

**CANADIAN SPACE AGENCY  
2013–14 DEPARTMENTAL PERFORMANCE REPORT**

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## **Annexe 1 Details on Transfer Payment Programs**

### **Contributions under the Canada / European Space Agency Cooperation Agreement**

**Name of Transfer Payment Program:** Contributions under the Canada/European Space Agency (ESA) Cooperation Agreement.

**Start Date:** 28 March 2012 (ratification of the latest Agreement);  
20 September 2012 (approval of the revised T&C).

**End Date:** 31 December 2019 (end date of the latest Agreement).

#### **Fiscal Year for Terms and Conditions:**

The revised terms and conditions for the contributions under the 2012-19 Cooperation Agreement were approved on 20 September 2012.

#### **Transfer Payment Program Description:**

Enhance Canadian industry's technological base and provide access to European markets for value added products and services in the fields of Earth observation (EO), telecommunications and generic technological activities; foster the participation of Canadian academia and make possible the demonstration of Canadian space technologies in European microgravity and space exploration missions and programs. This is achieved through a financial contribution by the CSA to European Space Agency (ESA) optional programs.

#### **Strategic Outcome:**

Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.

#### **Program Alignment Architecture:**

Program 1.3 - Future Canadian Space Capacity

Sub-program 1.3.2 Space innovation and Market Access

Sub-Sub-Program 1.3.2.1 – International market Access

#### **Expected Results Specific to the Transfer Payment Program:**

Canadian investments under the Canada-ESA Agreement allow Canadian industry to access the European institutional market.

The Canadian industry have access to flight opportunities for its technologies/components.

#### **Results Achieved:**

- Through Canada's participation in European Space Agency (ESA) Earth Observation programs, more specifically the Earth Observation Envelope Program and GMES Space Component, the CSA has continued to support Canadian companies to be involved in development of advanced space-borne instrument and sub-systems, user-oriented applications, and ensuring access to the data for Canadians. Examples of accomplishments in 2013-14 are:
  - The successful launch of the SWARM satellite on 22 November 2013 carrying the Canadian Electric Field Instrument (EFI), built by COMDEV with support from University of Calgary. EFI data have been received, calibrated and verified;

- The Sentinel-1 satellite has been successfully launched on 3 April 2014 carrying a C-band Synthetic Aperture Radar (SAR). Canadian company C-CORE of Newfoundland, designed and built the SAR active calibration transponders which have been deployed and are providing high quality calibration data during current satellite commissioning phase; and
- Several Canadian remote sensing companies were successful in obtaining contracts to support on- and –off shore oil and gas industries, and providing tool boxes for exploitation of Sentinel data.
- The CSA has supported the development and demonstration of innovative space technologies through its participation to ESA’s General Space Technology Program. Under that program, the Proba-V satellite was successfully launched on 7 May 2013. A Canadian company from Shrebrooke, NGC, provided the intelligent software for navigation, guidance and control to ensure the correct positioning and orientation of the satellite that maximize the quality of the images.
- Through its partnership with the European Space Agency (ESA), the CSA has continued to position the Canadian industry and scientists in future scientific and technological developments relating to the Aurora planetary exploration programs and the Life and Physical Science Program (ELIPS). More specifically, several Canadian companies have been awarded contracts to deliver key components of the Exomars missions scheduled in 2016 and 2018. Canada’s contribution to the ELIPS Program has provided opportunities to Canadians in Europe and on European assets such as bed rest facilities, sounding rockets and even ISS allocation to advance the Space Life Science mandate.
- Canada’s participation in the European Advanced Research in Telecommunications Systems (ARTES) has continued to allow our industry to access forward-looking studies on new telecommunications services, and to develop new satellites, technologies, equipments and applications. More specifically:
  - The ESA Alphasat Satellite was launched on 25 July 2014 with two Canadian provided components/technologies:
    - An advanced antenna feed in L-Band, provided by the Satellite division of MDA, in Ste Anne de Bellevue, Quebec; and
    - An advanced Pilot Tone Injection Unit (PTIU) and L-Band Test Interface Unit (LTIU) for Next Generation Processed Payloads on Geo-Mobile Communications Satellites provided by COMDEV International Products in Cambridge, Ontario.

<b>Contribution under the Canada/ESA Cooperation Agreement</b>						
<b>(\$ in millions)</b>						
	<b>2011–12 Actual Spending</b>	<b>2012–13 Actual Spending</b>	<b>2013–14 Planned Spending</b>	<b>2013–14 Total Authorities</b>	<b>2013–14 Actual Spending</b>	<b>Variance Planned minus Actual</b>
Total contributions	35.1	23.3	24.9	25.6	24.6	0.3
<b>Total program</b>	<b>35.1</b>	<b>23.3</b>	<b>24.9</b>	<b>25.6</b>	<b>24.6</b>	<b>0.3</b>

Notes: Due to rounding, decimals may not add up to totals shown.

This table details contribution program with funding in excess of \$5 million for the reporting year.

**Comment on Variance:** n/a

**Evaluations completed or planned:** 2015–16

**Fiscal Year of Previous Evaluation:** 2010–11

To learn more, go to: [http://www.asc-csa.gc.ca/pdf/evaluation\\_2010-canada-esa\\_eng.pdf](http://www.asc-csa.gc.ca/pdf/evaluation_2010-canada-esa_eng.pdf)

**General Targeted Recipient Group:**

Canadian space sector firms, universities and not-for-profit research organizations.

**Engagement of applicants and recipients:**

The CSA has consulted the Canadian space sector (industry and academia) and relevant GoC organizations as part of the Program selection process in preparation for the 2012 ESA Ministerial Council meeting during which ESA Member states and Canada announced new contributions to the proposed ESA Programs. Such consultations will also be held for subsequent Ministerial Council meetings.

