2021–22 Departmental Results Report

Canadian Space Agency

The Honourable François-Philippe Champagne, P.C., M.P.
Minister of Innovation, Science and Industry

Canadian Space Agency | Agence spatiale canadienne

Canada

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From the Minister

The Honourable François-Philippe Champagne

Minister of Innovation, Science and Industry

It is my pleasure to present the 2021–22 Departmental Results Report for the Canadian Space Agency (CSA).

Over the past year, the various teams and organizations in the Innovation, Science, and Economic Development (ISED) portfolio have worked hard together to make Canada a global innovation leader and build a resilient economy that works for everyone.

In a complex environment, Canada remains true to its values of peaceful space exploration and continues to maintain close ties with like-minded partners.

The James Webb Space Telescope, the result of an enduring international collaboration, was launched on December 25, 2021, and its first images have already filled the world with awe.

In return for our participation to the Lunar Gateway space station, our long-time partner, NASA, has committed to fly two Canadian astronauts to deep space, including one on the Artemis II mission, making Canada the first international partner to fly to the Moon. This will give Canada access to invaluable opportunities in deep space, paving the way for the exploration of Mars.

These are just some of the many achievements for Canada in Space in 2021–22. We invite you to read this report to learn more about how ISED and its portfolio partners are working with and for Canadians to position Canada as a leader in the global economy.

Results at a glance

Throughout 2021–22, the CSA's focus remained on the implementation of the Canadian Space Strategy: Exploration, Imagination, Innovation.[i] This strategy aims to create the right conditions for the growth of the Canadian space sector; ensure that Canada's space scientists are offered a rich environment in which to pursue science excellence; fully realize the benefits of space for Canadians; and ultimately help strengthen Canada's place in space. The CSA's priorities for 2021–22 were fully in line with the Canadian Space Strategy, its Departmental Results Framework (DRF) and its program inventory, and enabled the CSA to make progress on achieving its mandate and deliver unparalleled value for Canadians in a way that only space can provide.

Priority 1 — Lunar Program

Canada's participation in the Lunar Gateway space station[ii] builds upon the country's proud history as a leading space-faring nation. The technical definition of Canadarm3[iii] — our country's contribution to the Gateway — was concluded, and a contract for its preliminary design was put in place in March 2022. Given that this contribution will provide a Canadian astronaut flight on Artemis II[iv] in 2023–24, project planning for this mission was initiated, with the next milestone planned for October 2022.

The Lunar Exploration Accelerator Program[v] (LEAP) kicked off the definition phase of Canada's lunar rover mission and continued to support the Canadian providers of lunar equipment and vehicles through contributions to promote their insertion into global supply chains, as well as to enable first-time demonstrations of Canadian technologies on or around the Moon.

Priority 2 — Engage young Canadians: Junior Astronauts

Through the Junior Astronauts campaign, the CSA engaged with over 58,000 youth in every province and territory of Canada in 2021–22. In summer 2021, the campaign culminated with a five-day online camp for youth in grades 6 to 9 (secondary 3 in Québec) selected from across Canada to participate in activities alongside CSA astronauts, scientists and engineers.

Priority 3 — Space-based Earth observation and climate change science

Making as much space data available as possible remains one of the CSA's top priorities. It not only contributes to increased transparency, accessibility and inclusiveness in science and government, but also fosters the exchange of ideas from a diverse set of perspectives — one of our best tools for finding solutions to the global challenges of today and tomorrow, here and abroad.

In collaboration with Environment and Climate Change Canada (ECCC) and Natural Resources Canada (NRCan), the CSA developed Canada's first Strategy for Satellite Earth Observation (SEO).[vi] Formerly known as space-based Earth observation (SBEO),

this initiative lays the foundation for strategic investments to deliver data that best meets the needs of industry, academia, governments and Indigenous communities across Canada, as well as international partners, to tackle their priorities, such as climate change. Following the Ministerial announcement[vii] and release of the Strategy on January 20, 2022, the three departments worked together to further define and assess the potential missions and the infrastructure that will enable the collection and uptake of SEO data.

In 2021–22, the CSA has supported climate change science through its EO activities. Work continued on the maturing of Canadian instruments and data retrieval systems for a possible contribution to NASA's Atmosphere Observing System (AOS). This mission will help improve forecasts of extreme weather events and air quality. Following the signing of a collaborative agreement between the CSA, NRCan and ECCC, the early development phases were kicked off for the WildFireSat[viii] mission, a monitoring system that will use EO data to improve the management of wildfires. In addition, 43 application projects were supported by the smartEarth[ix] funding initiative for their ingenious use of satellite data in response to the challenges arising from climate change, as well as a myriad of other issues on Earth.

Priority 4 — The CSA's contribution to COVID-19 economic recovery

The reprioritization and adjustment of the CSA's activities and investments disrupted by the COVID-19 pandemic continued through programs such as the Space Capacity Development Program (SCDP), to provide further short-term support to the Canadian space sector and academic institutions. These investments contributed to alleviating economic hardships of Canada's space firms and scientists, helping them maintain key capabilities during the pandemic and carry out additional innovative research and development projects that supported Canada's economic recovery.

For more information on the CSA's plans, priorities and results achieved, see the "Results: what we achieved" section of this report.

Results: what we achieved

Core responsibility

Canada in space

The CSA coordinates the space policies and programs of the government of Canada; ensures that other government departments and agencies have access to space data, information, and services to deliver on their mandate; plans, directs and manages projects relating to scientific or industrial space research and the development of space science and technology; promotes the transfer and diffusion of space technology to and throughout the Canadian industry; and encourages the commercial exploitation of space capabilities, technology, facilities and systems. The CSA also aims to build Canada's capacity, engage the next generation of space scientists and engineers, and provide opportunities to inspire young people to develop the required skills and to pursue studies and careers in science, technology, engineering, and math (STEM).

Result 1 — Space research and development advance science and technology

The James Webb Space Telescope[x] (Webb) was launched on December 25, 2021. Once it reached its home orbit around the Sun, 1.5M kilometres away from Earth, the Fine Guidance Sensor[xi] (FGS), a Canadian instrument, was carefully awoken and played its crucial role in the alignment of the 18 mirrors and the telescope stabilization. In the weeks following this "fine phasing" step, the Webb team aligned the other instruments, such as the Canadian Near-Infrared Imager and Slitless Spectrograph[xii] (NIRISS), another Canadian contribution that will study the composition of exoplanet's atmosphere. Thus, the most powerful telescope ever built was able to start capturing the depths of our universe.

Canada's enduring role in space would not be possible without its significant contributions to the International Space Station[xiii] (ISS). Its onboard robotic system (consisting of Canadarm2,[xiv] the "arm," Dextre,[xv] the "hand" and the Mobile Base System,[xvi] a transport and storage platform) continued to meet all ISS demands.

In January 2022, NASA announced its plan to deorbit the ISS[xiii] in 2030. While continuing to take advantage of the largest peacetime engineering project ever undertaken, the CSA is preparing for the transition to the next major international collaboration in space, the Lunar Gateway space station,[iii] paving the way for the next generation of space robotics.

The first phase of Canadarm3,[iii] which identified the scope and specific tasks that will be carried out by the autonomous, AI-enabled "arm" on the Gateway,[ii] was finalized in February 2022, allowing the selected contractor to proceed with the next phase: the design. The application of the Industrial and Technological Benefits Policy[xvii] to the project helps ensure that previous and future investments and commercial activities take

place on Canadian soil — a contribution to the country's GDP estimated at over $70M annually and the maintaining of 630 jobs over 12 years. The definition phase of the Gateway External Robotic Interfaces (GERI) has also been completed, with their preliminary design having started in March 2022. The GERI are grips that will provide connection points between Canadarm3, the Gateway and visiting vehicles, allowing Canadarm3 to anchor itself, move around and reconfigure the station's modules, and perform operations such as catching arriving spacecrafts and repositioning them on the station.

The contribution of Canadarm3[iii] to the Lunar Gateway[ii] has earned the opportunity for the CSA to fly an astronaut around the Moon onboard the Artemis II[iv] mission, scheduled for launch in 2024. The groundwork for the Canadian participation has proceeded as planned in 2021–22: the project team has been formed and is currently preparing for the start of the next phase in October 2022, which will detail the requirements and specifications of this historical project.

