Canadian Space Agency

2018–19

Departmental Results Report

Supplementary Information Tables

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Departmental Sustainable Development Strategy

1. Context for the Departmental Sustainable Development Strategy

The *2016–2019 Federal Sustainable Development Strategy* (FSDS):

- sets out the Government of Canada's sustainable development priorities
- establishes goals and targets
- identifies actions to achieve them, as required by the *Federal Sustainable Development Act*

In keeping with the objectives of the act to make environmental decision-making more transparent and accountable to Parliament, Canadian Space Agency supports reporting on the implementation of the FSDS and its Departmental Sustainable Development Strategy, or equivalent document, through the activities described in this supplementary information table.

2. Sustainable development in Canadian Space Agency

The Canadian Space Agency's Departmental Sustainable Development Strategy for 2017 to 2020 describes the department's actions in support of achieving low-carbon government. This supplementary information table presents available results for the departmental actions pertinent to this goal. Last year's supplementary information table is posted on the department's website.This year, the Canadian Space Agency is also noting which UN SDG target each departmental action contributes to achieving.

3. Departmental performance by FSDS goal

FSDS goal: low-carbon government

FSDS target(s)	FSDS contributing action(s)	Corresponding departmental action(s)	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting point(s), target(s) and performance indicator(s) for departmental actions	Results achieved
Reduce greenhouse gas emissions from federal government buildings and fleets by 40% below 2005 levels by 2030, with an aspiration to achieve it by 2025	Improve the energy efficiency of our buildings/operations*	*1-* Net zero carbon study for our facility in Saint-Hubert – *in progress* 2- Options for energy efficiency measures included in our building studies 3- Control system analysis	7 13	**Performance indicator**: Percentage of greenhouse gas emissions reduction **Starting point:** 2018 **Target :** To be determined with the results of the net-zero carbon study	• No results yet. The net-zero carbon study will be conducted in 2019-20.
	Modernize our fleet	1- Fleet conversion into zero-emission vehicles 2- Purchase of our first charging station	7 13	**Performance indicator**: • Percentage of new light-duty administrative fleet vehicle purchases that are zero-emission vehicles • Percentage of greenhouse gas emissions reduction **Starting point:** 2018 **Target :** • 100% of our fleet will be zero emission or hybrid by 2025	• First low-carbon emission vehicle purchased • 25% of our fleet is now converted into zero-emission vehicles.

FSDS target(s)	FSDS contributing action(s)	Corresponding departmental action(s)	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting point(s), target(s) and performance indicator(s) for departmental actions	Results achieved
				• % our GHG emission reduction related to our fleet TBD.	
	Support the transition to a low-carbon economy through green procurement	Integrate environmental considerations into procurement management processes and controls • Ensure that acquisition card holder, procurement officers and materiel management functional specialists have the necessary training and awareness to support green procurement	12.7	**Performance indicator**: • Green Procurement Directive is in force • Green procurement criteria is integrated into procurement officers processes and CSA's controls. • Percentage of procurement officers and materiel management functional specialists that have taken the Canada School Public Service Green Procurement Course (C215); • Percentage of acquisition card holders that have taken Canada School Public Service Green Procurement Course (C215); **Starting point:** 2018	• Green Procurement Directive ready to be launched by 2020; • As part as our commitment on low carbon procurement, we have started to integrate environmental consideration and criteria in our construction and energy contracts.. • Green procurement criteria is integrated into the Contract Review Committee. • 100% of procurement officers and materiel management functional specialists have taken the Canada School Public

FSDS target(s)	FSDS contributing action(s)	Corresponding departmental action(s)	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting point(s), target(s) and performance indicator(s) for departmental actions	Results achieved
				• **Target :** • Green Procurement Directive is in force by 2020; • Green procurement criteria is integrated into procurement officers processes and CSA's controls; • 100% of procurement officers and materiel management functional specialists that have taken the Canada School Public Service Green Procurement Course (C215); • 100% of acquisition card holders that have taken the Canada School Public Service Green Procurement Course (C215);	Service Green Procurement Course (C215); • No results yet. We are currently planning the training to be taken by all acquisition card holders by early 2020.
	Demonstrate innovative technologies	Not applicable	Not applicable	Not applicable	Not applicable
	Promote sustainable travel practices	Not applicable	Not applicable	Not applicable	Not applicable

FSDS target(s)	FSDS contributing action(s)	Corresponding departmental action(s)	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting point(s), target(s) and performance indicator(s) for departmental actions	Results achieved
	Understand climate change impacts and build resilience	Climate change inventory in progress	13.2	**Performance indicator**: TBD **Starting point:** 2018 **Target :** TBD	Not applicable
	Improve transparency and accountability†	Not applicable	Not applicable	Not applicable	Not applicable
	Develop policy for low-carbon government†	Not applicable	Not applicable	Not applicable	Not applicable

Additional departmental sustainable development activities and initiatives related to responsible production and consumption and life below water

Additional departmental activities and initiatives	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting points, targets and performance indicators	Results achieved
Replacement of all our individual bins by centralized sorting stations in our facility in Saint-Hubert.	12 14	**Performance indicator**: • Divert at least 75% (by weight) of non-hazardous operational waste from landfills by 2030 • Divert at least 75% (by weight) of plastic waste from landfills by 2030	• Conducted a waste audit to obtain our baseline • Pilot-project to confirm the feasibility of this initiative