<b>Class Grant and Contribution Program to support Research, Awareness and Learning in Space Science and Technology</b>
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**Name of Transfer Payment Program:** Class Grant and Contribution Program to support Research, Awareness and Learning in Space Science and Technology

**Start Date:** 1 October 2009

**End Date:** N/A – Ongoing program

**Fiscal Year for Terms and Conditions:** 2009-10

**Strategic Outcome:**

Canada's exploration of space, provision of space services and development of its space capacity meet the nation's needs for scientific knowledge, innovation and information.

**Program Alignment Architecture:**

Program 1.1 Space Data, Information and Services

Sub-program 1.1.1 Earth Orbit Satellite Missions and Technology

Sub-Sub-Program 1.1.1.3 Scientific Missions

Sub-program 1.1.2 Ground Infrastructure

Sub-Sub-Program 1.1.2.2 Data Handling

Sub-Program 1.1.3 Space Data, Imagery and Services Utilization Development

Sub-Sub-Program 1.1.3.1 Earth Observation Data and Imagery Utilization

Sub-Sub-Program 1.1.3.3 Scientific Data Utilization

Program 1.2 Space Exploration

Sub-program 1.2.1 International Space Station

Sub-Sub-Program 1.2.1.2 International Space Station Utilization

Sub-Program 1.2.2 Exploration Missions and Technology

Sub-Sub-Program 1.2.2.1 Space Astronomy Missions

Sub-Program 1.2.3 Human Space Missions and Support

Sub-Sub-Program 1.2.3.2 Operational Space Medicine

Sub-Sub-Program 1.2.3.3 Health and Life Sciences

Program 1.3 Future Canadian Space Capacity Program

Sub-Program 1.3.1 Space Expertise and Proficiency

Sub-Program 1.3.2 Space innovation and Market Access

Sub-Sub-Program 1.3.2.2 Enabling Technology Development

**Transfer Payment Program Description:**

This program supports knowledge growth and innovation in the CSA priority areas while increasing the awareness and participation of Canadians in space-related disciplines and activities. The program has two components: a) Research and b) Capacity Building.

The Research component aims to support the development of science and technology; foster the continual development of a critical mass of researchers and highly qualified people in Canada; and, support information-gathering and, space-related studies and research pertaining to Canadian Space Agency priorities.

The Capacity Building component aims to provide learning opportunities to Canadian students and physicians in various space-related disciplines; to support the operations of organizations dedicated to

space research and education; and to increase awareness of Canadian space science and technology among Canadian students and their participation in related activities. It should be noted that the CSA conducted a review of all of its programs. As a result of this review, the CSA no longer supports financially initiatives under the Awareness and Learning component aimed at elementary and secondary students.

### **Expected Results Specific to the Transfer Payment Program:**

#### **1. Research Component**

- Increased knowledge from research projects in priority space science and technology areas;
- Maintained and/or increased space focus in universities, post-secondary institutions, and not-for-profit organizations;
- Partnerships established and/or sustained;
- Leveraged partner contributions; and
- Access to international collaboration for Canadian organizations.

#### **2. Capacity Building Component**

- Increased availability and use of the space theme in learning opportunities and materials related to science and technology at the university level; and
- Post-secondary level and physicians will have increased knowledge and skills in space-related disciplines.

### **Results Achieved:**

In 2013-14, Canadian Universities, for-profit and not-for-profit organizations established and operating in Canada have made significant contributions to knowledge creation in space science and technology priority areas through 32 new research projects and 5 new Announcement of Opportunities (AO) on the CSA Website such as Research in Space Life Sciences on the International Space Station, Flights for the Advancement of Science and Technology, R&D for Multi Satellite Data Integration - Earth Observation applications and utilization, International Planetary Exploration Missions Co-Investigator, and Geospace Observatory (GO) Canada – Instruments and Data. For more details consult the G&C [AO web page](#).

Results: All projects have resulted in 526 publications and 798 presentations among which 61% were peer reviewed. 800 research team members were involved in the supported initiatives representing 351 persons / year in terms of Full Time Equivalence (FTE). From these Highly Qualified Personnel, 278 were Faculty members (75 FTE), 372 students and Post-Doctoral Fellows (222 FTE) and 150 technicians and other research personnel (54 FTE).

A total of 190 research organizations have been involved in the funded projects (46% been Universities, 10% Foreign Research organizations, 20% from the private sector and 24% other). 43% of research partners are international and 42% are national. A total of 29 projects declared leveraged funds from which 6 projects reported international funding.

<b>Class Grant and Contribution Program to support Research, Awareness and Learning in Space Science and Technology</b>						
<b>(\$ in millions)</b>						
	<b>2011–12 Actual Spending</b>	<b>2012–13 Actual Spending</b>	<b>2013–14 Planned Spending</b>	<b>2013–14 Total Authorities</b>	<b>2013–14 Actual Spending</b>	<b>Variance Planned minus Actual</b>
Total grants	8.1	6.2	6.4	6.3	6.3	0.1
Total contributions	3.6	1.0	2.1	1.5	1.5	0.5
<b>Total program</b>	<b>11.7</b>	<b>7.2</b>	<b>8.4</b>	<b>7.8</b>	<b>7.8</b>	<b>0.6</b>

Notes: Due to rounding, decimals may not add up to totals shown.

This table details contribution program with funding in excess of \$5 million for the reporting year.

**Comment on Variance:**

The variance in contributions is mainly due to delays encountered in the establishment of contribution agreements.