As the world undertakes the challenge of establishing a sustainable presence on the Moon, the CSA's Lunar Surface Exploration Initiative (LSEI) has supported the development of the industrial capacity to launch Canada's space sector in this new era of space exploration. Seven contracts were put in place with Canadian companies to develop concepts and prototypes that will define the next major Canadian contributions to human spaceflight, especially on the lunar surface.

Meanwhile, a new wave of Space Technology Development Program[xviii] (STDP) investments was launched to support the development and maturation of technologies for future space missions. The STDP diversified its funding opportunities, now supporting the demonstration of capabilities in space while maintaining its commitment to research and development (R&D). Through LEAP,[v] $8.5M was awarded in 2021–22 for the development of Canadian lunar technologies and their integration into the lunar economy, including $3.6M for the capability demonstration of two technologies. In addition to contributing to Canada's Business Expenditures in R&D (BERD), which reached $479 M in 2020, STDP investments will lead to Canadian science and technologies being demonstrated on the Moon for the very first time in 2024.

Commitment to innovation, pillar of economic resilience

In 2020, the Canadian space sector investments in R&D **increased by 27%** from 2019. This unprecedented resilience is also observed in OECD economies: 2020 marks the first time on record in which a global recession does not translate into a drop in R&D expenditures, reflecting how they are an integral part of the policy response to the COVID-19 crisis.

The design of the Quantum Encryption and Science Satellite[xix] (QEYSSat) continued, with some delays mainly due to procurement challenges pushing off the implementation phase to 2023–24, with the launch now planned for early 2024. Once in service, QEYSSat's Quantum Key Distribution (QKD) technology will provide a communication

method whose security is based on the physical properties of quantum mechanics, providing Canada with a highly secure communication infrastructure.

Several instruments that aim to monitor the Earth from space have seen their technology readiness level[xx] (TRL) mature — the higher the TRL of a technology, the more secure, operational and market-ready it is. For example, the CSA and the American National Oceanic and Atmospheric Administration (NOAA) initiated a study to adapt the American Advanced Baseline Imager (ABI) instrument, which currently provides a complete picture of the atmosphere every five minutes, to be used on the Arctic Observing Mission (AOM), a joint proposed project of ECCC and the CSA.

Feasibility studies continued to demonstrate the measurement capability of the High-altitude Aerosols, Water vapour and Clouds (HAWC) instrument suite, which is the envisioned CSA contribution to the NASA's Aerosols – Clouds, Convection, Precipitation Earth science mission[xxi] (A-CCP). The data collected by this mission will allow Canada to better predict and adapt to floods, droughts and other weather events, such as poor air quality.

A series of grants were awarded to help Canadian scientists secure access to international missions to conduct high-calibre research that maintains Canada's reputation as a leading space-faring nation. Having acquired between up to 5% of the total Webb observation time,[xxii] Canadian scientists will be able to use up to 450 hours of exclusive access with instruments such as the Canadian NIRISS[xii] to study the atmospheres of exoplanets and the evolution of galaxies. Canadian universities that gained observation time on India's AstroSat[xxiii] mission, an opportunity made possible by Canada's contribution of sensitive detectors for the Ultraviolet Imaging Telescope (UVIT) instrument, were awarded four grants to study star formation. The CSA also obtained observation time on Japan's X-Ray Imaging and Spectroscopy Mission[xxiv] (XRISM) for Canadian scientists to study the X-rays emitted by the violent birth and death of stars and galaxies or the behaviour of matter close to black holes. Although XRISM's launch was delayed to February 2023, Canadian scientists continue to participate in the science team.

In preparation for the return of OSIRIS-REx[xxv] samples from asteroid Bennu[xxvi] in September 2023, the CSA laboratories are being upgraded to curate Canada's share of the precious cargo. After the Earth entry capsule is delivered, the OSIRIS-REx probe will head out to encounter another asteroid, Apophis. Canada's OSIRIS-REx Laser Altimeter[xxvii] will play a crucial role again, scanning the whole surface and creating a 3D model of the asteroid.

In the last 355 sols (Martian days), the equivalent of one year on Earth, the Alpha Particle X-Ray Spectrometer[xxviii] (APXS) instrument on NASA's rover Curiosity,[xxix] which criss-crosses the surface of the red planet searching for the signatures ancient life may have left behind, has measured the chemical elements of 169 rock and regolith samples and downlinked 376 experiment data records. Grants were awarded to two Canadian scientists selected through NASA's Mars Science Laboratory[xxx] Participating Scientists competition, who will contribute to find out if Mars ever was — or still is — a habitable planet. Curiosity's data will be used to investigate the planet's transition from a warmer, wetter era to the dry, subfreezing and inhospitable environment of today, and to examine the factors affecting the variations of the methane that seeps from the Martian underground, a gas produced both by inorganic processes and by living organisms on Earth.

A new SCISAT[xxxi] dataset on ozone-depleting substances and all major greenhouse gases (GHG) was released and made available to be used by ECCC and academic researchers around the world. In addition to having led to two journal publications thanks to the quality of its measurements, the dataset will contribute to the upcoming 2022 United Nations (UN) Ozone Assessment Report.[xxxii] Thanks to its excellent performance, the SCISAT mission is now moving beyond its original mandate, providing data on ozone depletion, and contributing to studies on climate change, air quality and pollution from space.

A more complete picture of our atmosphere

Using the Atmospheric Chemistry Experiment (ACE) data on SCISAT, a research published in *Science* showed that smoke from wildfires converted ozone-regulating compounds into more reactive compounds that destroy the ozone, allowing more damaging UV radiation from the sun to reach the ground.

By providing access to high-quality scientific data and supporting researchers, the CSA has contributed to the influence and impact of Canadian space-related research worldwide. Over the past year, Canada has improved its ranking on the Average of Relative Citations, which measures the frequency with which space-related scientific publications are cited, placing it the first among G7 countries and fifteenth among Organisation for Economic Co-operation and Development (OECD) nations.

Result 2 — Canadians engage with space

By building on Canadians' interest in space and by providing opportunities for youth of all horizons to acquire the skills to pursue studies and careers in STEM, the CSA continued to encourage the development of the next generation of scientists and engineers. The CSA quickly adapted to the challenges posed by COVID-19 restrictions, supporting students and young professionals, cementing its international partnerships, and expanding its outreach activities to connect with thousands.

The Junior Astronaut virtual camp was kicked off in June 2021, where 52 space enthusiasts from grades 6 to 9 (secondary 3 in Québec) were given the opportunity to work with experts and astronauts to design a lunar greenhouse, maintain their fitness, investigate environmental events using satellite data and remotely drive a rover on our analogue terrain situated in Longueuil. They also received a guided tour of the Robotics Mission Control Centre[xxxiii] and the Canadarm2 and Dextre training simulator.[xxxiv]

The CSA Speakers Bureau supported 130 outreach activities from coast to coast to give Canadians direct contact with space specialists. Among these events, 49 virtual presentations by experts and astronauts were held to engage with youth, from kindergarten to university. These initiatives allowed the CSA to reach over 51,000 participants, both virtually and in-person.

The Canadian CubeSat Project[xxxv] continued to support the 15 teams of students and professors across the country in the development of their miniature satellites. While the design of all CubeSats was approved and several webinars were held to guide the teams through every stage of their project, the timeline was adjusted following the shutting down of campus to limit the spread of COVID-19. The next step, putting the satellites through the vibration tests required to make sure they can sustain the rigours of a launch in space, was postponed to 2022–23, the first batch now planned to be launched from the ISS[xiii] in the fall of 2022.