Additional departmental activities and initiatives	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting points, targets and performance indicators	Results achieved
		• Number of office spaces where centralized sorting stations has been installed **Starting point:** 2018 **Target :** 1- Operational waste: a. 70 % by 2022 b. 80% by 2025 2- Plastic : TBD 3- By 2020: Cafeteria + toilet By 2021: Levels 1 and 2 By 2022 :Levels 3 and 4	
Compost introduction in headquarters by 2020	12 14	**Performance indicator**: • Divert at least 75% (by weight) of non-hazardous operational waste from landfills by 2030 **Starting point:** 2018 **Target :** Operational waste: a. 70 % by 2022 b. 80% by 2025	• Conducted a waste audit to obtain our baseline

Additional departmental sustainable development activities and initiatives related to sustainable cities and communities and Partnerships for the goals

Additional departmental activities and initiatives	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting points, targets and performance indicators	Results achieved
Our headquarter in Saint-Hubert is participating in a wide study conducted by the municipality of Longueuil, Longueuil public transportation (RTL), and the CCIRS (Chambre de commerce et d'industrie de la Rive-Sud) that includes all the industrial sectors of the south shore of Montreal. We have created a mobility survey that will be sent to all of our employees in Saint-Hubert. The data collected in this survey will provide valuable and essential information regarding our employees' transportation modes and to understand better the issues or challenges they face when coming to work. This will also help us reduce our scope 3 GHG emissions in the future.	11 17	**Performance indicator**: TBD **Starting point:** 2018 **Target :** % of scope 3 greenhouse gas emissions reduction	• No results yet. The study is in progress.

Additional departmental sustainable development activities and initiatives related to sustainable cities and communities and Partnerships for the goals

Additional departmental activities and initiatives	Support for United Nations Sustainable Development Goal (UN SDG) target	Starting points, targets and performance indicators	Results achieved
By observing the Earth from space, satellite imagery provides essential information on ocean, ice, land environments, and the atmosphere. Earth observation satellites help monitor and protect the environment, manage natural resources, and ensure the safety and security of Canadians.	3 11 13 14 15	Not applicable	Not applicable

4. Report on integrating sustainable development

During the 2018–19 reporting cycle, Canadian Space Agency had no proposals that required a Strategic Environmental Assessment and no public statements were produced.

Details on transfer payment programs of $5 million or more

General information

Name of transfer payment program	Contributions under the Canada/European Space Agency (ESA) Cooperation Agreement
Start date	March 28, 2012 (ratification of the current Agreement) June 2016 (approval of revised Terms and Conditions) Note: The Canada/ESA Cooperation Agreement was renewed on February 12, 2019. The ratification and approval of the renewed Terms and Conditions will occur in 2019-20.
End date	December 31, 2019 (end date of the current Agreement). The recently renewed agreement, to be ratified in 2019-20, will be in effect until January 1, 2030.
Type of transfer payment	Contribution
Type of appropriation	Annually through Estimates
Fiscal year for terms and conditions	The current revised Terms and Conditions for the contributions, under the 2012–19 Cooperation Agreement, were approved in June 2016.
Link to the department's Program Inventory	Space Capacity Development
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 ESA optional programs.

Results achieved	For the period of January 1, 2015 to March 31, 2019, Canada has achieved a return coefficient of 110%, which is much higher than the minimum guaranteed to ESA Member states (i.e. 91% at end of 2019) and the ideal value (i.e. 100%). This coefficient indicates that as a result of the Canada-ESA Agreement, Canada is successful in obtaining its fair share of ESA contracts although the period for the statistics is short. Through Canada's participation in ESA Earth Observation programs, more specifically the Earth Observation Envelope Program, Copernicus Space Component, and European Earth Watch, the CSA has continued to support Canadian companies with the development of advanced space-borne instruments and sub-systems, user-oriented applications, and ensuring access to the data for Canadians. In the spring of 2017, Canada announced a new subscription of $6.5M (€4.2M) in the European Earth Watch for the Climate Change Initiative (CCI+) and the ALTIUS mission elements. Last year, Canadian scientific teams were awarded contracts under the CCI+ element to work on three new Environment Climate Variables, namely Lakes, Snow and Water Vapour. For the ALTIUS mission, a scientific team from University of Saskatchewan is contributing in data processor development and end-to-end simulator, which are the key components in retrieving the final geophysical products (Ozone and other green house gases). Also, a Canadian company, NGC Aerospace, is supplying advanced AOCS subsystems for the satellite platform. The Sentinel-3B, part of Copernicus Space Component, was launched in 2018 to monitor ocean colour and surface heights, and land vegetation and temperature. MacDonald, Dettwiler and Associates (MDA), a Maxar subsidiary, designed and built a SAR Radar Altimeter (SRAL) for one of the on-board instruments,. Communication & Power Industries LLC continued the work to supply the Klystron High Power Amplifier for Wind Scatterometer Instrument on MetOp-Second Generation satellites, first of which is scheduled for launch in August 2022. The company C-CORE got a major contract for the design, development, production, delivery and installation of a calibration transponder for the BIOMASS mission slated for launch in 2021. The CSA has supported the development and demonstration of innovative space technologies through its participation in ESA's General Space Technology Program. For instance, Neptec Design Group and NGC Aerospace are providing critical technologies for the formation flying

