whole in British Columbia

In the current analysis it was estimated from Statistics Canada data that the total payroll for life sciences companies in British Columbia in 2011 was about \$300 million. For the sample of 24 life sciences organizations referred to immediately above, wages, salaries and benefits in this province totalled \$36.4 million, equivalent to 50.6 per cent of total expenditures. Extrapolating those to the full population of life sciences companies on the basis of wages, salaries and benefits yields an estimate of \$270 million for other expenditures in British Columbia in 2011 (before provincial or federal sales taxes). Of those, operating expenses would have been about \$170 million, capital expenditures approximately \$67 million, and miscellaneous expenditures roughly \$33 million. Total expenditures in the province in 2011 by the full population of life sciences companies thus would have been approximately \$570 million.

This reflects the total direct impact in the province from the British Columbia life sciences companies in the Statistics Canada record base for 2011.

3.7 Expenditures Outside of British Columbia

In addition, a similar calculation yields a further \$250 million in total expenditures in 2011 outside the province by British Columbia life sciences companies as identified for the analysis carried out by Statistics Canada. On an annualized basis, total expenditures inside and outside the province were approximately \$820 million in 2011, compared with an estimated \$660 million in 2010.

3.8 Gross Domestic Product

The size of the economy is usually reported in terms of gross domestic product (GDP), which is a measure of the value added to the economy by the current productive activities of individuals, businesses, governments and non-residents (who either purchase or sell goods and services to British Columbians). The province's GDP includes all activities that take place within its borders---.¹¹

¹¹ BC Stats, *BC Economic Accounts – FAQ*, “GDP: What does it mean and how is it measured?” http://www.bcstats.gov.bc.ca/data/bus_stat/bcea/bcea_faq.asp#Q2, accessed January 29, 2011.

GDP at Factor Cost comprises wages and salaries, supplementary labour income (cash benefits), net income of unincorporated businesses and corporate profits before taxes.

In the current analysis, the Gross Domestic Product attributable to the life sciences sector has been gauged in two facets. The contribution to the Gross Domestic Product of British Columbia from the life sciences companies found in the work described earlier involving Statistics Canada was analyzed. In addition, there are numerous academic and other institutions that conduct life sciences research but are not included in the definition of the life sciences sector as applied to the work carried out by Statistics Canada. As described later in this report, the funding provided for that life sciences research has also been analyzed in terms of impact on the Gross Domestic Product of British Columbia, and on employment in the province.

3.9 Indirect and Induced Economic Impacts

The importance of an entity to the economy cannot be gauged just by its direct economic impact. To produce a product or service, an organization purchases goods and services from other organizations. The impact of this is the *indirect* effect of the entity.

An organization pays its employees to produce products or services. The spending of these wages and salaries generates more economic activity in other organizations, resulting in the *induced* effect.

The total economic effects therefore include the *direct, indirect and induced* effects outlined above.

However, there are also other economic effects that can be attributed to an organization. These include the impacts of investment in machinery, equipment and construction, and the impact of tax payments made by the organization. To the extent that these have been identified in the analysis, those effects have been included.

Payments for scientific facilities create economic impact that is felt to a substantial extent in the province. Payments for equipment for scientific research tend to flow more to vendors or manufacturers outside of British Columbia. Only to the extent that there is a dealer or contractor in this province that shares in the payment or there is other value added in BC is there a contribution to provincial GDP here. Thus, it has been important to obtain information from life sciences sector organizations concerning this. That information with respect to Genome BC and the research universities in the province was already available for use in this analysis.

3.10 Estimation of Direct, Indirect and Induced Impacts of BC Life Sciences Companies

The data obtained from life sciences companies which participated in the LSBC survey showed that their expenditures other than wages, salaries and benefits were almost equal to payroll costs. This is in contrast to the point made in the preceding paragraph.