Two stratospheric balloon campaigns were launched as part of the CSA's stratospheric balloon program, STRATOS,[xxxvi] where post-secondary students had the opportunity to design, build and test new technologies, and integrate their payloads onto a stratospheric balloon to conduct experiments in a near-space environment. Four Canadian payloads testing EO technologies and atmospheric composition were launched: two from the Timmins Stratospheric Balloon Base,[xxxvii] and two from Kiruna, Sweden, during the Zero Pressure Balloon (ZPB) campaign KLIMAT 2021.[xxxviii]

KLIMAT 2021[xxxviii] is the result of a decade of collaboration between the CSA and France's Centre national d'études spatiales, and negotiations started on January 19th, which ultimately led to the successful renewal of this bilateral partnership for the next decade. While it will secure scientific ballooning opportunities for Canadian academia and industry, the agreement also covers the use of telemetry and tracking stations in Eastern Canada for launches from Europe's Spaceport[xxxix] in French Guiana (where

Webb[x] was launched from), space medicine and missions for environmental and climate science.

Post-secondary students from institutions across the country were awarded 22 grants, representing $4M, through the Science, Technology and Expertise Development in Academia (STEDiA) initiative for projects providing hands-on experience in space-related missions to develop the space science, technology and expertise that will be needed for future commercial and government space missions. The CSA issued two Announcements of Opportunity and provided financial support to participants of NASA's I^2 International Internship Project,[xl] so that high-calibre researchers, particularly affected by travel restrictions on internships and conferences, can keep transforming their knowledge into opportunities and promote Canadian science on the international scene.

Inspiring Canadians
Engagement on the CSA social media increased by **46.5%** from 2020–21, with posts from Webb being the most popular.

By providing opportunities for youth, students and young professionals to acquire the skills to pursue studies and careers in STEM and by cultivating a critical mass of highly qualified personnel (HQP), the CSA's efforts resulted in 1,489 new people, including 14 organizations, to enter space-related fields. The year 2021–22 was also exceptional for the interest generated by Canada's Space Program on social media, with the 5,176 posts having generated 4.1M engagements.

Result 3 — Space information and technologies improve the lives of Canadians

Since Alouette I's[xli] launch in 1962, Canadian satellites have provided information that is integral to our daily lives and essential for evidence-based decision-making. As our capacity to monitor the planet and use the data has increased, Canada's investments in EO capabilities enabled it to build a world-class space sector. Industry, researchers, and governments develop and deliver space-based solutions for a myriad of terrestrial challenges such as food security, weather forecasts, cultural preservation, water and air quality, national defence, wildfires, emergency responses and disease monitoring.

To date, the RADARSAT Constellation Mission[xlii] (RCM) team has provided over 300,000 EO images of the entire Canadian territory and maritime approaches to 10 federal departments and agencies, supporting them in their requirement for space data to deliver responsive and cost-effective services to Canadians in disaster management, ecosystem monitoring and maritime surveillance. It has become one of the most responsive systems of the International Charter "Space and Major Disasters."[xliii] Complemented by the 13 years of RADARSAT-2[xliv] archives and processing services, RCM delivered critical data to disaster management authorities for every charter activation that requested its help, and this, in less than four hours.

Satellite data for emergency assistance

In 2021–22, RCM's support was requested for 50 of the 53 total Charter activations for situations ranging from floods to oil spills, to wildfires and many more.

Since RCM[xlii] can provide snapshots of 90% of the world's surface up to four times a day in any weather conditions, the value-added potential of its data is driving an increased demand for access. Through sustained collaboration with other departments, regulatory organizations and user communities, RCM's data offer[xlv] has been broadened to meet the expanding needs of its growing clientele. All categories of non-governmental users can now apply to become vetted, gaining access to virtually all archived data. In fact, 119 organizations from the Canadian industry, academia, provinces and territories are already accredited, as well as many international partners.

With RCM's[xlii] prime design life ending in 2026, the CSA has initiated concept studies to find cost-effective solutions to minimize disruptions in EO data offer. The CSA established the foundations for ongoing and future partnerships with international space agencies, and coordinated numerous comprehensive analyses, all aimed at determining the best way to ensure service continuity post-RCM (2026–2041).

In line with its commitment to Open Government,[xlvi] the CSA, through its partnership with NRCan, NASA's Alaska Satellite Facility and the private sector, has repatriated both raw and processed RADARSAT-1[xlvii] data. The 674,000 historical images from the satellite that generated the longest timespan of synthetic aperture radar[xlviii] data in the

world is now available to the public on the Earth Observation Data Management System[xlix], for free.

An agreement between the CSA, NRCan and ECCC was signed to consolidate the partnership for WildFireSat,[viii] a collaboration that will drastically increase Canada's ability to manage and reduce losses from wildfires. The CSA satellite-based data will be used to monitor wildfires from space; information on their location, progression, on the air quality and carbon emissions will then be relayed to responders on the ground, so that they can determine which resources to deploy in priority.

The rich data provided by EO satellites has to be processed into usable information for making evidence-based decisions and providing services: smartEarth,[ix] the CSA's EO application funding development program, continued to address this need by supporting innovative solutions derived from satellite data in 2021–22. Ten Climate Change Impacts and Ecosystem Resilience (CCIER) projects led by the Canadian EO industry were completed in 2021. These applications, addressing challenges ranging from agriculture to infrastructure, coastal and marine environments, forestry and climate change, have yielded close partnerships with the EO community. The CCIER investments contributed to an increase in key performance indicators for knowledge, data and information, workforce, outreach, collaboration and economic growth.

Satellite data can also be used to protect fauna: five companies are developing EO applications under smartWhales,[l] a smartEarth[ix] initiative, to detect, monitor, and ultimately protect the endangered North Atlantic right whale. Working with Fisheries and Ocean Canada and Transport Canada, the CSA will contribute to enhancing Canada's ability to predict and model the whales' movements by providing satellite data to mitigate the risk of collision with ships, help spot whales tangled in fishing nets and prevent further population decline.

To prepare for the launch in December 2022, four grants were awarded to Canadian universities to support the use of the Surface Water and Ocean Topography[li] (SWOT) data as it becomes available. By providing a crucial component to the mission — a set of high-power radar signal amplifiers called "extended interaction klystrons" — Canada has gained early access to the data, which the scientific teams are ready to collect and process. Combined with RCM[xlii] data, as well as oceanographic and hydrological models, the information received from the SWOT mission should lead to improvements in coastal and water-related services in Canada, such as forecasts of currents, storm surges, and floods.

To better prepare Canada in the event of a major solar storm, the CSA continued to support the 13 Canadian research teams that use satellite data to improve our space weather forecasting capabilities and our understanding of the Sun–Earth system.[lii] In 2021–22, the contracts and grants awarded to academia led to advancements in models used by researchers in government departments that observe the space environment and the effect of space weather on communications over Canada.

Space debris threats have become a routine hazard faced by all satellites. They can provoke serious damage, disrupt services dependent on space data, and endanger lives. Throughout 2021–22, the Conjunction Risk Assessment and Mitigation System (CRAMS) delivered critical analyses so satellite operators could mitigate collision risks. The space situational awareness services maintained their contribution to the sustainability of the space environment with the continuous operation of the CSA's Near-Earth Orbit Surveillance Satellite[liii] (NEOSSat). This satellite provides Canada with a platform for tracking satellites, space debris and asteroids, as well as for conducting advanced research. Through NEOSSat's Guest Observer Program, scientists can acquire and analyze data on near-Earth asteroids and comets and even on other star and exoplanet systems.

Going to the Moon takes about three days; the round trip to Mars takes roughly 21 months. Keeping astronauts safe and healthy during these long missions will be critical, as there will be little to no possibility of resupply or emergency evacuation, and communication delays will become increasingly significant. Fortunately, scientific research on the ISS[liv] provides unparalleled data for deep-space exploration, as well as applicable solutions to the challenges faced by people living in remote communities.

The activities for six studies conducted both aboard the ISS[xiii] and on Earth were successfully performed, including Vection,[lv] Wayfinding,[lvi] and Vascular Aging.[lvii] These studies and their data have the potential to help with Parkinson's disease, type 2 diabetes, osteoporosis and balance problems. With limited time and resources aboard the ISS, it is critical to optimize their use and expand research opportunities on Earth. Nine grants were awarded for research projects to enhance and complement studies undertaken on the ISS by using the data collected to further our understanding of health risks related to spaceflight.