	mission Proba 3, to be launched in 2021. NGC Aerospace is also involved in the development of vision-based navigation algorithms for precise landing on the Moon and Mars. Through its partnership with the ESA, the CSA has continued to position the Canadian industry and scientists in future scientific and technological developments related to the European Exploration Envelop Program (E3P), which took over activities previously covered by the Aurora planetary exploration programs and the European Life and Physical Science (ELIPS) Program, in order to integrate ESA's space exploration efforts into one program. Under this program, MDA and Neptec Design Group continued the significant development of their respective rover subsystems as part of the second of two ExoMars missions, which is planned for launch in 2020. Under the same E3P program, MDA and Canadensys got involved in two different studies for the design of a sample fetch rover for a potential ESA contribution to a Mars Sample Return mission. 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, equipment and applications. The additional contribution to ARTES made at the 2016 ESA Council meeting at Ministerial level, that included a supplementary $30M announced in Budget 2016 for that program, resulted in many important contracts to Canadian industry. For example, MacDonald, Dettwiler and Associates (MDA) is developing and providing antenna for the OneWeb megaconstellation and is also involved in the European Data Relay System (EDRS) Global project, a PPP between ESA and Airbus. Other examples include Honeywell's development on Q/V Band High Power Devices, MPB's SMART Optical Amplifier for the European TESAT satellite supplier, Optelian's Optical Polarization Modulator development and Xiphos Technology providing major subsystems for the IODA platform. Finally, Canada joined the new Navigation Innovation and Support Program (NAVISP) in the spring of 2018 with a subscription of $3.1M (€2.0M). A total of four contracts were awarded to Canadian organizations under that program: Tallysman Wireless got a contract to develop a high performance, low-profile multi-constellation antenna targeting Survey, Precision Agriculture, Marine and Aviation

	market segments; RX Networks is developing a high-precision, cloud-based corrections service for Global Navigation Satellite System (GNSS) receivers; Skydel is expanding its existing fully featured software-defined GNSS simulator to seize arising European market opportunities; and Space Codesign Systems is developing a hardware/software codesign framework for GNSS software receiver.
Findings of audits completed in 2018–19	N/A
Findings of evaluations completed in 2018–19	The program evaluation covering the period from April 2013 to March 2018 was completed and approved by the President on October 22, 2018. The evaluation revealed that the cooperation agreement between Canada and ESA, and the contribution program that supports the implementation of the agreement, are critical means by which the Canadian space sector can maintain a meaningful engagement in space activities in Europe. Results confirm that the contribution program is achieving one of its primary objectives, which is to allow the Canadian space sector to be actively engaged and to collaborate with European space actors, including the large European prime contractors of ESA. Beyond its direct participation in ESA missions and activities, the contribution program is strengthening the ability of the Canadian space sector to engage in other foreign space markets. Finally, the evaluation concluded that the contribution program is efficiently delivered. Moving forward, the successful consultations held by the CSA with the Canadian space sector prior to the 2016 meeting of the ESA Council at the Ministerial Level provides a strong foundation for supporting Canada's planning activities in anticipation of the 2019 meeting of the ESA Council at the Ministerial Level. Beyond these consultations, the evaluation also identified an opportunity for the CSA to facilitate the sharing of experiences and lessons learned among the Canadian space sector working within the ESA context. This would be particularly beneficial for new entrants among the Canadian space sector.

Engagement of applicants and recipients in 2018–19	The CSA actively consulted the Canadian space sector (i.e. both industry and academia) and Government of Canada (GoC) organizations as part of the program selection process in preparation for the 2016 ESA Ministerial Council meeting during which ESA member states and Canada announced their position on contributions to the proposed ESA Programs. Similar consultations are planned for the ESA Ministerial Council meeting planned for November 2019.

Financial information (dollars)

Type of transfer payment	2016–17 Actual spending	2017–18 Actual spending	2018–19 Planned spending	2018–19 Total authorities available for use	2018–19 Actual spending (authorities used)	Variance (2018–19 actual minus 2018–19 planned)
Total contributions	34,498,797	41,766,413	29,568,000	30,011,643	29,977,215	409,215
Total program	**34,498,797**	**41,766,413**	**29,568,000**	**30,011,643**	**29,977,215**	**409,215**
Explanation of variances	The variance of $0.4 million is due to the increase in payments, in accordance with the budgetary feasibility principle governing member states' and Canada's contributions to ESA, against Canada's binding multiyear legal obligations with respect to its participation in ESA optional programs.					

Name of transfer payment program	Class Grant and Contribution Program to Support Research, Awareness and Learning in Space Science and Technology.
Start date	October 1, 2009
End date	N/A – Ongoing program
Type of transfer payment	Grant and Contribution
Type of appropriation	Annually through Estimates
Fiscal year for terms and conditions	2009–10
Link to the department's Program Inventory	Space Utilization Space Exploration Space Capacity Development Internal Services
Description	This program supports knowledge development and innovation in the CSA's 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) Awareness and Learning. 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 Awareness and Learning Component aims to provide learning opportunities to Canadian students 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. This Transfer Payment Program is composed of grants and non-repayable contributions.

Results achieved	In 2018–19, 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 10 new Announcements of Opportunity (AOs) posted on the CSA's website, resulting in 55 new supported research projects. For more information regarding these initiatives consult the Programs Results Section of the DRR. Global Results: The annual web based follow-up project survey showed results of 674 publications among which 68% were peer reviewed and 1195 presentations among which 240 vulgarization presentation with the focus on the general public and 84 other Outreach/General Scientific Awareness Activities. 2,265 research team members were involved in the supported initiatives representing 663 persons per year in terms of Full-Time Equivalence (FTE). From these Highly Qualified Personnel (HQP), 588 were Faculty members, 1337 students and Post-Doctoral Fellows and 340 technicians and other research team members. A total of 347 research organizations have been involved in the funded projects (i.e. 51% been Universities, 17.3% Foreign Research organizations, 17.3% from the private sector and 11% other). 63.5% of research partners are international and 36.5% are national.
Findings of audits completed in 2018–19	No audit completed in 2018-19 An audit is underway and completed in October 2019-20
Findings of evaluations completed in 2018–19	No evaluation completed in 2018-19 Next evaluation is planned and expected to be completed in March 2021–22
Engagement of applicants and recipients in 2018–19	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 with other potential recipient groups, are ongoing and will continue.