To estimate the size of the indirect and induced impacts of life sciences sector expenditures, expert services previously were utilized involving the British Columbia Input Output Model (BCIOM) located at BC Stats in Victoria. BC Stats is the central statistical agency of the government of British Columbia.

This report includes estimates based on use of the BCIOM applied to the expenditures of life science organizations in the province to produce estimates of their direct, indirect and induced impacts and hence the total economic effects. For this report the indirect and induced impacts have been estimated based on similar work previously carried out for the consultants with respect to life sciences organizations in British Columbia.

Extrapolating from that work, the direct impact for 2011 in terms of Gross Domestic Product from the group of companies analyzed by Statistics Canada is estimated to have been \$330 million on an annualized basis. The Indirect GDP impact is estimated to have been \$120 million, the Induced GDP impact \$150 million, and the total GDP impact \$600 million. The comparable total for 2010 was estimated to have been \$480 million.

3.11 Life Sciences Research Funding in British Columbia

The figures cited above are for life sciences companies according to the categories noted earlier in this report, which include biopharmaceuticals, medical devices, bioproducts and bioenergy. However, there are numerous academic and other institutions that conduct life sciences research but are not included in these definitions of life sciences organizations. That research should be considered as a part of the life sciences cluster; it is that activity that to a large extent provides the impetus for the establishment and operations of the life sciences companies included in the Statistics Canada analysis.

As shown in Table 1, for fiscal year 2011-2012 or the nearest year to this we have identified life sciences research funding sources for British Columbia of \$264 million. A substantial majority of this funding is from senior governments. The list likely is not complete, since some of the data involved is not readily available. Consequently, the following estimate of this aspect of the economic impact of life sciences in British Columbia is conservative.

As outlined in the proposal to undertake this work and elsewhere in this preliminary report, the economic impact of the research cited above has been estimated based on prior work undertaken by the consultants, including assessment of the impact of some of the funding outlined.

3.12 Internal Funding Allocated by Universities to Their Research

In addition to external funding attracted by universities to support the research they perform, universities allocate substantial internal and other funding to research activities. In 2007, Canadian universities on average funded approximately 45.6 per cent of their research from internal sources. This funding originated primarily through Provincial operating contributions and tuition, although the Indirect Costs Program of the federal government is another substantial source. The estimate is based on the estimated dollar value of faculty time spent on research (approximately 40 per cent), unfunded institutional costs and some costs associated with research conducted in affiliated hospitals.¹²

However, the federal government since 2003 through its Indirect Costs Program has paid a significant proportion of the costs of Canadian universities with respect to research funded by key federal agencies. In the case of life sciences research, this would apply to research funding

¹² *Momentum: The 2008 report on university research and knowledge momentum*, Association of Universities and Colleges of Canada, Ottawa, 2008.

provided by the Canadian Institute for Health Research and NSERC. This does not change the amount expended on this research, but rather the source of funds used to pay for it.

The same rationale applies to the funding provided by the Canadian Foundation for Innovation for research infrastructure. Those grants involve matching payments from provincial government funds and the remaining twenty per cent from the university involved or private sources. Once again, the amount of the expenditure does not change, and hence the economic impact remains the same regardless of the source.

It is estimated that the total amount of life sciences research funded internally by British Columbia universities or supplemental sources in fiscal year 2011 – 2012 or thereabouts was approximately \$160 million. Adding that to the \$264 million in externally sponsored health sciences research in BC as previously estimated yields a total of approximately \$424 million. The comparable estimate for 2009-2010 was \$367 million.

The funds for life sciences research based in British Columbia are in part spent outside of the province, particularly with respect to the purchase of specialized equipment and special purpose computers. To analyze the economic impact in the province, the various types of expenditures have been reviewed and the estimated value of amounts spent outside of British Columbia have been deducted. Of the total of \$424 million identified, it is estimated that in 2011-2012, \$332 million was spent in the province. In comparison, the amount spent in British Columbia in 2009-2010 was approximately \$297 million.