One of the main factors affecting the body in space is microgravity (when astronauts and objects float), whose impact mirrors the effects of aging and the complications of a sedentary lifestyle. Eight new grant agreements were signed to support Canadian scientists' leadership in research on the physiological and psychological effects that spaceflight has on astronauts, through bed-rest studies and dry-immersion studies (where participants are immersed up to the neck in water tanks while protected with waterproof fabric) sponsored by the European Space Agency (ESA). Bed-rest studies that tested the efficacy of centrifugation to mitigate the effects such as muscle loss were initiated, and the data collection was completed for all cohorts. The results will provide crucial insight for the new astronaut health protocol, which has begun its elaboration phase. In addition, these findings will be complemented by results from experiments using the Bio-Monitor,[lviii] a non-invasive technology that makes the monitoring of vital signs easier.

Canada is in a unique position to leverage the synergy between spatial and terrestrial health challenges and take on a major leadership role in remote healthcare delivery in space and to underserved populations on Earth. The vision of a potential program and recommendations to leverage deep-space healthcare were outlined in the Health Beyond

report,[lix] published in June 2021. One of its proposed actions was to accelerate the establishment of a demonstration site in a northern and remote setting as a means to evaluate remote clinical approaches and innovations and to nurture fruitful relations with Indigenous communities and other critical stakeholders. As for the National Research Council's (NRC) Arctic and Northern Challenge program,[lx] its launch has been delayed. Considering the new timeline, the Health Beyond team will assess the capacity of the initiative to support the CSA's goal of demonstrating healthcare solutions that address concerns for both human spaceflight and isolated communities.

Through its long-standing partnership with NRC and its Industrial Research Assistance Program,[lxi] the CSA has launched an R&D activity and approved eight projects from small and medium-sized enterprises and academia to develop space health technologies, which all have potential direct applications for healthcare delivery in remote and isolated communities, and are excellent candidates for potential deep-space missions.

New detection and diagnostic technologies that can address challenges facing both front-line workers in remote communities and crews on deep-space missions have also found support from the Deep Space Healthcare Challenge,[lxii] a CSA and Impact Canada collaboration. After submitting their designs in February 2022, 20 semi-finalists have moved on to phase 2 — determining if their idea can be turned into a reality.
Five finalists will be announced in the fall of 2022 to begin building their prototypes.

Long trips in space require growing food in remote and harsh environments. Another CSA–Impact Canada competition, the Deep Space Food Challenge,[lxiii] seeks to address this challenge by developing ideas on producing sustainable, nutritious and tasty food that requires minimal input and generates minimum waste. Ten semi-finalists were selected in November 2021 to build the prototype of a food production technology. The teams received the CSA's guidance and expertise, and attended an information session on food safety by the U.S. Food and Drug Administration and the Canadian Food Inspection Agency to help them integrate the safety standards and quality requirements to eventually bring their product to market.

The CSA has contributed to improving the lives of Canadians in two significant ways in 2021–22. First, by enabling 101 services dependent on the CSA's space-based data, such as early season crop classification and crop disease risk assessment, river ice monitoring to manage flood impact, and coast monitoring to improve hunters' safety and to support the traditional Inuit way of life. Second, through the 25 technologies and applications developed for space that were reused in space or adapted for use on Earth (or both) for the benefit of Canadians. For example, sensors developed to help dock payloads on the ISS[xiii] were reused on Earth to guide autonomous vehicles in underground mines.

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Result 4 — Canada's investments in space benefit the Canadian economy

It is paramount that the Canadian space industry remains strong, healthy and agile to ensure it has the required readiness to respond to national demand, as well as the necessary competitiveness to secure an increased share of commercial and institutional markets worldwide. Only through innovation and continued R&D investments can Canada develop both the range of skills and the depth of knowledge necessary for its industry to remain a valued player in the international arena.

In the spring of 2021, the STDP[xviii] awarded nine contracts totalling $10.3M over three years for the development of technologies for future space missions. The STDP also launched the next wave of investments for the concept studies and prototyping of cutting-edge technology for the next major Canadian infrastructure contributions to human spaceflight, in particular on the lunar surface. The publication of requests for proposals for the development of EO technologies for future space missions was delayed to early 2022–23.

There is still a great deal to learn about the Moon, Earth's only natural satellite. Its uneven, pockmarked terrain — featuring highlands, ancient impact basins, and frigid polar regions — promises to reveal much to the researchers who dare to explore it. As part of a new chapter of lunar exploration, LEAP[v] is positioning Canada's space sector to be actively involved in capturing their market share of the developing lunar economy.

The CSA awarded $1.8M over five years to two projects to shed light on the Moon's origin, composition, and structure while strengthening Canada's talent pool by training HQP. The research aims to develop high-resolution models of the Moon's surface, and tell us more about its internal structure and its volatile components — substances such as water and hydrogen that could be used to make rocket fuel, breathable air or drinking water, but which evaporate readily. By awarding a $200,000 grant for the analysis of ice samples (water being a volatile substance) from NASA's Volatiles Investigating Polar Exploration Rover[lxiv] (VIPER) rover using remote sensing, the CSA also supported the integration of Canadian expertise into the lunar science network.

Before setting foot on the Moon, it is essential to already have eyes and hands on the terrain, and rovers can help scientists learn more about the resources needed to establish a long-term presence on the Moon and send humans further into space. Canada is therefore designing its first lunar rover under the LEAP[v] initiative to explore the lunar South Pole of the Moon within the next five years. Two concepts, designed by Canadian companies, were awarded $3.4M to test key technologies related to mobility and navigation, communications and thermal management, which are essential for tackling the significant technological challenge of surviving lunar polar nights that can reach a shivering - 250 °C, in pitch-black darkness. The Canadian Lunar Rover Mission,[lxv] to be launched in partnership with NASA, will host at least two payloads, one Canadian and one American.

LEAP's[v] support for integrating Canadian companies into the global lunar supply chain and developing their industrial capacities is generating tangible results for the Canadian economy. In May 2021, three Canadian companies announced that their technologies would be launched on the Japanese ispace's HAKUTO-R lunar lander.[lxvi] Scheduled to be tested on the Moon in 2022, all three payloads — an AI flight computer, a lightweight panoramic camera and a lunar navigation system — were funded by LEAP.

In collaboration with Innovative Solutions Canada, (ISC) the CSA has developed four challenges addressed at SMEs to help them start, grow and get to market in a highly competitive environment. The challenge on the development of space exploration technologies has been revisited, evolving into three distinct challenges that will be launched in 2022–23. The awarding of contracts for the development of prototypes of the first challenge[lxvii] (on applying artificial intelligence and big-data analytics to space robotics) has been postponed due to the realignment of priorities to reflect industry needs in the context of the COVID-19 pandemic.

The smartEarth[ix] Enabler track, a stream of the funding initiative that focuses on developing the downstream industry's capacity for the use of satellite data, supported 38 companies and organizations to develop new disruptive applications using EO data. These projects also aim to address sustainable development challenges on Earth, including those outlined in Canada's national strategy[lxviii] to respond to the 2030 Agenda for Sustainable Development.

The CSA continued to support the competitiveness and capacity of the Canadian space sector in the international market through the enduring Canada–ESA Cooperation Agreement.[lxix] The investments in selected ESA programs announced by Canada during the ESA 2019 Ministerial Meeting[lxx] continued to be implemented, allowing the Canadian industry to participate in world-class missions in EO, satellite communications, space exploration, and technology development areas.

The David Florida Laboratory[lxxi] (DFL) continued to perform assembly, integration and testing activities to support government space missions and commercial space programs, while conducting infrastructure improvements to maintain its uniqueness in Canada to provide testing solutions.

With these investments, the CSA seeks to ensure that the Canadian space sector develops value-added goods and services with a high impact on the value of Canada's exports, so as the Canadian space sector can capture new markets, foster economic growth, and be a driving force of innovation. As such, in 2021–22, the CSA's investments have contributed $1.9B in exports and maintained 6,902 highly qualified jobs in Canada.