Financial information (dollars)

Type of transfer payment	2016–17 Actual spending	2017–18 Actual spending	2018–19 Planned spending	2018–19 Total authorities available for use	2018–19 Actual spending (authorities used)	Variance (2018–19 actual minus 2018–19 planned)
Total grants	11,870,329	8,674,322	10,766,000	10,423,661	10,423,648	(342,352)
Total contributions	9,146,442	10,507,215	16,077,000	15,975,696	15,975,628	(101,372)
Total other types of transfer payments	0	0	0	0	0	0
Total program	**21,016,771**	**19,181,537**	**26,843,000**	**26,399,357**	**26,399,276**	**(443,724)**
Explanation of variances	The residual difference consists of multiple variations inherent to the Canadian Space Program (CSP) Resource Management. They result from the fact that budgetary requirements by vote are not linear from one year to the next, requiring vote transfers or fund carry forwards to another fiscal year.					

Gender-based analysis plus

General information

Governance structures	The Canadian Space Agency's (CSA) GBA+ implementation plan consists of 6 elements: 1. A CSA Policy on GBA+ 2. A Responsibility Center composed of the CSA GBA+ Champion and Points of Contact in each Branch 3. Training for executives, managers, supervisors, analysts and others identified on a case by case basis 4. Tools and guides 5. Monitoring 6. Reporting on the above (internally and externally) The CSA GBA+ Policy was approved in March 2017. The policy states the roles and responsibilities of CSA personnel and stipulates that all initiatives that are new or which need re-approval will be subject to a Gender-Based Analysis Plus (GBA+). More specifically, the policy requires that: • All CSA initiatives (e.g. policies, programs, projects, grants and contributions, budget proposals) that are new or which need re-approval will be subject to GBA+ to ensure they do not have detrimental impacts on certain diverse groups of women and men and that they seek to achieve better results for all Canadians. • Documented evidence of the elaboration of GBA+ is required to support approval of initiatives for Treasury Board (TB) Submissions and Memorandum to Cabinet (MC) • The documented evidence of the elaboration of GBA+ will be collected in order to monitor the implementation and continuous improvement of the GBA+ processes at CSA, and for reporting to Status of Women Canada (SWC) on a regular basis. The CSA GBA+ Policy stipulates that: The President is responsible for ensuring that the Government of Canada's commitment to implementing GBA+ is fulfilled at the CSA as per the aforementioned policy requirements. The Executive Committee Members are responsible for:

	• Ensuring that gender and other identity factor considerations are identified and that inequalities are corrected within the context of their respective program's activities, from policy and program development to service delivery, including in MC and TB Submissions. • Supporting and encouraging GBA+ training opportunities for their employees. • Appointing one of their members as the GBA+ Champion that will be the functional authority for GBA+ at the CSA. • Appointing a GBA+ Point of contact for each branch of the CSA. The Executives and managers are responsible for: • Applying GBA+, and for integrating the results thereof, to the decision-making process within their sector. • Supporting their employees who are engaged in applying GBA+ to the initiatives under their responsibilities, from concept to implementation to operations as applicable, and for supporting related adjustments that might be required in this regard. • Providing training opportunities in GBA+ for their employees Also, since 2017, GBA+ is integrated in the requirements of the Investment Governance and Monitoring Framework (IGMF) and is part of the roles and responsibilities of the executive sponsor of each investment. All investments presented to the Integrated Investment Review Board (IIRB) are required to have a GBA+ completed in order for the Gate 2 of the investment to be approved at the IIRB. At each subsequent phases of the investment, the GBA+ is updated on a need basis. The annual reporting to the department of Women and Gender Equality Canada (WAGE) includes information on the inclusion of GBA+ into departmental decision-making processes. To be noted, each GBA+ elaborated is reviewed and approved by the GBA+ Champion of the Canadian Space Agency.
Human resources	We added up all the portions of full-time equivalents (FTEs) that were partly dedicated to GBA+ implementation in 2018-2019 and it totals 1 FTE. This includes: • FTEs that were part of the GBA+ Responsibility Centre, i.e., the Champion • Departmental GBA+ Focal Points in each branch

	• FTEs who draft GBA+ analysis in branches
Major initiatives: results achieved	Although no initiatives have been provided in the 2018–2019 Departmental Plan, several GBA+ analyses have been conducted during the year. All of these initiatives are directly aligned with three of the six key areas identified in the Gender Results Framework, namely 1) education and skills development 2) economic participation and prosperity and 3) Gender equality around the world. The analysis for the three initiatives below indicates that there are no negative impacts expected since women will benefit more greatly from the anticipated creation of STEM jobs than they would have in the past due to the increasing number of engineering and other STEM graduates. However, they will not benefit equally from the anticipated STEM jobs created by the proposals. Three of the GBA+ analyses conducted led to concrete actions and are presented below. Furthermore, each program evaluation undertaken now includes a section that looks at the results, the efficiency and the economy of programs using a GBA+ lens. **1) Gateway External Robotic interfaces (GERI):** • Canada, as a partner in the International Space Station (ISS), has undertaken important discussions with the international partnership to determine the next step for human exploration. The common long-term goal is the human exploration of Mars. One step towards this long-term goal is to demonstrate and prove technologies beyond the ISS. The International Partners (IPs) have developed a conceptual Gateway architecture in the lunar vicinity that addresses both goals, along with a pathway to develop that architecture. The Gateway External Robotic Interfaces (GERI) project aims to provide the initial set of robotic interfaces installed on the first Gateway element. • Because women and underrepresented groups are currently underrepresented in high-quality occupations in space robotics, CSA will continue to seek to reduce systemic barriers to participation by specifically targeting girls, women, and other underrepresented groups in its STEM outreach and education initiatives. • The CSA plans to use space to inspire youth through astronauts/scientist/engineering role models who are representative of the Canadian population as well as demonstrating how space can benefit their lives in a tangible manner. The CSA will be launching a “Women in STEM” webpage on its website with profiles of CSA role models and other resources to inspire young women to pursue careers in STEM-related fields.