3.13 Impact of Other Life Sciences Research Funding in British Columbia

As indicated in Table 2, the \$332 million of expenditures in British Columbia cited above is estimated to have had a direct impact of \$275 million in GDP in the province. Indirect and induced GDP impact is calculated to have been about \$155 million, for a total GDP contribution of approximately \$430 million.

The direct employment impact involved with respect to other life sciences research in British Columbia is estimated to have been 4,300 full time equivalent positions. The indirect and induced employment would have been approximately 2,200, for a total of 6,500.

TABLE 1**LIFE SCIENCES RESEARCH FUNDING IN BRITISH COLUMBIA**

(millions of dollars annually)

(based on fiscal year 2011-12 or nearest year to this)

Note: The subtotal represents external funding attracted largely by universities/hospitals and research facilities from the sources listed. In addition, universities/hospitals allocate substantial internal funding to research as shown below the subtotal.

	Total Life Sciences Research <u>Expenditures</u> (\$ millions)
Canadian Foundation for Innovation	17
British Columbia Knowledge Development Fund	17
Canadian Institute for Health Research	79
Canada Research Chairs*	10
Genome British Columbia	29
Michael Smith Foundation**	11
British Columbia Cancer Foundation	18
Canadian Cancer Society-BC&Yukon Branch	6
Natural Sciences and Engineering Research Council	21
Western Economic Diversification	2
Heart and Stroke Foundation of BC and Yukon	4
National Institute of Health - U.S.	7
Medicine Patent Holders (Rx&D, etc.)	43
 SUBTOTAL	 264
 Estimated Internal Funding Allocated by B.C. Universities and Hospitals to Life Sciences Research	 <u>160</u>
 Total Estimated Life Sciences Research Funding in B.C.	 424 (\$ million)

Some of these funds are spent outside of B.C. as noted in text of report.

* Not included in other sources

** Excluding administrative costs

There may be other sources of life sciences research funding not included above.
Clinical trial research expenditures are included.

Data sources: web sites, annual reports, personal communications and prior work.

3.14 Total Life Sciences Economic Impact in British Columbia

As shown in Table 2, the total expenditures of life sciences companies in this province (based on 2011-2012) are estimated to be \$570 million annually, and like expenditures from life sciences research \$332 million. Thus the combined annual total of these expenditures would be about \$900 million.

Similarly, the total annual GDP impact for life sciences companies is estimated to be \$600 million and for life sciences research organizations about \$430 million, for a total of approximately \$1 billion.

Direct employment in British Columbia by life sciences companies carrying out research and development in 2011 was roughly 4,200 (full time equivalents). Employment in other life sciences research in the province was about a further 4,300, for a total of approximately 8,500. Indirect and induced employment impacts from life sciences in British Columbia were roughly 3,300 for life sciences companies and 2,200 for other life sciences research. The total employment impact from life sciences companies in the province in 2011 was approximately 7,500 and for other life sciences research 6,500, for a total of about 14,000. As explained previously, this is a conservative estimate.

The employment numbers are expressed in terms of full time equivalents. Employment in life sciences companies is largely full time, but many of the people involved in other life sciences research would be employed in more than one activity or part time (e.g. graduate students or university faculty involved in research). The numbers cited in the text have been rounded to avoid any undue impression of accuracy.

TABLE 2**ESTIMATE OF ANNUAL ECONOMIC IMPACT OF LIFE SCIENCES COMPANIES
AND LIFE SCIENCES RESEARCH IN BRITISH COLUMBIA****Based on 2011-12 or nearest fiscal year.**

	Life Sciences Companies In BC	Other Life Sciences Research In BC	TOTAL
	\$ millions	\$ millions	\$ millions
Total Life Sciences Expenditures in BC*	570	332	902
Direct GDP Impact	331	275	606
Indirect GDP Impact	120	30	150
Induced GDP Impact	<u>149</u>	<u>124</u>	<u>273</u>
Total GDP Impact	600	429	1,029
	FTEs **	FTEs **	FTEs **
Direct Employment	4,200	4,300	8,500
Indirect + Induced Employment	3,300	2,200	5,500
Total Life Sciences Generated Employment in British Columbia	7,500	6,500	14,000

Note: In the text and in the employment figures above, some figures have been rounded to avoid any undue impression of accuracy.