Gender-based analysis plus

Reducing equality gaps requires measuring the impacts that policies, initiatives and programs have on systemic inequalities, and involves adopting sustainable practices to address them. Following the publication of the Evaluation of the implementation of

gender-based analysis plus (GBA Plus) at the CSA[lxxii] in September 2021, the CSA has issued a series of enhanced tools to guide GBA Plus assessments in contracts and contributions agreements to incentivize companies to include more underrepresent groups in STEM in their hiring plans. New survey questions have also been developed to improve the collection of gender and diversity information for the hundreds of small businesses, multinationals, not-for-profit organizations, research centres and universities participating in the Canadian Space Sector survey.

Barriers to participation can also be mitigated by organizing activities that specifically target underrepresented groups. Among the projects funded through the Awareness and Learning stream of the Grants and Contributions program[lxxiii] are activities designed to engage youth from underrepresented groups including girls, indigenous and visible minority communities, as well as youth living in Northern regions.

United Nations 2030 Agenda for Sustainable Development and the Sustainable Development Goals

The effects of climate change on our planet, its ecosystems and its people are growing in extent and severity. Improving our knowledge of its processes and impacts is critical if today's actions are to create a sustainable tomorrow — and SEO is proving indispensable in helping us understand, adapt, fight, and fully implement the UN 2030 Agenda for Sustainable Development[lxxiv] for people, planet, prosperity and peace. Along with the 193 countries of the UN General Assembly, the CSA has answered the UN's urgent call for action by supporting and strengthening Canada's capacity to advance the Sustainable Development Goals[lxxv] (SDGs).

The CSA's EO missions are an essential tool to observe climate change on a daily basis[lxxvi] and strengthen the adaptive capacity to related hazards and natural disasters not only in Canada, but also across the globe. In addition to supporting over 60 applications and services to ensure sustainable food production systems (SDG 2.4),[lxxvii] RCM[xlii] supports the strengthening, of resilience and adaptive capacity to climate-related hazards and natural disasters in all countries (SDG 13.1)[lxxviii] by providing timely and critical data through the International Charter "Space and Major Disasters."[xliii]

SCISAT's[xxxi] data allowed Canada to monitor the ozone layer and honour its mandate under the Montreal Protocol,[lxxix] and for the discovery of the chemical composition of extreme fire smoke. The SWOT[li] mission, scheduled for launch in 2022, is designed to improve our understanding of how lakes, rivers, reservoirs and oceans change over time, and will contribute to the responsible water resource development in Canada. WildFireSat[viii] seeks to provide responders with actionable information on air quality and emissions from wildfires (SDG 13.1).[lxxviii]

The first version of the CSA's 2021–24 Open Science Action Plan[lxxx] was presented to the Office of the Chief Science Advisor of Canada on October 6, 2021. Contributing to the government's Roadmap for Open Science[lxxxi] and its efforts to make federal science open to all, this plan lays out 10 actions to modernize space data governance and align

policies and rules for SEO data through sustained collaboration with international and national partners. The launch of two applications on the CSA portal that enable the user to explore Alouette I and SCISAT data[lxxxii] also contributed to enhancing access to science, technology and innovation and promote knowledge sharing (SDG 17.6).[lxxxiii]

Health[lxxxiv] and food-related[lxxxv] initiatives conducted both on Earth and on the ISS[xiii] are helping to find autonomous, sustainable healthcare and agricultural solutions here on Earth, especially in remote regions (SDG 3.8).[lxxxvi]

Initiatives such as LEAP[v] and the STDP[xviii] contribute to higher levels of economic productivity through diversification, technological upgrading, and innovation (SDG 8.2),[lxxxvii] and by supporting job creation, entrepreneurship, and innovation, contributing to sustainable economic growth (SDG 8.3).[lxxxvii]

Through its numerous activities targeted at youth, such as the Canadian CubeSat Project,[xxxv] the CSA contributed to increasing the number of youth and adults who pursue education and skills development (SDG 4.4).[lxxxviii] The project, which was designed to promote the social and economic inclusion of all, involves more than 500 post-secondary students, with a roughly equal gender split (SDG 10.2).[lxxxix]

Experimentation

In spring 2021, the CSA held its first annual "From Ideas to Action to Innovation" (I^2A) challenge, which was devoted to finding innovative solutions to manage and alleviate workload. From the pool of ideas proposed, two were selected by the Executive Committee. The possible avenues for the development and implementation of these ideas will be explored in 2022–23.

Key risks

In 2021–22, the CSA updated its Corporate Risk Profile and identified three key risks facing the organization related to talent, cybersecurity and innovation. Several measures were implemented to mitigate these risks, such as

- developing a Strategic Workforce Management Plan to ensure the CSA is at the forefront of HR management;
- developing of a cybersecurity training program for employees; and
- integrating a new framework to manage innovative ideas at the CSA.

Results achieved

The following table shows, for Canada in space, the results achieved, the performance indicators, the targets and the target dates for 2021–22, and the actual results for the three most recent fiscal years for which actual results are available.

Departmental results	Performance indicators	Target	Date to achieve target	2019–20 actual results	2020–21 actual results	2021–22 actual results
Space research and development advances science and technology	I1: Business Expenditures in Research and Development (BERD) in the space sector	$324M	March 31, 2021	$356M (2018)	$376M (2019)	$479M[1] (2020)
	I2: Canada's rank among OECD nations on the citation score of space-related publications	13	March 31, 2021	16 (2018)	17 (2019)	15 (2020)
Canadians engage with space	I3: Number of new people and organizations entering space-related fields as a result of CSA funding	1,090	March 31, 2021	1,041 (2018)	2,024 (2019)	1,489 (2020)
	I4: Number of engagements on social media related to the CSA	2M	March 31, 2021	3,59M (2019)	2,77M (2020)	4,10M[2] (2021)
Space information and technologies improve the lives of Canadians	I5: Number of services offered to Canadians dependent on CSA information (such as remote sensing data, including imagery and science observations)	100	March 31, 2021	109 (2019)	111 (2020)	101 (2021)
	I6: Number of Canadian space technologies adapted for use on Earth or re-use in space	20	March 31, 2021	22 (2018)	23 (2019)	25 (2020)
Canada's investments in space benefit the Canadian economy	I7: Number of highly qualified people in the Canadian space sector	4,250	March 31, 2021	4,120 (2018)	6,936 (2019)	6,902[3] (2020)
	I8: Value of exports of the Canadian space sector	$2.1B	March 31, 2021	$2.3B (2018)	$2.3B (2019)	$1.9B (2020)

Financial, human resources and performance information for the CSA's Program Inventory is available in GC InfoBase.[xc]

[1] The increase in BERD is a trend that has been observed over the past decade in the Canadian space sector. Companies are investing more in R&D, with their internal expenditures growing significantly in 2020. Increased government spending (external expenditures) is likely buoying investments higher as well.

[2] The year 2021–22 was exceptional, thanks to the enthusiasm generated by Webb.

[3] A new definition for Highly Qualified People (HQP) became effective in 2020–21 in order to align it with the methodology used in other departments and agencies, which largely explains the discrepancy between the target (4,250) and the result (6,902). The CSA assesses that there would have been 4,367 HQP in 2021–22 under the old definition, which would have represented a decrease of 6% from 2020–21 (4,639 HQP) and would have been 3% above the target of 4,250 (set under the old definition).

Budgetary financial resources (dollars)

The following table shows, for Canada in space, budgetary spending for 2021–22, as well as actual spending for that year.

2021–22 Main Estimates	2021–22 planned spending	2021–22 total authorities available for use	2021–22 actual spending (authorities used)	2021–22 difference (actual spending minus planned spending)
346,069,680	346,069,680	432,607,769	307,943,051	(38,126,629)

The $38.1M negative variance is mainly due to procurement difficulties and delays in the awarding of contracts, primarily for the QEYSSat[xix] project, and a change in the scope of the WildFireSat[viii] project, which caused the rework of deliverables and mission requirements to meet the revised scope agreed with mission partners.

Financial, human resources and performance information for the CSA's Program Inventory is available in GC InfoBase.[xc]

Human resources (full-time equivalents)

The following table shows, in full-time equivalents (FTEs), the human resources the department needed to fulfill this core responsibility for 2021–22.