	2) Canadian Wildland Fire Monitoring Sensor (CWFMS) Project: • Wildfires is a significant concern in Canada and improving the fire management capacity is a priority for the government. The CSA fire management long-term initiative aims to address this concern by a space-based asset. The key instrument of this space-based asset is the EMIR sensor. This sensor is a unique instrument, miniaturized and uncooled, at the leading edge of the technology. However, despite the fact it is very promising, it is required to first demonstrate the technology on an aircraft. The demonstration plan includes two campaigns, during summers 2019 and 2020. While the first campaign aims to better characterize the EMIR sensor using flights over controlled fires, the second aims to validate the data by flying over real wildfires. • The positive impacts on Women, Visible Minorities and Indigenous people have been noted. However, it has been decided to reinforce the intention of the CSA and Federal Government to reach male-female equity. • The following statement has been added to the official documents: "The contractor is encouraged to propose solutions that increase the representation and advancement of women in the space sciences and engineering, as one means to foster excellence in research and training. The contractor should strive for a balanced gender representation in the group of trainees and in their supervisors, role models and mentors. If the discipline of the proposed projects tends to have a gender imbalance in the trainee population, applicants are strongly encouraged to demonstrate that this imbalance has been considered and addressed in their plan for trainee recruitment." **3) Meeting Canada's Obligations Arising from the Extension of Participation in the International Space Station (ISS) to 2024:** • The ISS program is a joint partnership among five participating agencies: NASA, CSA, European Space Agency, Japan Aerospace Exploration Agency, and Russian Space Agency. The ownership and use of the ISS are established by a legal framework comprising intergovernmental treaty and bilateral agreements between NASA and partner agencies. Under this legal framework, Canada is obligated to operate and maintain its contribution to the ISS and to pay an equitable share of the ISS Common System Operating Cost (CSOC). An authority is requested to negotiate and conclude arrangements with NASA on activities to meet Canada's obligations under the ISS CSOC as a follow up to the 2016 Cabinet decision to extend Canada's participation in the ISS to 2024. • A GBA+ analysis concluded that "Meeting Canada's Obligations Arising from the Extension of Participation in the International Space Station (ISS) to 2024" could increase opportunities for

	women and underrepresented groups to participate in the Canadian Space Sector both in STEM and non-STEM HQP jobs. • The CSA will be launching a "Women in STEM" webpage on its website with profiles of CSA roles models and other resources to inspire young women to pursue careers in STEM-related fields. The CSA in conjunction with initiatives from other federal departments (i.e. ISED's CanCode, Digital Skills for Youth, Computers for Schools, NSERC's PromoScience) is actively seeking to improve diversity and inclusion in post-secondary STEM education as well as within the Canadian STEM workforce.
Reporting capacity and data	N/A None of our Program Inventory programs collect individual recipient microdata information.

Response to parliamentary committees and external audits

Response to parliamentary committees

There were no parliamentary committee reports requiring a response in 2018–19.

Response to audits conducted by the Office of the Auditor General of Canada (including audits conducted by the Commissioner of the Environment and Sustainable Development)

There were no audits in 2018–19 requiring a response.

Response to audits conducted by the Public Service Commission of Canada or the Office of the Commissioner of Official Languages

There were no audits in 2018–19 requiring a response.

Status report on projects operating with specific Treasury Board approval

Project name and project phase	Original estimated total cost (dollars)	Revised estimated total cost (dollars)	Actual total cost (dollars)	2018–19 Main Estimates (dollars)	2018–19 Planned spending (dollars)	2018–19 Total authorities (dollars)	2018–19 Actual spending (dollars)	Expected date of close-out
Space Data, Information and Services								
RADARSAT-CONSTELLATION MCP EPA	600,000,000	1,089,635,459	1,025,360,386	75,556,648	86,923,105	86,849,796	37,473,228	2020-2021
SURFACE WATER & OCEAN TOPOGRAPHY (SWOT-C)	8,496,507	10,127,596	6,637,646	2,949,736	4,391,155	4,503,527	1,759,605	2021-2022
Space Exploration								
JAMES WEBB SPACE TELESCOPE MCP (JWST) EPA	67,160,000	173,211,953	169,812,701	1,583,824	2,499,680	2,499,680	599,690	2021-2022
MOBILE SERVICING SYSTEM REPLACEMENT CAMERA (MSS RCAM)	15,465,270	19,619,835	18,094,684	1,675,672	1,675,672	2,210,056	1,628,456	2021-2022
DEXTRE DEPLOYABLE VISION SYSTEM (DDVS)	23,351,302	26,378,302	10,258,332	2,786,408	7,019,100	8,450,100	4,062,222	2021-2022
LIFE SCIENCE RESEARCH SYSTEM (LSRS)	15,268,161	20,026,950	17,786,264	2,933,528	3,624,357	5,591,357	5,206,533	2021-2022
Internal Services								
DAVID FLORIDA LABORATORY INFRASTRUCTURE ACCELERATED REFIT (DFL-IAR)	12,022,802	13,544,547	12,559,241	-	3,982,367	4,024,358	3,034,226	2019-2020

Note: Dollar amounts exclude both the goods and services tax (GST) and the harmonized sales tax (HST).