The figures for life sciences research likely are somewhat conservative.

*Excluding federal and provincial government sales taxes.** Full time equivalents

3.15 Other Impacts

There are limitations in the extent that funding and expenditure data can describe the total economic effects of these organizations. Life sciences organizations impact the economy in other ways, some of which are mentioned below.

Life sciences organizations play an important role with respect to the research universities in the province, and vice-versa. These organizations provide a means for university researchers to pursue the development of drugs and equipment, based on university work. Well-established researchers are attracted to teach and do research here while also pursuing commercialization of their research. Life sciences organizations also provide employment for university graduates and post-graduates.

The economic impact and potential economic impact of other fruits of life sciences research can only be speculated upon. Consider for example, the following excerpt from a posting several years ago by the University of British Columbia:

Dr. Anthony Phillips and Dr. Yu Tian Wang, university professors and members of the Brain Research Centre, wanted to understand how the brain learns new things, specifically what molecular mechanisms underlie how we learn and make memories. The tools and drugs they developed for their study led them to discover a way to block the communication between brain cells that triggers drug cravings, a finding that could lead to new therapies to treat addiction and relapse as well as compulsive behaviours associated with schizophrenia.¹³

The economic impact of addiction and mental illness is huge; any treatment that could significantly reduce these very serious societal problems would be of immense economic value. This is but one illustration of the potential impact of the BC life sciences sector.

¹³ <http://www.publicaffairs.ubc.ca/ubcreports/2008/08mar06/passion.html>

APPENDIX A

British Columbia Research Institutions Involved in the Life Sciences

We have accepted as a given that Genome BC would be included in the definition of life sciences. However, as we have reviewed a number of other institutions that could be considered as closely related to life sciences, it is not as clear that all of their activities should be counted as being within the sector.

For example, the **Michael Smith Foundation for Health Research** supports research across the broad spectrum of health. A substantial part of this is in the area of life sciences as defined by LifeSciences BC. However, in the case of the Michael Smith Foundation, we have contacted the foundation and have been provided with information concerning the extent of financial resources included in grants for life sciences research.

The following information generally has been drawn from the web sites of the organizations listed.

The **BC Cancer Agency** “--- research ranges from basic molecular and genetic studies to epidemiological and clinical research on cancer prevention, early diagnosis, molecular characteristics of the cancer process and new treatments for cancer using drugs and radiotherapy.” It appears that all of this fits within the definition of life sciences.

Providence Health Care Research Institute has over 100 principal investigators and is home to several research centres whose areas of research are directly aligned with the priority care programs of Providence Health Care. Much of this research is carried out at St. Paul's Hospital, and includes research in the areas of heart, lung and kidney care, HIV/AIDS, critical care, mental health and addiction and other urban health issues. A great majority of the work of the Institute appears to fit within the sense of life sciences.

Vancouver Coastal Health Research Institute is a partnership between Vancouver Coastal Health Authority and the University of British Columbia. The institute has researchers that carry out a wide variety of work within life sciences, and receives nearly \$136 million annually in research funding. Some of its research centres include the Brain Research Centre; the Centre for Epidemiology & Evaluation; the Centre for Respiratory & Critical Care Medicine; the International Collaboration on (spinal cord) Repair Discoveries; the Immunity & Infection Research Centre; and the Vancouver Prostate Centre.

The Provincial Health Services Authority (PHSA) and its agencies conduct approximately \$180 million worth of health research annually, improving the health of British Columbians and the sustainability of the provincial healthcare system. Research funding supports the activities of a network of about 1,200 researchers and staff involved in lab-based, clinical and community health research. PHSA researchers attract about 35 per cent of all health research money that comes into BC. Its research centres include the BC Cancer Agency's Research Centre; the Michael Smith Genome Sciences Centre; the BC Centre for Disease Control; and others.