**Audits completed or planned:** 2013-14

**Evaluations completed or planned:** 2014-15

**Eligible recipients for Grants:**

The Research Component includes Canadian universities and post-secondary institutions, not-for-profit organizations established and operating in Canada and not-for-profit international research organizations or a cluster formed by a combination of the above.

**Eligible recipients for Contributions:**

The Research Component include Canadian universities and post-secondary institutions, for-profit and not-for-profit organizations established and operating in Canada, and not-for-profit international research organizations or a cluster formed by a combination of the above.

**Engagement of applicants and recipients:**

Since January 2012, an initiative to engage recipients has been undertaken through an automated annual follow-up of projects. The Agency has extended this initiative in order to establish a dialogue with potential applicants and recipients.

Consultations, presentations to and discussions with the academic and industrial communities as well as with other potential recipient groups are ongoing and will continue.



## **Annexe 2 Status Report on Transformational and Major Crown Projects**

### **RADARSAT Constellation Mission**

#### **Description:**

The RADARSAT Constellation Mission (RCM) is the next generation of Canadian Earth observation radar satellites. RADARSAT-1 was launched in 1995 and continued its operation until March 2013. RADARSAT-2, developed in partnership with the private sector, was launched in 2007 for a seven-year mission, but given its current performance, it is expected to remain operational for many more years. Canada has established itself as a leading global supplier of C-band satellite radar data for Earth observation. The RADARSAT Constellation Mission will enhance this leadership and position Canadian industry in technology and value-added product markets.

The RADARSAT Constellation Mission is comprised of three small identical satellites orbiting the Earth. The launch of the constellation is planned in 2018. With a constellation, the time between successive imaging of a specific point on Earth is significantly reduced. The creation of a three-satellite constellation will increase the frequency of available information, as well as the reliability of the system, making it better suited to the operational requirements of departments.

The scope of the RCM Major Crown Project includes the requirement definition, design, development manufacturing, integration, testing and launching of the satellites as well as the design, development, manufacturing and installation of the associated ground segment. One year of operation of the three-satellite constellation is also included as well as an applications development program.

The RADARSAT Constellation Mission will provide reliable all-weather day and night data in support of federal departments' operations and mandates in areas such as: maritime surveillance, disaster management, environmental monitoring and natural resources management. The three-satellite constellation provides average daily coverage of most of Canada and its surrounding waters. The satellite coverage increases significantly in the North, where the constellation will provide coverage two to three times daily of the Arctic and the Northwest Passage.

In support of the maritime surveillance requirements of federal departments, the RCM is the principal data source envisaged for wide area surveillance of Canada's remote areas and marine approaches. Only satellite data can offer regular cost effective coverage to task ships and aircraft in order to intercept suspicious vessels. The daily coverage of marine areas will also support fisheries monitoring, ice and iceberg monitoring, pollution monitoring and integrated ocean and coastal zone management. The RCM's maritime surveillance capabilities also support Canadian sovereignty and security. Recently, the technology was developed to capture ship-originated Automatic Identification System (AIS) signals from space. The combination of space-based radar images and AIS signals will provide a powerful surveillance capacity over Canada's maritime approaches.

In support of disaster management, both in Canada and around the world, the RCM will provide critical and timely data to support disaster mitigation, warning, and response and recovery activities carried out by the Department of National Defence and by Public Safety Canada, as well as to help Canada meet its obligations with respect to international disaster relief. The types of disasters for which RCM data will be used for monitoring and relief purposes include floods, oil spills, volcanic eruptions, earthquakes and hurricanes.

In support of environmental monitoring RCM will provide data for wide area change detection in order to provide support for activities such as water monitoring, wetlands mapping, coastal change monitoring and changes in the permafrost in northern Canada. RCM data will contribute to the production of more accurate weather forecasts and warnings pertaining to marine conditions, winds, severe storms and floods.

In support of natural resources management, RCM data will be a critical source of information used by government departments to monitor the changing state of Canada’s agricultural areas, forests and wildlife habitats. RCM data will also be used in the mining and energy sectors for resource explorations operations to ensure that critical infrastructure is monitored properly for safety and integrity.

In addition, the RADARSAT Constellation Mission sustains the development of Canadian high technology design and manufacturing capabilities and the integration of satellite data into information products and services. Canada’s space and geomatics industries will benefit from better positioning in international markets and privileged access to data deemed essential by many international users.

**Project phase:** Phase D - Implementation

<b>Sponsoring and Participating Departments and Agencies</b>	
<b>Sponsoring Agency</b>	Canadian Space Agency
<b>Contracting Authority</b>	Public Works and Government Services Canada (PWGSC)
<b>Users and Participating Departments</b>	Aboriginal Affairs and Northern Development Canada Agriculture and Agri-Foods Canada Canadian Coast Guard Canadian Ice Service Department of Foreign Affairs and International Trade Department of National Defence Environment Canada Fisheries and Oceans Canada Industry Canada Natural Resources Canada Parks Canada Public Safety Canada Royal Canadian Mounted Police Statistics Canada Transport Canada

<b>Prime and Major Sub-Contractors (Phases B/C/D)</b>	
<b>Prime Contractor</b>	MDA Systems Ltd (a division of MacDonald, Dettwiler and Associates), Richmond, British Columbia
<b>Major Sub-Contractors</b>	<ul style="list-style-type: none"> <li>- MDA Montréal, Ste.-Anne-de-Bellevue, Québec</li> <li>- Magellan Aerospace, Winnipeg, Manitoba</li> <li>- MDA, Halifax, Nova Scotia</li> <li>- Space X, Hawthorne, California, USA</li> <li>- EADS, Astrium, United Kingdom</li> <li>- COMDEV Europe, United Kingdom</li> </ul>
<b>Canadian Tier 2 and Tier 3 Subcontractors:</b>	<ul style="list-style-type: none"> <li>- EADS, Composites Atlantic, Lunenburg, Nova-Scotia</li> <li>- IMP Group, Halifax, Nova-Scotia</li> <li>- DRS, Ottawa, Ontario</li> <li>- Mecachrome, Mirabel, Quebec</li> <li>- Maya, Montreal, Quebec</li> </ul>