Status report on transformational and major Crown projects

General information

Project name	RADARSAT Constellation Mission (RCM)
Description	The RADARSAT Constellation Mission (RCM) is the next generation of Canadian Earth observation (EO) radar satellites. RADARSAT-1 was launched in 1995 and continued its operation until March 2013. RADARSAT-2, developed by the private sector in partnership with the Government of Canada (GoC), was launched in 2007 for a seven-year mission, but given its current performance, it is expected to remain operational for several more years. Canada has established itself as a leading global supplier of C-band satellite radar data for EO. The successor mission to RADARSAT-2, the RCM will maintain the leadership and position of Canadian industry in space radar technology and value-added product markets. The RCM is comprised of three identical satellites and was successfully launched in June 2019. With a constellation, the time between successive imaging of a specific point on Earth is significantly reduced from 24 to four days. 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 requirements of operations of both public and private users. The scope of the RCM Major Crown Project includes the requirement definition, design, development, manufacturing, integration, testing and launch 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 application development program. The RCM will provide reliable data in all weather and illumination conditions in support of federal departments' operations and mandates in areas such as maritime surveillance, disaster management, environmental monitoring, and natural resource management. The satellite constellation will provide average daily coverage capacity of most of Canada and its surrounding waters. In the North, the

	constellation will provide two to three times daily coverage capacity 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 information to task ships and aircraft in order to intercept suspicious vessels. The daily coverage of marine areas will also support fisheries monitoring, ice and icebergs monitoring, pollution monitoring, and integrated ocean and coastal zone management. The RCM's maritime surveillance capabilities also support Canadian sovereignty and security. The RCM satellites will be able 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 and elsewhere in the world. 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, while helping 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, the 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 resource management, RCM data will be a critical source of information 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 exploration operations to ensure that critical infrastructure is monitored properly for safety and integrity. In addition, the RCM will sustain 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 outcomes	This Major Crown Project (MCP) contributes to the Space Utilization program, 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 and cost-effective programs and services within the purview of their respective mandates, each 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 Information Profile results and indicators.
Industrial benefits	The RCM is expected to generate significant industrial benefits in the space and Earth Observation sectors, such as employment, economic growth and improved productivity. Investments in RCM also support the growth of small and medium-sized companies as well as Canadian capabilities in terms of infrastructure and services. The prime contract includes a requirement for 70% Canadian content, excluding launch services and subsystems for which there are no suppliers available in Canada. As of September 30, 2017 (the latest date for which data is available) this corresponds to a Canadian content requirement of $485.2 million. For the same period, the CSA had provided the Canadian industry with funding of more than $575.3

	million to carry out work resulting directly from the design of the RCM MCP, thus surpassing the requirement. The prime contract also requires that 3.5% of the 70% Canadian content be subcontracted in the Atlantic Canada region. For the same period, the actual Atlantic Canadian content was $22.6 million, considerably higher than the requirement of $17.0 million. The prime contract includes reporting obligations and performance measurements as well as financial penalties for not meeting the minimum Atlantic Canada content requirement.
Sponsoring department	Canadian Space Agency (CSA)
Contracting authority	Public Services and Procurement Canada (PSPC)
Participating departments	Agriculture and Agri-Food Canada Environment and Climate Change Canada Canadian Ice Service Fisheries and Oceans Canada Canadian Coast Guard Global Affairs Canada Indigenous and Northern Affairs Canada Innovation, Science and Economic Development Canada National Defence and the Canadian Armed Forces Natural Resources Canada Parks Canada Public Safety Canada Royal Canadian Mounted Police Statistics Canada Transport Canada
Prime contractor	MDA Systems Ltd. (a division of MacDonald, Dettwiler and Associates), Richmond, British Columbia
Major subcontractors	Tier 1 Major Subcontractors:

	- MDA Montreal, Ste-Anne-de-Bellevue, Quebec - Magellan Aerospace, Winnipeg, Manitoba - MDA, Halifax, Nova Scotia - SpaceX, Hawthorne, California, USA - Airbus Defence and Space, United Kingdom - Honeywell Aerospace, United Kingdom Tier 2 and Tier 3 Canadian Subcontractors: - Stelia Aerospace North America, Lunenburg, Nova Scotia - IMP Group, Halifax, Nova Scotia - DRS, Ottawa, Ontario - Mecachrome, Mirabel, Quebec - Maya, Montreal, Quebec
Project phase	Phase D – Implementation
Major milestones	Phase A: Requirement Definition (March 2008) Phase B: Preliminary Design (March 2010) Phase C: Detailed Design Review (November 2012) Phase D: Launch satellite #1, #2, and #3 (2018) Phase E1: Operations (part of MCP) (2020) Phase E2: Operations (not part of MCP) (2026)
Progress report and explanation of variances	On December 13, 2004, the Domestic Affairs Committee of Cabinet granted approval-in-principle to a 10-year program to implement a RADARSAT Constellation Mission (RCM) aimed at addressing the operational needs of users from the public and private sectors in relation to Canadian sovereignty and marine surveillance,

	environmental monitoring and change detection, and disaster management. The RCM is government-owned and operated. On June 6, 2005, Treasury Board granted Preliminary Project Approval (PPA) for the RCM and expenditure authority for the Project Initial Planning and Identification (i.e. 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 for 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. In March 2007, Treasury Board approved a revised PPA submission to proceed to Phases B and C. Following a competitive Request for Proposal (RFP) process, PWGSC obtained authority to enter into negotiations with MDA, the prime contractor, and awarded the contract for Phase B in November 2008. The Preliminary Design (i.e. Phase B) was completed in March 2010. The contract for Phase B was subsequently amended to include the detailed design (i.e. Phase C). A second revised PPA 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 for Automatic Identification System (AIS) payloads, funded by the National Defence. 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, such as completing the design qualification activities and the procurement of long-lead items, pursued under Phase C were completed in November 2015. These selected activities were scheduled to be completed in March 2014 but were delayed due to technical difficulties encountered during the building of the qualification models. The delay has no impact on the project.