The BC Centre for Disease Control (BCCDC) operates in close collaboration with the UBC Centre for Disease Control and, increasingly, Simon Fraser University. Basic research at BCCDC and the PHSA Laboratories situated there includes work toward developing new vaccines, strengthening diagnostics, genomic characterization of new and emerging disease agents, and mathematical modeling of major communicable disease and environmental health challenges. Applied health research at BCCDC is focused on evaluating public health interventions in such areas as drinking water safety, vaccination, recognition and control of disease outbreaks, and antimicrobial treatment of communicable diseases.

Researchers at **BC Mental Health & Addiction Services (BCMHAS)** and the **BC Mental Health & Addiction Research Institute** are engaged in both basic and translational research, and conduct research across all of the agency's clinical program areas, including adult psychiatry, forensic psychiatry, and child and youth mental health.

The Child & Family Research Institute (CFRI) is dedicated to world-class research spanning a wide range of children's and women's health concerns. Approximately 200 investigators and more than 200 trainees, including graduate students and postdoctoral fellows, are affiliated with CFRI. The Institute's main areas of research include: Childhood Cancer; Diabetes; Nutrition & Metabolism; Developmental Neurosciences & Child Health; Genetics & Health; Immunity in Health & Disease; Innovations in Acute Care & Technology; and Reproduction & Healthy Pregnancy.

The Women's Health Research Institute (WHRI) is devoted to improving the health and health care of girls and women, serving as a catalyst for research in women's health and supporting an expanding national network of women's health researchers, policy makers and health care providers.

The British Columbia Centre of Excellence for Womens' Health has focused its work since 1996 on conducting or facilitating innovative, multidisciplinary research that examines the determinants of women's health. The mandate of the Centre is to improve women's health and to recognize the emergence of a new theme on chronic disease. Another theme that is beginning to emerge is women and physical activity.

The BC Provincial Renal Agency (BCPRA) works to improve quality of life and outcomes for renal patients through BC. In cooperation with the regional health authority renal programs, the BCPRA coordinates all aspects of kidney care. In support of continual improvement in all areas of renal care, the BCPRA is committed to ongoing research and evidence-based decision making. These activities are supported by the agency's clinical information system, which provides real-time, accurate data to support a broad range of functions. This database – the only one of its kind in North America – is an essential tool for renal research leading to improved care.

BC Transplant (BCT) is responsible for all aspects of organ donation and transplantation in BC, including clinical trials. Research at BCT and the BC Transplant Research Institute ranges from basic scientific investigation focused on better understanding the immune system response to organ transplants and improving organ preservation and donation techniques, to exploring the ethical and social issues of transplantation.

Cardiac Services BC is responsible for planning, coordinating, monitoring and evaluating cardiac services across the province in collaboration with the regional health authorities. The agency's cardiac services database, one of the most comprehensive clinical databases in Canada, collects data from BC's cardiac care hospitals, providing a valuable tool for research toward improving cardiac care.

The Centre for Molecular Medicine and Therapeutics at the University of British Columbia is dedicated to the practice of world-class discovery research to uncover new insights in the life sciences and deepen our understanding in the determination and control of genetic susceptibility to disease. Founded in 1995, the Centre is focused on exploring the genetic basis of disease and translating this knowledge into new treatment strategies for common and neglected diseases.

The **BC Bioenergy Network** was among the organizations for which contact information was submitted to Statistics Canada, and therefore the organization's data is included in the results of the Statistics Canada analysis.

The **Centre for Drug Research and Development** responded to the survey by LSBC, so the data for that organization is on hand and all applies to life sciences.