2021–22 planned full-time equivalents	2021–22 actual full-time equivalents	2021–22 difference (actual full-time equivalents minus planned full-time equivalents)
430.0	434.1	4.1

The positive variance of 4.1 FTEs is mainly due to the hiring of additional staff to support space exploration initiatives such as Canadarm3,[iii] as well as an increase in the number of student internships during the year.

Financial, human resources and performance information for the CSA's Program Inventory is available in GC InfoBase.[xc]

Internal services

Description

Internal services are those groups of related activities and resources that the federal government considers to be services in support of programs and/or required to meet corporate obligations of an organization. Internal services refers to the activities and resources of the 10 distinct service categories that support program delivery in the organization, regardless of the internal services delivery model in a department. The 10 service categories are:

- acquisition management services
- communication services
- financial management services
- human resources management services
- information management services
- information technology services
- legal services
- material management services
- management and oversight services
- real property management services

To support the needs of its employees, its programs and its obligations towards its partners and Canadians, the CSA continued to improve its internal processes and its business model to ensure that its services are delivered in an efficient and inclusive way.

The CSA has reviewed its service standards in order to provide updated and accurate information to its stakeholders on what they can expect from its services,[xci] which in turn helps prioritize departmental resources. In 2021–22, 94% of the CSA's services met their targets.

Robust internal governance processes support informed decision-making and allow for the responsible and priority-based allocation of resources. To this end, the CSA has made available to its stakeholders new templates to streamline criteria for investment and project-management decisions, and has developed product assurance requirements for small and microsatellites.

To mitigate the main organizational risks to departmental security, the three-year departmental security plan continued to roll out and was adapted to the context of the COVID-19 pandemic.

The CSA delivered its real property asset maintenance goals, with the exception of a subset of projects that experienced pandemic-related delays. A major achievement was the launch of a smart building pilot project at the headquarters, which will contribute to optimal facility performance and advance the greening of government operations[xcii] over

the long term. This project, a collaboration with NRCan, aims to reduce energy consumption and costs, peak electrical loads, natural gas usage and GHG emissions.

With its goal of achieving representation of marginalized groups within four years, the 2021–24 Employment Equity, Diversity and Inclusion Action Plan[xciii] began its implementation. It sets specific objectives to improve the representation of designated groups while ensuring compliance with the Employment Equity Act.[xciv]

In order to be an employer of choice and to attract and retain talent, the CSA has to offer a modern work environment. Workshops, conferences and learning activities were offered to provide support and tools for an open, convivial, work environment and to facilitate the transition in the context of the pandemic. A multidisciplinary Future of Work working group was established and held consultations where all employees were invited to share their reflections on the future of work and reintegration in the workplace.

Extensive consultations were held as part of the Optimized Previsions: Staffing and Salaries (OPSS) project, a self-service platform where financial and human resources data are brought together through a single point of entry. In addition to allowing employees to update their personal information, authorized users will be able to view aggregated data, create staff mobility scenarios, generate payroll reports, and allocate resources to a project, to name a few possibilities. Implementation is expected to begin in 2022–23 and continue through March 2025.

Human resources data optimization continued with the development of a digital tool to log telework arrangements while ensuring that health and safety responsibilities are covered. A prototype for tracking staffing activities and candidate pools was also launched in January 2022 to tailor recruitment strategies to needs. In addition, the recruitment model for entry-level positions in the engineering group was updated to ensure that the CSA remains competitive in the labour market, to reduce organizational risks related to hiring, and to ensure the retention of its staff.

The year 2021–22 was pivotal for digital transformation at the CSA. The adoption of cloud computing gained momentum with the migration of emails to the Microsoft 365 (M365) environment, which paved the way for the introduction of M365 collaboration tools in 2022–23. Moreover, the Data Centre of Expertise, along with many collaborators at the CSA, has developed microapplications to process and visualize space and science mission data through the Open Data Portal,[xcv] helping to nurture a data-driven governance and culture. The CSA has also drafted its strategic priorities to further modernize its tools and infrastructure.

Budgetary financial resources (dollars)

The following table shows, for internal services, budgetary spending for 2021–22, as well as spending for that year.

2021–22 Main Estimates	2021–22 planned spending	2021–22 total authorities available for use	2021–22 actual spending (authorities used)	2021–22 difference (actual spending minus planned spending)
57,560,992	57,560,992	58,942,737	60,165,098	2,604,106

The $2.6M positive variance is mainly due to the centralization of computer asset expenditures in the Information Technology Directorate.

Human resources (full-time equivalents)

The following table shows, in full-time equivalents (FTE), the human resources the department needed to carry out its internal services for 2021–22.

2021–22 planned full-time equivalents	2021–22 actual full-time equivalents	2021–22 difference (actual full-time equivalents minus planned full-time equivalents)
357.4	332.1	(25.3)

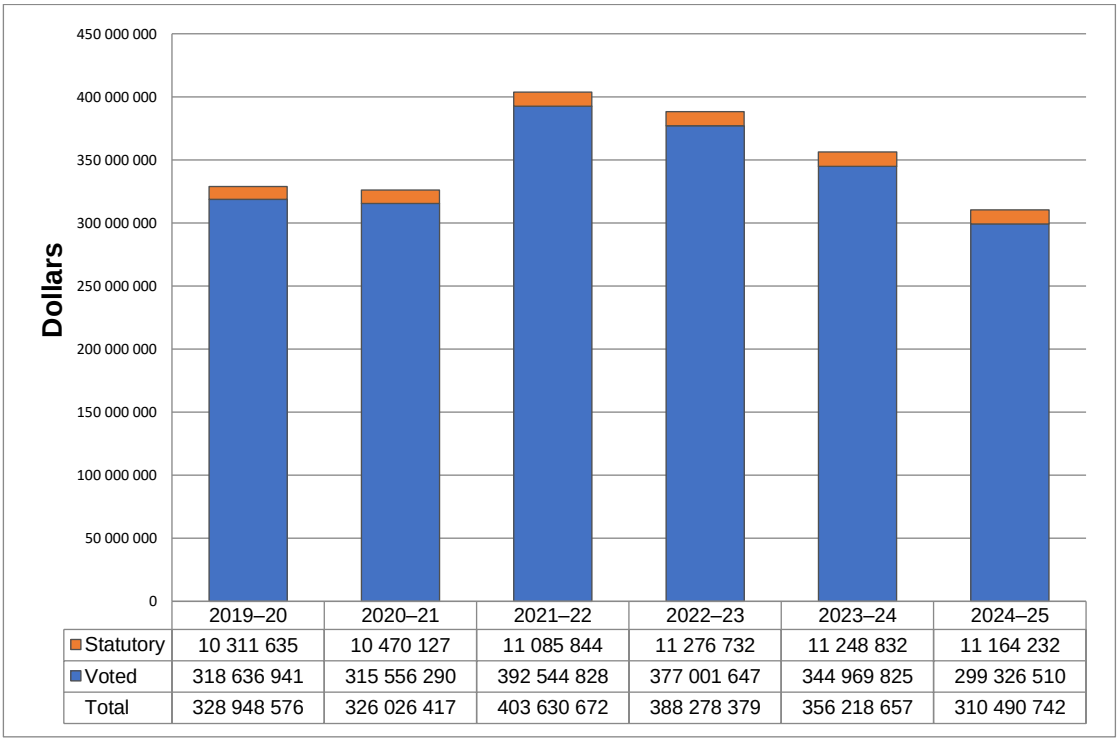
The negative variance of 25.3 FTE is mainly due to the delay in the creation and staffing of positions within the Information Management Directorate.

Spending and human resources

Spending

Spending, 2019–20 to 2024–25

The following graph presents planned (voted and statutory spending) over time.



	2019–20	2020–21	2021–22	2022–23	2023–24	2024–25
Statutory	10 311 635	10 470 127	11 085 844	11 276 732	11 248 832	11 164 232
Voted	318 636 941	315 556 290	392 544 828	377 001 647	344 969 825	299 326 510
Total	328 948 576	326 026 417	403 630 672	388 278 379	356 218 657	310 490 742

Spending variances are primarily attributable to specific funds allocated to the following initiatives, in which funding exceeded the CSA's ongoing resource allocations.