**Major Milestones**

The following are the major milestones of the RADARSAT Constellation Major Crown Project, by phase:

<b>Major Milestones</b>		
<b>Phase</b>	<b>Major Milestones</b>	<b>Date (at completion)</b>
A	Requirement Definition	March 2008
B	Preliminary Design	March 2010
C	Detailed Design Review	November 2012
D	Launch satellite #1, #2, and #3	2018
E1	Operations (part of MCP)	2019-2020
E2	Operations (not part of MCP)	2025-2026

**Project Outcomes:**

This MCP contributes to the Program 1.1 Space Data, Information and Services which includes the provision of space-based solutions and the progression of their utilization. It also serves to install and run ground infrastructure that processes the data and operates satellites. This Program utilizes space-based solutions to assist Government of Canada (GoC) organizations in delivering growing, diversified or cost-effective programs and services within their mandate, which is related to key national priorities, such as sovereignty, defence, safety and security, resource management, environmental monitoring and the North. It also provides academia with data required to perform its own research. The contribution of the MCP to the program objectives is measured through the Performance Measurement Framework (PAA, result and performance indicator).

## **Program 1.1 Space Data, Information and Services**

Result: Government of Canada (GoC) organizations offer more diversified or cost-effective programs and services due to their utilization of space-based solutions.

Performance Indicator # 1: Number of new GoC's programs offering more diversified or efficient services.

### **Sub-Program 1.1.1 Earth Orbit Satellite Missions and Technology**

Result: GoC organizations are using space-based data to deliver their mandate.

Performance Indicator # 1: Number of GoC's programs using space data or services to deliver their mandate.

Performance Indicator # 2: Percentage of RADARSAT data used in program's delivery.

### **Progress Report and Explanation of Variances:**

On 13 December 2004, the Domestic Affairs Committee of Cabinet granted approval-in-principle to a ten-year program to implement a RADARSAT Constellation Mission aimed at addressing user needs in relation to Canadian sovereignty and marine surveillance, environmental monitoring and change detection, and disaster management. The RCM is to be government-owned and operated.

On 6 June 2005, Treasury Board granted Preliminary Project Approval (PPA) for the RADARSAT Constellation Mission and expenditure authority for the Project Initial Planning and Identification (Phase A). During Phase A, feasibility studies were completed, user requirements were defined, and risk mitigation activities and options analysis for the bus and payload were carried out. The initial scope of work of Phase A was completed in December 2006. Phase A was then extended to allow additional technical risk reduction activities to continue during the period prior to the Phase B contract award. This was completed in March 2008.

A revised Preliminary Project Approval Treasury Board Submission to proceed to Phases B and C was approved in March 2007. Following a competitive Request for Proposal (RFP) process, Public Works and Government Services Canada (PWGSC) obtained authority to enter into a contract with MDA, the prime contractor, and awarded the contract for Phase B in November 2008. The Preliminary Design (Phase B) was completed in March 2010. The contract for Phase B was subsequently amended to include the detailed design (Phase C).

A second revised Preliminary Project Approval was approved by Treasury Board in December 2010. The purpose of this revised PPA was to provide additional expenditure authority to include the procurement of long-lead items during Phase C and also to include a technology demonstration program for the Department of National Defence funded Automatic Identification System (AIS) payload.

The final review of the overall mission-level system detailed design, the Mission Critical Design Review (CDR), was conducted in November 2012. A selected set of activities are pursued until March 2014 on Phase C, such as closing actions resulting from the design reviews and the procurement of long-lead items.

Treasury Board granted Effective Project Approval for the RCM in December 2012, which provides expenditure and contracting authorities to complete the project and carry out the first year of RCM operations. The contract for Phase D and E1 was awarded on 9 January 2013. Since contract award, planning activities were completed and major milestones were achieved to initiate the implementation phase of the satellites and associated ground system.

Significant progress was accomplished in the manufacturing of the RCM satellites throughout 2013-14. Several satellite units are nearing completion and are to be delivered in 2014-15 for integration into the satellites. Problems with some of the satellite units are being addressed and are not expected to impact the launch date. The plans for integration and testing of the three satellites were prepared and will be finalized in 2014-15. Work on the design of the RCM ground segment equipment also continued and is expected to

be completed in 2015-16. As per current planning, the equipment will then be delivered and installed at the CSA headquarters in 2016-17. A potential issue with the three-satellite launch configuration has been identified by the launch service provider. The prime contractor, MDA, is evaluating alternate launch options, should this become necessary. The launch currently remains scheduled for 2018.

**Industrial Benefits:**

Significant industrial benefits in the space and Earth Observation sectors are expected from the RADARSAT Constellation program. It is expected to generate employment growth in the Canadian knowledge-based economy and spur the growth of small and medium-sized businesses as the Canadian infrastructure and services industry continues to grow.

Regarding Canadian content and the distribution of contracts within Canada, the prime contract includes a requirement for 70% Canadian content, excluding launch services and sub-systems for which there are no suppliers available in Canada. As of 31 March 2014 this corresponds to a Canadian content requirement of \$235.1 million. For the same period the CSA had provided the Canadian industry with funding of more than \$ 273.9 million to carry out work resulting directly from the design of the RADARSAT Constellation Major Crown Project, thus surpassing the requirement.