The **Michael Smith Foundation for Health Research** is the provincial support agency for health research in British Columbia. The foundation is an independent, third party organizations that works to develop the province as a leading force in health research, supporting improvements to health, health care and economic opportunity.

The **Dr. Tong Louie Living Laboratory** at BCIT clearly falls within the category of medical devices (or at least medical device research) in the life sciences sector.

Based on a review of their web sites, **The Pacific Institute for Climate Solutions** and **FP Innovations** (solid wood and pulp and paper) do not appear to fall within the definition of life sciences.

APPENDIX B

Consulting Resources Involved in Analysis of Importance of Life Sciences Sector in British Columbia

David E. Park, FCMC

This analysis was directed by Mr. David Park, who also had a major involvement in the work.

Mr. Park has substantial experience in relevant projects. He has been responsible for and carried out a great deal of the work involved in the assessment of the economic impact of the research and innovation expenditures of the Ministry of Advanced Education (that part of the Ministry since transferred to a new ministry). This included analysis of expenditures of the Innovation Council and other entities relevant to the life sciences sector.

Mr. Park was responsible for and carried out a good deal of the work involved in assessing the economic importance of Genome British Columbia. He has directed an analysis of the fundamental driving forces of the B.C. economy, which included the assessment of the economic impact of each sector of the economy. He also has assessed the importance of specific sectors to the economy of this province and other provinces. He has gauged the economic impact of particular projects, developments and organizations, and has carried out a great deal of other economic analysis work.

He is a past President of the Association of Professional Economists of British Columbia, and is a Fellow of the Institute of Management Consultants of British Columbia. He is also a past president the Institute of Management Consultants of Canada.

Mr. Park has been Chairman of a variety of committees and task forces of The Vancouver Board of Trade, including the Economic Development Committee. He subsequently joined the staff of The Board, and in 2008 retired from the position of the Chief Economist and Assistant Managing Director of The Board. He holds the title of Economist Emeritus of The Board, and has been or is engaged on projects of mutual interest to The Board, the Sauder School of Business at the University of British Columbia, and the Justice Institute of British Columbia. He also undertakes other consulting work, particularly with respect to applied economics such as in the case of the current project.

Mr. Park worked for three decades as a management consultant, with a good deal of that work involving economic analysis and related subjects. Prior to joining the staff of The Vancouver Board of Trade, he was a partner-level member of a Vancouver-based management consulting firm and Director in the Vancouver office of a national management consulting firm. Previously he was a Partner of a major international management consulting firm, and was responsible for marketing and economic consulting services in British Columbia on behalf of that organization.

Mr. Park holds the degree of Bachelor of Applied Science (Engineering) from the University of British Columbia, and Master of Business Administration from Stanford University.

Peter McCaffrey

Mr. Park has been assisted by Mr. Peter McCaffrey, an independent consultant who was extensively involved in the analysis of data concerning the research and innovation expenditures of the Ministry of Advanced Education, including the Innovation Council and other entities relevant to the life sciences sector. He was similarly involved in analysis of the economic importance of Genome British Columbia. Mr. Park and Mr. McCaffrey have worked together extensively in the past.

Mr. McCaffrey graduated with a Bachelor of Arts degree (major - Public Administration) from the University of Alberta, and has completed course work in the Master of Public Administration program at the University of Alberta and the University of Victoria. He has attended numerous courses, workshops and seminars dealing with management and other professional development subjects.

Early in his career, Mr. McCaffrey was with a major national management consulting firm where he worked in the area of economic development. Projects included the development and implementation of surveys, database development and economic impact studies including employment analysis. Feasibility studies, marketing plans and a variety of other work also were performed.

Subsequently Mr. McCaffrey became an Economic Development Officer, and was instrumental in the establishment of two Economic Development Commissions in different regions of British Columbia.

Later Mr. McCaffrey was employed by Human Resources Development Canada (HRDC) for more than a decade, initially as a labour market analyst and then as manager of a Human Resource Centre in a community in the Interior of British Columbia.