- As indicated in the Budget 2015 and 2016 announcements, additional funding of $30M over four years was authorized to maintain Canada's participation in the ESA's Advanced Research in Telecommunications Systems (ARTES) Program.
- In accordance with the Budget 2015 announcements, and with $379M in new funds earmarked in the Budget 2016, additional funding of $318M over eight years, beginning in 2017–18, has thus far been authorized to support activities on board the ISS[xiii] and to fulfill common systems operations costs related to the extension of Canada's participation in the ISS until 2024, in accordance with international treaty obligations.
- Additional funding of $25.1M spread over six years starting in 2018–19 for the QEYSSat[xix] project.

- As indicated in Budget 2019, additional funding of $150M over five years starting in 2019–20 to carry out activities under LEAP.[v]
- In accordance with 2019 announcements, commitment of $1.9G over 24 years for the Canadarm3[iii] as a Canadian contribution to the NASA-led Lunar Gateway Program,[ii] additional funding of $27.4M spread over four years starting 2020–21 to undertake the first definition phase of the Canadarm3 project and STEM activities.

At the same time, the cumulative effect of reallocating unused funds to subsequent years stemming from the sound management on high-risk projects, including increased technological risks, long-term development cycles, and work schedule uncertainties, has also had an impact on the CSA's spending trend in recent years.

Budgetary performance summary for core responsibilities and internal services (dollars)

The "Budgetary performance summary for core responsibilities and internal services" table presents the budgetary financial resources allocated for the CSA's core responsibility and for internal services.

Core responsibilities and internal services	2021–22 Main Estimates	2021–22 planned spending	2022–23 planned spending	2023–24 planned spending	2021–22 total authorities available for use	2019–20 actual spending (authorities used)	2020–21 actual spending (authorities used)	2021–22 actual spending (authorities used)
Canada in space	346,069,680	346,069,680	329,883,029	300,528,357	432,607,769	273,268,394	271,954,249	307,943,051
Subtotal	**346,069,680**	**346,069,680**	**329,883,029**	**300,528,357**	**432,607,769**	**273,268,394**	**271,954,249**	**307,943,051**
Internal services	57,560,992	57,560,992	58,395,350	55,690,300	58,942,737	51,167,697	58,455,404	60,165,098
Total	**403,630,672**	**403,630,672**	**388,278,379**	**356,218,657**	**491,550,506**	**324,436,091**	**330,409,653**	**368,108,149**

The variances in 2021–22 to 2023–24 planned spending are mainly attributable to investments in the Canada's participation on the ISS[xiii] until 2024, which includes the Mars sample-return mission, investments in LEAP[v] and the smart robotic system Canadarm3.[iii] It is important to note that the CSA's project and mission funding profile varies from year to year, depending on the status of each mission, which has an impact on planned spending and actual spending (expenditures).

The CSA lapsed $123.4M in 2021–22, of which 88% ($108.7M) was mainly related to capital project funding envelopes (including the risk budget) that are rolled over year to year until the project is closed. This is an inherent part of projects within the Canadian Space Program, and for 2021–22, 99.99% of lapsed funds are reprofiled to future years.

The variances in 2019–20 to 2021–22 in actual spending generally follow the same variances in allocated funds for specific initiatives in which funding exceeded the CSA's ongoing resource allocations. In recent years, procurement difficulties and delays in the awarding of contracts following the COVID-19 pandemic also had an impact on the spending trend. This contributed to the cumulative effect of reallocating unused funds to subsequent years as a sound management practice for high-risk projects. The same trends are expected in the short-term future because of ongoing issues in procurement and supply chain.

Human resources

The "Human resources summary for core responsibilities and internal services" table presents the full-time equivalents (FTEs) allocated to each of the CSA's core responsibilities and to internal services.

Human resources summary for core responsibility and internal services

Core responsibilities and internal services	2019–20 actual full-time equivalents	2020–21 actual full-time equivalents	2021–22 planned full-time equivalents	2021–22 actual full-time equivalents	2022–23 planned full-time equivalents	2023–24 planned full-time equivalents
Canada in space	387.6	391.2	430.0	434.1	415.6	412.9
Subtotal	**387.6**	**391.2**	**430.0**	**434.1**	**415.6**	**412.9**
Internal services	289.9	317.5	357.4	332.1	408.4	400.4
Total	**677.5**	**708.7**	**787.5**	**766.2**	**824.0**	**813.3**

The variance in the number of FTE since 2019–20 is mainly attributable to the additional resources required to fill certain gaps and priorities, including

- additional scientific and technical staff to support the activities of the ISS[xiii] until 2024;
- additional changes as a result of the Canadarm3[iii] mission;
- increased investments to recruit the next generation of public servants, which includes the student programs; and
- new departmental requirements for internal services, such as managing Phoenix, setting up a data expertise centre, results-based accountability, and policy resets.

For 2021–22, the 21.3 negative variance between planned and actual FTE is mainly due to delays in the creation and staffing of positions and the departure of employees who could not be replaced during the year. The same trends are expected in the short-term future because of ongoing issues surrounding staffing due to labour shortages in various streams of employment across the federal government.

Expenditures by vote

For information on the CSA's organizational voted and statutory expenditures, consult the Public Accounts of Canada 2021.[xcvi]

Government of Canada spending and activities

Information on the alignment of the CSA's spending with Government of Canada's spending and activities is available in GC InfoBase.[xc]

Financial statements and financial statements highlights

Financial statements

The CSA's financial statements (unaudited) for the year ended March 31, 2022, are available on the departmental website.[xcvii]

Financial statement highlights

Condensed Statement of Operations (unaudited) for the year ended March 31, 2022 (dollars)

Financial information	2021–22 planned results	2021–22 actual results	2020–21 actual results	Difference (2021–22 actual results minus 2021–22 planned results)	Difference (2021–22 actual results minus 2020–21 actual results)
Total expenses	567,586,030	552,299,437	355,554,364	(15,286,593)	196,745,073
Total revenues	17,771	172,518	56,204	154,747	116,314
Net cost of operations before government funding and transfers	567,568,259	552,126,919	355,498,160	(15,441,340)	196,628,759

Note: The CSA is funded by the Government of Canada through Parliamentary authorities. Financial reporting of authorities provided to the CSA does not parallel financial reporting according to generally accepted accounting principles, since authorities are primarily based on cash flow requirements. Consequently, items recognized in the Condensed Statement of Operations are not necessarily the same as those reported under authorities from Parliament.

Total planned expenses for 2021–22 was $567.6M, which is a slight variance of $15.3M (2.8%) when compared to actual results of $552.3M.

In 2021–22, total expenses were $552.3M, an increase of $196.7M (55%) when compared with the previous year's total expenses of $355.6M. This increase is mainly due to the following:

- Increased amortization expenses related to the RCM[xlii] satellites. The three satellites became operational in March 2021, and amortization started in 2022 ($161.4M).

- Increased operational expenses related to the RCM. The construction phase was completed in 2021, and the operational phase started in 2022. This has led to higher operating expenses, mainly in Professional and Special Services and Communications expenses ($14.9M).
- Increased expenses related to Canadarm3[iii] mainly in Professional and Special Services ($15M).

The CSA's total expenses were incurred to pursue its core responsibility and internal services and were mainly incurred in amortization of tangible capital assets of $216.6M, professional and special services of $127.2M and salaries and employee benefits of $95M.

- Canada in Space: $487M (88.2%)
- Internal Services: $65.3M (11.8%)

The CSA's total revenues were $0.17M in 2021–22 ($0.06M in 2020–21), which represents the re-spendable portion of overall revenues of $1.5M. The majority of these revenues are reported under the sale of goods and services provided by the DFL,[lxxi] i.e., sale of goods and services to private business or other Government of Canada departments, rental and use of public property, as well as other revenues, including a gift to the Crown.

Condensed Statement of Financial Position (unaudited) as of March 31, 2022 (dollars)

Financial information	2021–22	2020–21	Difference (2021–22 minus 2020–21)
Total net liabilities	113,531,344	89,222,861	24,308,483
Total net financial assets	103,074,847	80,165,848	22,908,999
Departmental net debt	10,456,497	9,057,013	1,399,484
Total non-financial assets	1,364,108,896	1,542,287,336	(178,178,440)
Departmental net financial position	1,353,652,399	1,533,230,323	(179,577,924)

Total net liabilities of $113.5M consist mainly of accounts payable and accrued liabilities. These represent goods and services received at the end of the year, but that have not yet been paid by the CSA.