The Prime Contractor is also required to meet the CSA’s overall regional distribution targets on a “best efforts” basis. In addition, given some past challenges in achieving regional targets, a minimum requirement of 3.5% of the 70% Canadian content has been set for the Atlantic. As of 31 March 2014 this corresponds to \$8.2 million. For the same period the actual Atlantic Canada content was \$6.7 million, somewhat short of the requirement. The prime contractor, MDA, remains confident in meeting the Atlantic Canada content requirement at the end of the contract.

The prime contract includes reporting obligations and performance measurements as well as financial penalties for not meeting the minimum Atlantic Canada content requirement. The CSA works closely with the Atlantic Canada Opportunities Agency (ACOA) to monitor regional distribution and to help support the Prime Contractor achieve the said targets.

**Regional Distribution of RADARSAT Constellation Mission  
Contracts to Canadian Industry (\$ in millions)  
(As of March 31, 2014)**

	<b>British Columbia</b>	<b>Prairies</b>	<b>Ontario</b>	<b>Quebec</b>	<b>Atlantic Provinces</b>	<b>Total Canada</b>
Targets (%)	10	10	35	35	10	100
Actual (%)	26.5	15.0	17.6	38.5	2.4	100
Actual (\$ in millions)	72.6	41.0	48.1	105.6	6.7	273.9

\* The absolute Canadian Content requirement for the Atlantic Canada Region is of 2.45% of the total contract value (3.5% of the 70% Canadian Content Requirement).

**Summary of Non-Recurring Expenditures  
(As of March 31, 2014)  
(\$ in millions)**

	<b>Current Estimated Total Expenditure</b>	<b>Actual at March 31, 2014</b>	<b>Future Years</b>
RADARSAT Constellation Mission	1088.8	486.8	602.0

## James Webb Space Telescope (JWST)

### **Description:**

The James Webb Space Telescope (JWST) is a joint mission of NASA, the ESA, and the Canadian Space Agency. The mission concept is for a large field-aperture telescope to be located 1.5 million km from Earth. Like Hubble, the JWST will be used by the astronomy community to observe targets ranging from objects within our solar system to the most remote galaxies which can be seen during their formation in the early universe. The science mission is centered on the quest to understand our origins and is focused on the following:

- Observing the very first generation of stars to illuminate the dark universe when it was less than one billion years old;
- Understanding the physical processes that have controlled the evolution of galaxies over cosmic time and, in particular, identifying the processes that led to the assembly of galaxies within the first 4 billion years after the Big Bang;
- Understanding the physical processes that control the formation and early evolution of stars in our own and other nearby galaxies; and
- Studying the formation and early evolution of proto-planetary disks, and characterizing the atmospheres of isolated planetary mass objects.

The JWST is scheduled for launch in 2018. JWST instruments will be designed to work primarily in the infrared range of the electromagnetic spectrum, with some capability in the visible range. JWST will have a large mirror, 6.5 meters in diameter and a sun shield that will be the size of a tennis court once deployed in outer space.

Canada is providing the Fine Guidance Sensor (FGS) and Near Infra-Red Imager and Slitless Spectrometer (NIRISS). The NIRISS instrument replaces the Tuneable Filter Imager (TFI) originally planned. The FGS is integral to the attitude control system of JWST, and consists of two fully redundant cameras that will report precise pointing information of JWST. Canadian expertise in this area has been established with the successful fine error sensors for the FUSE mission. Packaged with the FGS but functionally independent, the Near Infra-Red Imager and Slitless Spectrometer covers the 0.7 to 5 micrometer spectral range. NIRISS provides a specialized capability for surveys of objects such as primeval galaxies, for the study of transiting planetary systems and for high-contrast imaging applications such as the detection of extra-solar planets.

Developed in partnership with COM DEV Canada, the JWST-FGS Major Crown Project consists of the design, development, testing and integration into the spacecraft, launching and commissioning of the FGS and NIRISS. By participating in this leading-edge international space exploration mission, the Canadian Space Agency is actively promoting Canadian scientific expertise and innovative, advanced space technologies.

The National Research Council's National Science Infrastructure (NSI), formerly known as Herzberg Institute of Astrophysics, is a key Government of Canada partner for activities related to the development of science instruments and distribution of telescope data. In return for its overall investment in the JWST, Canada will obtain a minimum of 5% of the time on this unique space telescope.

Already, the news of Canada's involvement in this international space exploration mission is inspiring youth, educators and amateur astronomers, and rallying members of Canada's world-renowned astrophysics community.

**Project phase:** Phase D - Implementation

<b>Sponsoring and Participating Departments and Agencies</b>	
<b>Sponsoring Agency</b>	Canadian Space Agency
<b>Contracting Authority</b>	Public Works and Government Services Canada for the Canadian Space Agency
<b>Participating Departments</b>	NRC's National Science Infrastructure Industry Canada

<b>Prime and Major Sub-Contractors</b>	
<b>Prime Contractor</b>	- COM DEV Canada, Ottawa, Ontario
<b>Major Sub-Contractors</b>	- Teledyne, USA. - Corning Netoptix, USA. - IMP Aerospace Avionics, Canada - ABB Bomem, Canada - MDA, Canada - INO, Canada - BMV, Canada - CDA, USA. - ESTL, Europe - Bach Research Corporation, USA. - Materion, USA. - Camcor, Canada

**Major Milestones:**

The following are the major milestones, by phase:

<b>Major Milestones</b>		
<b>Phase</b>	<b>Major Milestones</b>	<b>Date</b>
A	Requirement Definition	2003-2004
B	Preliminary Design	August 2004 to May 2005
C	Detailed Design	July 2005 to September 2008
D	Manufacturing/Assembly; Integration/Testing; Pre-launch preparations, Launch/System Commissioning	May 2007 to March 2019
E	Operations	2019 to 2024

**Note:** The Major Crown Project terminates with the completion of Phase D.

**Project Outcomes:**

This MCP contributes to the Program 1.2 Space Exploration which provides valuable Canadian science, signature technologies and qualified astronauts to international space exploration endeavours. It fosters the generation of knowledge as well as technological spin-offs that contribute to a higher quality of life for Canadians. This Program appeals to the science and technology communities. It is targeted mostly towards Canadian academia and international space exploration partnerships. Canadian industry also benefits from the work generated within this Program. The contribution of the MCP to the program objectives is measured through the Performance Measurement Framework (PAA, results and performance indicators).