	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 (Phases D and E1). The contract was awarded on January 9, 2013. Since the contract award, planning activities were completed and major milestones achieved to initiate the implementation phase of the satellites and associated ground system. In 2013, a Deputy Ministers' Governance Committee (DMGC) was established to provide oversight, coordination and accountability on the RCM MCP. The DMGC reports to the Minister of Innovation, Science and Economic Development and provides strategic direction while making timely decisions to address issues and risks that could affect the success of the MCP. Significant progress continued in the manufacturing of the RCM satellites throughout 2016–17. Assembly, integration and testing of the last of the three synthetic aperture radar (SAR) and automatic identification system (AIS) payloads were completed, and the payloads were delivered. Challenges in completing the flight software were addressed. Assembly and integration of the first satellite were completed, and testing was well underway. Assembly, integration and testing of the second satellite had started. Assembly, integration and testing of the third satellite started once the third satellite bus was completed and delivered early in 2017–18. Three of the eight ground segment subsystems were completed. Upgrades to the CSA headquarters in Saint-Hubert to accommodate the RCM ground segment also progressed significantly. The launch dispenser was completed and the period of the launch event was narrowed from twelve months to three months (July 17, 2018, to October 14, 2018). Significant progress continued in the manufacturing of the RCM satellites throughout 2017–18. Assembly, integration and testing of the last satellite bus was completed and delivered. By March 2018, the three satellites had progressed to a state of completion of 87%, 61% and 41% respectively. All of the ground segment subsystems were delivered to and integrated into the Primary Control Facility in Saint-

	Hubert, Quebec. Upgrades to the CSA headquarters in Saint-Hubert to accommodate the RCM ground segment were also completed in time for the arrival of the ground segment subsystems. Significant progress was also achieved in finalizing the Data Policy. A provisional Operating Licence was issued by Global Affairs Canada. The period of the launch event was narrowed from three months to 30 days (October 30, 2018, to November 29, 2018). Significant progress continued throughout 2018-19. Assembly, integration and testing of all three RCM satellites was completed and the three satellites were shipped to a storage facility near the launch site. Work on the RCM ground segment was also completed. The Data Policy was finalized and its approval is expected shortly after the launch of the RCM satellites. The operating license was issued by Global Affairs Canada. The RCM was successfully launched in June 2019, a few months after the expected launch in 2018-19.

Project name	James Webb Space Telescope
Description	The James Webb Space Telescope is a joint international mission involving National Aeronautics and Space Administration (NASA), the European Space Agency (ESA) and the Canadian Space Agency (CSA). The mission concept is for a large field-aperture telescope to be located 1.5 million km from Earth. Like Hubble, the James Webb telescope 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 centred on the quest to understand our origins: • 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 four 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 James Webb telescope is currently planned to launch in 2021. James Webb instruments are designed to work primarily in the infrared range of the electromagnetic spectrum, with some capability in the visible range. The James Webb telescope will have a large mirror, 6.5 metres 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 the Near-Infra-Red Imager and Slitless Spectrometer (NIRISS). The FGS is integral to the attitude control system of the James Webb telescope, and consists of two fully redundant cameras that will report precise

	pointing information. Canadian expertise in this area was established previously with the successful fine error sensors for the former Far Ultraviolet Spectroscopic Explorer (FUSE) mission. Packaged with the FGS but functionally independent, the NIRISS 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. With COM DEV (now Honeywell Aerospace) Canada as the prime contractor, the James Webb Space Telescope-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 CSA is actively promoting Canadian scientific expertise and innovative, advanced space technologies. The National Research Council's Herzberg Astronomy and Astrophysics (NRC Herzberg) is a key Government of Canada (GoC) partner for activities related to the development of science instruments and distribution of telescope data. In return for its overall investment in the James Webb telescope, 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 outcomes	This Major Crown Project (MCP) contributes to Space Exploration program 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 Information Profile results and indicators.
Industrial benefits	Most of the direct industrial benefits from the construction of the Webb-FGS and NIRISS system will accrue to Ontario.
Sponsoring department	Canadian Space Agency (CSA)
Contracting authority	Public Services and Procurement Canada (PSPC)
Participating departments	NRC Herzberg Astronomy and Astrophysics Innovation, Science and Economic Development (ISED)
Prime contractor	- Honeywell Aerospace, Ottawa, Ontario
Major subcontractors	- Teledyne, USA - Corning Netoptix, USA - IMP Aerospace Avionics, Canada - ABB Bomem, Canada - MDA, Canada - INO, Canada - BMV, Canada - CDA Intercorp, USA - ESTL, Europe - Bach Research Corporation, USA - Materion, USA - Camcor, Canada
Project phase	Phase D – Implementation