The $24.3M (27.2%) increase in net liabilities is mainly due to a $23.2M increase in accounts payable and accrued liabilities. These variances are normal, as payment schedules may vary from one year to another, especially those related to space programs.

Total assets were $1,467M at the end of 2021–22 ($103.1M in net financial assets and $1,364M in non-financial assets), a decrease of $155.3M mainly attributable to the decrease in tangible capital assets.

Non-financial assets are mainly composed of space-related assets ($1.14B over $1.36B or 83.9%).

The 2021–22 planned results information is provided in the CSA's Future-Oriented Statement of Operations and Notes 2021–22.[xcviii]

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Corporate information

Organizational profile

Appropriate minister: The Honourable François-Philippe Champagne, P.C., M.P.

Institutional head: Lisa Campbell, President

Ministerial portfolio: Innovation, Science and Economic Development

Enabling instrument: Canadian Space Agency Act, S.C. 1990, c. 13[xcix]

Year of incorporation/commencement: Established in March 1989

Other: The CSA was established in 1989. Approximately 84% of its employees work at the headquarters located at the John-H.-Chapman Space Centre, in Saint-Hubert, Quebec. The remaining personnel serve the CSA at the DFL[lxxi] in Ottawa, Ontario, and its policy and planning offices in Gatineau, Quebec, with officials in Houston, Washington and Paris.

Raison d'être, mandate and role: who we are and what we do

"Raison d'être, mandate and role: who we are and what we do" is available on the CSA's website.[c]

For more information on the department's organizational mandate letter commitments, see the Minister's mandate letter.[ci]

Operating context

Information on the operating context is available on the CSA's website.[cii]

Reporting framework

The CSA's Departmental Results Framework and Program Inventory of record for 2021–22 are shown below.

Supporting information on the program inventory

Financial, human resources and performance information for the CSA's Program Inventory is available in GC InfoBase.[xc]

Supplementary information tables

The following supplementary information tables are available on the CSA's website:[cii]

- Departmental Sustainable Development Strategy / Reporting on Green Procurement
- Details on transfer payment programs
- Gender-based analysis plus
- Response to parliamentary committees and external audits

Federal tax expenditures

The tax system can be used to achieve public policy objectives through the application of special measures such as low tax rates, exemptions, deductions, deferrals and credits. The Department of Finance Canada publishes cost estimates and projections for these measures each year in the Report on Federal Tax Expenditures.[ciii] This report also provides detailed background information on tax expenditures, including descriptions, objectives, historical information and references to related federal spending programs, as well as evaluations and GBA Plus of tax expenditures.

Organizational contact information

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Email: asc.info.csa@canada.ca

Website: www.asc-csa.gc.ca

Appendix: definitions

appropriation *(crédit)*

Any authority of Parliament to pay money out of the Consolidated Revenue Fund.

budgetary expenditures *(dépenses budgétaires)*

Operating and capital expenditures; transfer payments to other levels of government, organizations or individuals; and payments to Crown corporations.

core responsibility (responsabilité essentielle)

An enduring function or role performed by a department. The intentions of the department with respect to a core responsibility are reflected in one or more related departmental results that the department seeks to contribute to or influence.

Departmental Plan *(plan ministériel)*

A report on the plans and expected performance of an appropriated department over a three-year period. Departmental Plans are usually tabled in Parliament each spring.

departmental priority *(priorité)*

A plan or project that a department has chosen to focus and report on during the planning period. Priorities represent the things that are most important or what must be done first to support the achievement of the desired departmental results.

departmental result (résultat ministériel)

A consequence or outcome that a department seeks to achieve. A departmental result is often outside departments' immediate control, but it should be influenced by program-level outcomes.

departmental result indicator (indicateur de résultat ministériel)

A quantitative measure of progress on a departmental result.

departmental results framework (cadre ministériel des résultats)

A framework that connects the department's core responsibilities to its departmental results and departmental result indicators.

Departmental Results Report (rapport sur les résultats ministériels)

A report on a department's actual accomplishments against the plans, priorities and expected results set out in the corresponding Departmental Plan.

experimentation (expérimentation)

The conducting of activities that seek to first explore, then test and compare the effects and impacts of policies and interventions in order to inform evidence-based decision making, and improve outcomes for Canadians, by learning what works, for whom and in what

circumstances. Experimentation is related to, but distinct from innovation (the trying of new things), because it involves a rigorous comparison of results. For example, using a new website to communicate with Canadians can be an innovation; systematically testing the new website against existing outreach tools or an old website to see which one leads to more engagement, is experimentation.

full-time equivalent (équivalent temps plein)

A measure of the extent to which an employee represents a full person-year charge against a departmental budget. For a particular position, the full-time equivalent figure is the ratio of number of hours the person actually works divided by the standard number of hours set out in the person's collective agreement.

gender-based analysis plus (GBA Plus) (analyse comparative entre les sexes plus [ACS Plus])

An analytical tool used to support the development of responsive and inclusive policies, programs and other initiatives; and understand how factors such as sex, race, national and ethnic origin, Indigenous origin or identity, age, sexual orientation, socio-economic conditions, geography, culture and disability, impact experiences and outcomes, and can affect access to and experience of government programs.

government-wide priorities (priorités pangouvernementales)

For the purpose of the 2021–22 Departmental Results Report, government-wide priorities refers to those high-level themes outlining the government's agenda in the 2020 Speech from the Throne, namely: Protecting Canadians from COVID-19; Helping Canadians through the pandemic; Building back better — a resiliency agenda for the middle class; The Canada we're fighting for.

horizontal initiative *(initiative horizontale)*

An initiative where two or more federal organizations are given funding to pursue a shared outcome, often linked to a government priority.

non-budgetary expenditures *(dépenses non budgétaires)*

Net outlays and receipts related to loans, investments and advances, which change the composition of the financial assets of the Government of Canada.

performance (*rendement)*

What an organization did with its resources to achieve its results, how well those results compare to what the organization intended to achieve, and how well lessons learned have been identified.

performance indicator *(indicateur de rendement)*

A qualitative or quantitative means of measuring an output or outcome, with the intention of gauging the performance of an organization, program, policy or initiative respecting expected results.

performance reporting *(production de rapports sur le rendement)*

The process of communicating evidence-based performance information. Performance reporting supports decision making, accountability and transparency.

plan *(plan)*

The articulation of strategic choices, which provides information on how an organization intends to achieve its priorities and associated results. Generally, a plan will explain the logic behind the strategies chosen and tend to focus on actions that lead to the expected result.

planned spending *(dépenses prévues)*

For Departmental Plans and Departmental Results Reports, planned spending refers to those amounts presented in Main Estimates.

A department is expected to be aware of the authorities that it has sought and received. The determination of planned spending is a departmental responsibility, and departments must be able to defend the expenditure and accrual numbers presented in their Departmental Plans and Departmental Results Reports.

program *(programme)*

Individual or groups of services, activities or combinations thereof that are managed together within the department and focus on a specific set of outputs, outcomes or service levels.

program inventory *(répertoire des programmes)*

Identifies all the department’s programs and describes how resources are organized to contribute to the department’s core responsibilities and results.

result *(résultat)*

A consequence attributed, in part, to an organization, policy, program or initiative. Results are not within the control of a single organization, policy, program or initiative; instead they are within the area of the organization’s influence.

statutory expenditures *(dépenses législatives)*

Expenditures that Parliament has approved through legislation other than appropriation acts. The legislation sets out the purpose of the expenditures and the terms and conditions under which they may be made.

target *(cible)*

A measurable performance or success level that an organization, program or initiative plans to achieve within a specified time period. Targets can be either quantitative or qualitative.

voted expenditures *(dépenses votées)*

Expenditures that Parliament approves annually through an appropriation act. The vote wording becomes the governing conditions under which these expenditures may be made.

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