**Program 1.2 Space Exploration**

Result # 1: Expansion of scientific knowledge acquired through space exploration endeavours.

Performance Indicator # 1: Number of peer-reviewed scientific publications, reports and conference proceedings based on space exploration data produced by researchers (sciences and technologies) in Canada.

Result # 2: Multiple use and applications of knowledge and know-how acquired through space exploration endeavours.

Performance Indicator # 1: Number of terrestrial applications of knowledge and know-how acquired through space exploration endeavours.

Performance Indicator # 2: Number of space re-utilization of knowledge and know-how acquired through space exploration endeavours.

**Sub-Program 1.2.2 Exploration Missions and Technology**

Result # 1: Technological know-how acquired through Space Exploration endeavours (Astronomy and Planetary).

Performance Indicator # 1: Proportion of CSA's missions/solutions/instruments that met their mission performance requirements at acceptance review and/or at commissioning.

Result # 2: CSA's participation in space exploration missions provides access to scientific data about the Solar system and the Universe.

Performance Indicator # 1: Number of CSA's sponsored astronomy and planetary missions' providing data to Canadian scientific community.

Result # 3: Canada maintains a strategic positioning which supports its capacity to influence space exploration missions and decision making process in key international space exploration forums.

Performance Indicator # 1: Number of CSA's sponsored highly qualified personnel (HQP) nominated on the International Space Exploration Decision bodies.

**Progress Report and Explanation of Variances:**

In March 2004, the Treasury Board granted Preliminary Project Approval for Phases B, C and D. In December 2006, before the completion of the detailed design of the FGS, the CSA requested increased expenditure authority to complete the project. In February 2007, the Treasury Board granted Effective Project Approval with the condition "that the Canadian Space Agency provide reports to Treasury Board at the completion of Phases C and D of the JWST project which include up-to-date information on the project scope, costs, schedule and risks". At the same time, the project became a Major Crown Project (MCP).

In March 2007, the first Critical Design Review (CDR) for the guider function of the FGS, revealed some technical issues which required additional effort to resolve. This review took place after the Effective Project Approval (EPA) received in February 2007. During the preparation of the system level CDR, new



issues requiring additional analysis became apparent. Testing of the Tunable Filter Imager prototype also revealed technical issues that needed to be addressed.

On December 2007, the Treasury Board granted a revised Effective Project Approval (EPA) after the CSA's costs had risen significantly at the end of the detailed design phase.

In 2010, NASA discovered that the infrared detectors, extremely sensitive cameras capable of 'seeing' light produced by heat, were showing signs of performance degradation due to a design issue. Following an extensive investigation, NASA concluded that all detectors, including the four procured by Canada, needed to be replaced. Two years after their acceptance by the project, the detectors started to show the same degradation as seen by NASA during extensive testing of the FGS/NIRISS. NASA initiated with Teledyne Scientific & Imaging LLC an improvement project in order to address the design issue causing the degradation.

In 2011–12, the participants in the project were very busy with hardware and software development. COMDEV Canada, the prime contractor for the JWST Fine Guider Sensor (FGS) project, worked on the Proto Flight Model (PFM). The Proto Flight Model FGS successfully completed a very stringent environmental test campaign during which the instrument was subjected to cryogenic temperatures over a period of 80 continuous days. The detector design improvement with Teledyne Scientific & Imaging LLC was completed and testing demonstrated that the new design addressed the degradation issues. NASA then initiated the procurement process for acquiring new detectors for the JWST Mission. The detectors for the FGS/NIRISS were under the responsibility of the CSA for their acquisition.

The FGS Engineering Test Unit (ETU) was integrated into the NASA Goddard Space Flight Center (GSFC) test set-up and underwent system level testing with the other science instrument engineering units. An integration test onto the integrated science instrument module (ISIM) of the JWST was successfully conducted. On the Tunable Filter Instrument (TFI), development of the etalon proved to be technically challenging. In July 2011, the CSA decided to halt all etalon activities because the challenges facing this subsystem could not be resolved within the delivery timeframe defined by NASA. As a result, the Principal Investigator for the TFI proposed a plan to salvage the Canadian science instrument. From this was born the Near Infrared Imager and Slitless Spectrograph (NIRISS). This new instrument relied on all existing components of the old TFI with the exception of the etalon. The function of the etalon was replaced by selecting new optical elements capable of covering the light spectrum required for the science mission. Significant progress was achieved during this period.

On 30 July 2012, the PFM FGS/NIRISS was delivered to NASA GSFC. On 15 November 2012, the PFM FGS/NIRISS was officially accepted by NASA following the successful completion of post delivery functional checks. The FGS/NIRISS was the first instrument officially accepted by NASA as part of the JWST project.

On the detector front, the CSA and NASA concluded an agreement regarding the cost sharing for the procurement of 4 detectors for the FGS/NIRISS. Under this agreement, NASA would manage the procurement with Teledyne Scientific & Imaging LLC until the detectors are completed at which point they would be procured off-the-shelf by PWGSC.