Major milestones	Phase A: Requirement Definition (2004) Phase B: Preliminary Design (May 2005) Phase C: Detailed Design (September 2008) Phase D: Manufacturing/Assembly, Integration/Testing, Pre-launch preparations, Launch/System Commissioning (March 2022) Phase E: Operations (part of MCP) (2026)
Progress report and explanation of variances	In March 2004, Treasury Board granted Preliminary Project Approval for Phases B, C and D. In December 2006, before the completion of Phase C, 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 (EPA) and the project became a Major Crown Project (MCP). In March 2007, the first Critical Design Review (CDR) for the guidance function of the FGS revealed technical issues. During the preparation of the system-level CDR, new issues became apparent. The technical issues needed to be addressed. In December 2007, Treasury Board granted a revised EPA after project costs had raised significantly due to technical issues by the end of Phase C, 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 fault. Following investigation, NASA concluded that all detectors, including the four procured by Canada, needed to be replaced. In effect, two years after their acceptance by the project, the detectors started to show the same degradation. NASA initiated an improvement project with Teledyne Scientific & Imaging LLC to address the design issue causing the degradation. In 2011–12, work continued on hardware and software development. COMDEV Canada worked on the Proto Flight Model (PFM) which

	successfully completed a very stringent environmental test campaign during which the instrument was subjected to cryogenic temperatures over a period of 80 continuous days. Teledyne Scientific & Imaging LLC completed the detector design improvements and, pursuant to testing successfully addressed the degradation issues. NASA then initiated the procurement process for new detectors for the James Webb telescope Mission; the acquisition of the detectors for the FGS/NIRISS was under the responsibility of the CSA. 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. The integration test onto the Integrated Science Instrument Module (ISIM) of the James Webb telescope was successfully conducted. A technical issue surfaced with a component, the Tunable Filter Instrument (TFI), which triggered the need for a change in the design approach and led to the design and development of the Near-Infrared Imager and Slitless Spectrograph (NIRISS). This new instrument relied on existing components of the old TFI but used a different approach to cover the light spectrum required for the science mission. On July 30, 2012, the PFM FGS/NIRISS was delivered to NASA GSFC. On November 15, 2012, the PFM FGS/NIRISS was officially accepted by NASA following the successful completion of post-delivery functional tests. The FGS/NIRISS was the first instrument officially accepted by NASA as part of the James Webb Space Telescope project. As to the procurement of the four new detectors for FGS/NIRISS, the CSA and NASA agreed on cost sharing: 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 the CSA (through PWGSC).

	In August 2013, NASA initiated a cryogenic test campaign with the Integrated Science Instrument Module (ISIM). The test was completed in November 2013, and the FGS/NIRISS performed as expected. The second cryogenic test campaign was conducted in 2014–15 as the integration and test activities at NASA with ISIM continued. As well, in 2014, the FGS/NIRISS detectors were replaced after the completion of the second cryogenic test campaign. 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 direct engineering post-delivery support must be provided to NASA for the integration of the FGS/NIRISS into the observatory, for the launch activities and for the observatory commissioning activities which are planned to be completed 6 months after launch. Official mission operations will commence after the completion of the telescope's commissioning, six months after its launch. The James Webb telescope operations centre 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 mission's operations. The operations will also be supported by engineering staff in order to be able to address technical issues if and when they 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 2007 project authorities. As well, PWGSC needed contractual authorities for acquiring the new detectors under a sole-source contract with a US supplier. As a result, the CSA prepared a new submission to Treasury Board addressing the issues above. The submission was approved in February 2014. Treasury Board granted a revised EPA of $169.9 million (excluding taxes).

	In January 2016, NASA completed the third and final cryogenic test campaign of ISIM at NASA's GSFC. During this test campaign, the FGS/NIRISS performed as expected, thus successfully closing the final performance verification of Canada's contribution to the James Webb Space Telescope. In March 2016, NASA entered the next level of spacecraft integration and testing with the joining of ISIM and the Optical Telescope Element to form the OTIS (Optical Telescope element and Integrated Science instrument module). In 2016–17, the Integrated Science Instrument Module (ISIM) was integrated with the Optical Telescope and the new assembly (nicknamed OTIS, which stands for Optical Telescope and Science Instruments) underwent a series of rigorous environmental testing, comprised of ambient functional, vibration and acoustic testing, at NASA Goddard Space Flight Center in Maryland. The FGS/NIRISS team has supported these tests and prepared for the OTIS cryogenic tests planned for the summer of 2017. In May 2017 the OTIS module was shipped to the NASA Johnson Space Center where it went through a series of cryogenic vacuum tests designed to ensure the telescope functioned as expected in an extremely cold, airless environment akin to that of space. These tests, which lasted about 100 days, were completed successfully in November 2017, with flawless performance from the Canadian instruments FGS and NIRISS. In February 2018 the OTIS was shipped to Northrop Grumman Aerospace Systems (NGAS) in California, where it will be integrated with the spacecraft element to form the complete James Webb Telescope Observatory. Although the OTIS module testing was completed successfully and on schedule, in 2017–18 the James Webb Space Telescope mission saw significant delays. On September 28, 2017, NASA announced that the launch planned for October 2018 was delayed until the spring of 2019, due to a combination of some integration activities on the spacecraft bus and sunshield at NGAS taking longer than planned and the

	integration of lessons learned from earlier testing. Then, after an independent assessment of the remaining integration and test tasks, on March 27, 2018, NASA announced a further launch delay to approximately May 2020. In April 2018 an Independent Review Board (IRB) was mandated by NASA' Science Mission Directorate to evaluate all factors influencing JWST mission success, to ensure that NASA's approach to completing the integration and testing, the launch campaign and the commissioning is appropriate. The IRB released its report in May 2018 with 32 recommendations. One of the IRB's recommendations was to establish the launch date as March 2021, and identified schedule risks that were not part of the recommended March 2021 date. On June 27, 2018, NASA announced the launch date moved to March 2021, based on the integration and test anomalies encountered to date and an 80% confidence level. On the technical side, in 2018-19 the OTIS assembly remained at the Northrop Grumman facilities in California while waiting for the spacecraft and sunshield integration and test activities to be completed (planned for 2019-20). Some risk reduction activities were performed on OTIS, with support from the FGS/NIRISS team. The main support activities for the Canadian team in 18-19 included planning and rehearsals for the commissioning, as well as flight software work.