In August 2013, NASA started its first cryogenic test campaign with the Integrated Science Instrument Module (ISIM) which was completed in November 2013. The FGS/NIRISS performed as expected during this first of 3 cryogenic test campaigns.

The second cryogenic test campaign is planned to be conducted in 2014-15 as the integration and test activities at NASA with ISIM continue. As well, in 2014, the FGS/NIRISS detectors will be replaced as soon as the second cryogenic test campaign is completed.

On the programmatic front in 2013, the CSA prepared a Treasury Board submission seeking an amended Effective Project Approval in order for the JWST project to proceed to completion. In 2007, when the project obtained TB approval for the revised EPA, the mission launch date was anticipated to be May 2013. Following a re-planning exercise conducted by NASA to implement a JWST mission plan with a high certainty of achieving the launch date, the launch date was slipped to October 2018, extending the project life by 5.5 years. In addition to this overall delay by NASA, there was an associated increase in the mission's integration and test phase, due to NASA having originally underestimated the work needed for this phase. The scope of work remaining to be completed for this project is as follows:

- Although the flight instrument has now been delivered, the project is still in the implementation phase where support must be provided for the integration of the FGS/NIRISS to the spacecraft, for the launch activities and for the spacecraft commissioning activities.
- With all the integration and test activities at NASA having been delayed and the duration of these activities revised under the NASA re-plan, the CSA and COM DEV are required to provide direct engineering post delivery support to NASA for FGS/NIRISS and to the JWST mission commissioning activities from 2014 up until April 2019.
- Official mission operations will commence after the completion of the telescope's commissioning, 6 months after its launch. The JWST operations center will be located in the Space Telescope Institute in Baltimore, Maryland in the United States. Canadian scientists will be on location to directly support the operations of the FGS and NIRISS throughout the missions operations. The operations will also be supported by engineering staff in order to be able to address technical issues if and when they will occur to ensure the functionality of Canada's instruments.

Ultimately this remaining scope of work and the extension of the mission schedule resulted in cost increases that could not be absorbed by the CSA project's 2007 Treasury Board authorities. As well, PWGSC needed to seek contractual authorities for acquiring the new detectors under a sole source contract with a US supplier. The Treasury Board submission addressing these issues was approved in February 2014 as a result the Treasury Board granted a revised Effective Project Approval (EPA) of \$169.9 million (excluding taxes).

**Industrial Benefits:**

As of 31 March 2014, the CSA had funded close to \$ 116 millions of work for Canadian industry that was directly attributable to the JWST-FGS Major Crown Project. Direct industrial benefits from the construction of the JWST-FGS, TFI and NIRISS system will benefit Canada's central regions. Although there is no regional distribution requirement for this project, the following table provides an approximate distribution:

**Regional Distribution of JWST Contracts to Canadian Industry  
(As of March 31, 2014)  
(\$ in millions)**

	<b>Ontario</b>	<b>Quebec</b>	<b>Atlantic Provinces</b>	<b>Total Canada</b>
Actual (%)	90.6	7.8	1.6	100.0
Actual (\$ in millions)	105.1	9.0	1.8	116.0

**Summary of Non-Recurring Expenditures**  
**(Forecasts to March 31, 2014)**  
**(\$ in millions)**

	<b>Current Estimated Total Expenditure</b>	<b>Actual at March 31, 2014</b>	<b>Future Years</b>
JWST-FGS and NIRISS	169.9	153.0	16.9

### **Annexe 3 Internal Audits and Evaluations**

<b>Name of internal audit</b>	<b>Internal audit type</b>	<b>Status</b>	<b>Completion date</b>
Process of Preparing Annual Financial Statements and Quarterly Financial Reports <a href="http://www.asc-csa.gc.ca/eng/publications/ar-1213-0103.asp">http://www.asc-csa.gc.ca/eng/publications/ar-1213-0103.asp</a>	Management Framework	Completed	June 2013
Class Grants and Contribution Program to Support Research, Awareness and Learning in Space Science and Technology <a href="http://www.asc-csa.gc.ca/eng/publications/ar-1213-0101.asp">http://www.asc-csa.gc.ca/eng/publications/ar-1213-0101.asp</a>	Management Framework	Completed	June 2013
Advanced Exploration Technology Development Program Management Framework <a href="http://www.asc-csa.gc.ca/eng/publications/ar-1213-0106.asp">http://www.asc-csa.gc.ca/eng/publications/ar-1213-0106.asp</a>	Management Framework	Completed	December 2013
Project Management Framework <a href="http://www.asc-csa.gc.ca/eng/publications/ar-1314-0103.asp">http://www.asc-csa.gc.ca/eng/publications/ar-1314-0103.asp</a>	Management Framework	Completed	March 2014
Office of the Comptroller General Horizontal Audit of Financial Forecasting	Management Framework	Completed	June 2014

Name of Evaluation	Program	Status	Completion date
Evaluation of the Advanced Exploration Technology Development Program <a href="http://www.asc-csa.gc.ca/pdf/eng/publications/er-1213-0201.pdf">http://www.asc-csa.gc.ca/pdf/eng/publications/er-1213-0201.pdf</a>	1.2.2.3	Completed	February 2014
Evaluation of the Near Earth Object Surveillance Satellite (NEOSSat) Project <a href="http://www.asc-csa.gc.ca/eng/publications/er-1314-0202.asp">http://www.asc-csa.gc.ca/eng/publications/er-1314-0202.asp</a>	1.2.2.1	Completed	February 2014
Evaluation of the CASSIOPE Contribution Program <a href="http://www.asc-csa.gc.ca/pdf/eng/publications/er-1314-0201.pdf">http://www.asc-csa.gc.ca/pdf/eng/publications/er-1314-0201.pdf</a>	1.1.1.3	Completed	February 2014
Evaluation of the Qualifying Testing Services Program	1.3.3	In progress	November 2014
Evaluation of the Class Grants and Contribution Program	Includes several PAA elements	In progress	February 2015
Evaluation of the International Market Access Program	1.3.2.1	In progress	June 2015

## **Annexe 4 Response to Parliamentary Committees and External Audits**

<b>Response to Parliamentary Committees</b>
No response requested in 2013-14
<b>Response to the Auditor General</b>
No recommendations received in 2013-14
<b>External audits conducted by the Public Service Commission of Canada or the Office of the Commissioner of Official Languages</b>
No external audits in 2013-14

## **Annexe 5 Sources of Responsible and Non-Responsible Revenue**

### **Responsible Revenue**

Program	2011–12 Actual (\$ in millions)	2012–13 Actual (\$ in millions)	2013–14 (\$ in millions)			
			Main Estimates	Planned Revenue	Total Authorities	Actual
Responsible Revenue	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Responsible Revenue</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

### **Non-Responsible Revenue**

Program	2011–12 Actual (\$ in millions)	2012–13 Actual (\$ in millions)	2013–14 (\$ in millions)	
			Planned Revenue	Actual
<b>1.1 Space Data, Information and Services</b>				
<b>1.1.2 Ground Infrastructure</b>				
Royalty Revenues	0.7	1.0	0.9	0.5
Miscellaneous Revenues	0.1	0.1	0.0	0.0
<b>1.3 Future Canadian Space Capacity</b>				
<b>1.3.3 Qualifying and Testing Services</b>				
David Florida Laboratory Testing Facilities and Services	5.3	2.2	2.8	1.9
<b>1.4 Internal Services</b>				
Royalties from Intellectual Property	0.1	0.0	0.0	0.0
Miscellaneous Revenues	0.3	0.3	0.3	0.4
<b>Total Non- Responsible Revenue</b>	<b>6.5</b>	<b>3.6</b>	<b>4.0</b>	<b>2.9</b>

## Annexe 6 Status Report on Projects Operating With Specific Treasury Board Approval

Project (\$ units)	Original estimated total cost [1]	Revised estimated total cost [2]	Actual cost total [3]	2013-14				Expected date of close-out [4]
				Main Estimates	Planned spending	Total authorities	Actual	
<b>1.1 Space Data, Information and Services</b>								
RADARSAT Constellation MCP EPA	600,000,000	1,088,796,532	486,790,207	241,228,404	248,168,404	258,742,551	175,553,551	2018-19
Maritime Monitoring and Messaging Micro- Satellite (M3MSAT) EPA	5,404,000	8,224,430	5,470,873	226,582	4,479,582	4,769,829	2,021,829	2015-16
<b>1.2 Space Exploration</b>								
Osiris-Rex Laser Altimeter (OLA) - EPA	26,696,400	33,542,564	20,712,888	12,125,248	12,522,073	17,435,577	16,501,124	2016-17
Canadian Metrology System (CAMS) on Japan 's Astro-H Space Observatory Satellite - EPA	4,767,320	5,217,320	3,879,953	1,553,500	3,200,592	3,399,157	2,372,943	2015-16
James Webb Space Telescope MCP (JWST) - EPA	67,160,000	169,902,953	153,032,283	1,240,500	2,105,500	8,146,557	4,700,427	2019-20
Near Earth Object Surveillance Satellite (NEOSSAT) - EPA	5,436,000	9,890,229	9,890,229	165,534	679,534	620,540	415,829	2013-14
<b>Total [5]</b>	<b>709,463,720</b>	<b>1,315,574,028</b>	<b>679,776,433</b>	<b>256,539,768</b>	<b>271,155,685</b>	<b>293,114,211</b>	<b>201,565,704</b>	

[1] Very first Total Estimated project cost approved by Treasury Board.

[2] Most recent Total Estimated project cost approved by Treasury Board.

[3] All expenditures as of March 31st 2014

[4] Expected date (Fiscal Year) for the beginning of operations

[5] Excluding GST/QST



## **Annexe 7 User Fees Reporting**

**User Fee:** Fees charged for the processing of access to information requests filed under the Access to Information Act (ATIA)

**Fee Type:** Other products and services (O)

**Fee-Setting Authority:** Access to Information Act

**Date Last Modified:** 1992

### **Performance Standards:**

Response provided within 30 days following receipt of request; the response time may be extended pursuant to section 9 of the ATIA. Notices of extension are to be sent within 30 days after receipt of request. The Access to Information Act provides fuller details.

### **Performance Results:**

The CSA received 38 new requests for access to information and had 6 that were outstanding from the previous period. Six were reported to be processed in the following year, for a total of 38 processed requests. The CSA routinely waives fees in accordance with TBS guidelines. The response time was within time limits in 81% of the requests.

<b>2013–14 (\$ in thousands)</b>			<b>Planning Years (\$ in thousands)</b>		
<b>Forecast Revenue</b>	<b>Actual Revenue</b>	<b>Full Cost</b>	<b>Fiscal Year</b>	<b>Forecast Revenue</b>	<b>Estimated Full Cost</b>
0.1	0.1	95	2014-15	0.1	100
			2015-16	0.1	100
			2016-17	0.1	100

### **Other Information:**

The CSA collects user fees for information requests in accordance with the Access to Information Act. The total amount of user fees collected in 2013-14 are for application fees. There was one request where we had to charge preparation fees but these were refunded as there was not as much preparation as estimated.