



September 13, 2024

To whom it may concern:

Re: Impact of Supplemental Mobile Coverage by Satellite (SMCS; SMSE-006-24) on Canada's national radio-astronomy facility

The National Research Council Canada (NRC) is mandated by the NRC Act to "operate and administer any astronomical observatories established or maintained by the Government of Canada". The Herzberg Astronomy and Astronomy (HAA) Research Centre is the portfolio responsible for fulfilling this mandate, including Canada's participation in all current and future offshore facilities. HAA provides financial contributions and designs/develops instruments to support the administration and operation of observatories supported by Canada. HAA directly supports two national observatories located in British Columbia, the Dominion Astrophysical Observatory (DAO) and the Dominion Radio Astrophysical Observatory (DRAO), as well as five offshore observatories: the Canada-France-Hawaii Telescope (CFHT), the International Gemini Observatory, the Atacama Large Millimetre/submillimetre Array (ALMA), the Thirty Meter Telescope (TMT), and the Square Kilometre Array (SKA).

As Canada's National Facility for radio astronomy, and the only domestic, open-access radio observatory, DRAO fills an essential role in the astronomical community, both within Canada and globally. It provides forefront scientific instruments, engineering testbeds for new technologies, and a training ground for future Canadian radio engineers and astronomers. DRAO's engineers are world-renowned, and technology they have developed is central to major radio telescopes across the globe, including the Jansky Very Large Array (JVLA) in the USA, the Atacama Large Millimetre/submillimetre Array (ALMA) in Chile, and the Square Kilometre Array (SKA) under construction in South Africa and Australia. It should be noted here that these large international observatories also require RFI-clean environments.

The DRAO site was selected following a nation-wide search in the late 1950s. As noted in paragraph 120, DRAO was situated in the White Lake basin because the encircling mountains provide geographic isolation from terrestrial sources of radio-frequency interference (RFI) originating beyond. This "terrain shield" remains effective today, but the proposed SMCS system would negate those benefits since there is no protection from RFI originating from above.

DRAO has long been recognized in national and international spectrum management processes. It has been registered with the International Telecommunications Union (ITU) as a radio astronomy station since 1965, and holds a radio licence issued by ISED for all frequency bands allocated to radio astronomy in Canada. ISED coordinates licensing of other spectrum users in the broader geographic area to limit the deployment of nearby transmitters that could interfere with DRAO operations, and when RFI is detected, they assist in identifying and stopping sources of RFI that impinge on our licensed frequency allocations.

Substantial investments in DRAO quickly followed site selection, with construction commencing in 1959, and provisions made for RFI protection. In 1960 the Province of BC created a 919-acre (372 ha) Reserve for radio astronomy at DRAO, and over the ensuing decades NRC has acquired nearly 4600 acres (1860 ha) of adjacent farmlands, with an approximate 2023 value of \$46 million (Statistics Canada). These lands

span much of the White Lake basin, preventing development within the terrain shield, and provide an extensive RFI-protected site suitable for large radio astronomy experiments, which is unique in Canada, and one of few world-wide. In parallel with land acquisitions, development of radio telescopes and supporting laboratories has continued through to the present day. A recent estimate puts the value of our facilities at \$150 million.

Multiple transformational radio telescopes have been constructed and operated since DRAO opened in 1960, and the “radio-quiet” site continues to attract major projects with Canadian and international partners. Some key projects include:

- Low-frequency antenna arrays at 10 and 22 MHz, operated in the mid-1960s, probed key questions in early radio astrophysics. NRCan continues to operate a 30-MHz instrument (riometer) at DRAO for studying ionospheric conditions to provide warning of radio communication blackouts. Observations at such low frequencies are very challenging in high-RFI environments.
- The invention of Very Long Baseline Interferometry (VLBI) in 1967 used the DRAO 26-m Telescope, earning the team the prestigious Rumford Prize in 1971, and the technique’s on-going importance was recognized by an IEEE Milestone Award in 2010.
- The development of the Synthesis Telescope, begun in 1970, culminated with the instrument that observed the Canadian Galactic Plane Survey (CGPS) during the 14-year period 1995-2009, creating an unparalleled vista of the interstellar medium in our Galaxy, and inspiring similar projects in other countries to similarly cover parts of the sky not visible from DRAO.
- The Solar Radio Flux Monitor, which is solely responsible for measuring and distributing the internationally significant F10.7 index of Solar activity, has been at DRAO since 1991, after being relocated upon the closure of the Algonquin Radio Observatory in Ontario. These flux data are critical for space weather modelling on which satellite operators themselves rely, among numerous other science and industry applications.
- The Canadian Hydrogen Intensity Mapping Experiment (CHIME) was opened in 2017 and has been in full operation since 2018. Operated by a consortium of 9 institutions (5 in Canada), with initial funding of \$16 million, it quickly drew attention of scientists with interests outside the original cosmology objectives. Additional funding was acquired to add capabilities, in particular allowing important contributions to the study of Fast Radio Bursts (FRBs), a newly recognized but enigmatic phenomenon, detecting 90% of all FRBs currently known. It has received the *2020 Governor General’s Innovation Award* and the *2022 Natural Sciences and Engineering Research Council of Canada’s (NSERC) Brockhouse Canada Prize for Interdisciplinary Research in Science and Engineering*. CHIME has recently been awarded \$8.5 million in new funding to extend the lifetime of this project past the initial 5-year span, in recognition of the valuable contributions it continues to make.
- The Canadian Hydrogen Observatory and Radio-transient Detector (CHORD) is currently under construction, featuring 512 six-metre antennas on the DRAO site. A consortium of 13 institutions (8 in Canada) is pursuing similar science goals to those of CHIME, with greater sensitivity. Total funding for this project to date is \$27 million dollars.

- Canadian Galactic Emission Mapper (CGEM) is also under construction. Cosmology experiments conducted by CHIME and CHORD must remove non-cosmology signals from the data, the largest of which is the emission from our own Galaxy. CGEM aims to accurately characterize the Galactic emission to improve the fidelity of the cosmology experiments. This is a collaboration amongst 3 partners, part of a project that received \$1.6 million in funding.

DRAO has a significant impact on the local economy. An independent assessment in 2020 concluded that the Observatory:

- directly generated \$5.3 million in GDP and 56 person-years of employment;
- indirectly generated \$1.4 million in GDP and 15 person-years of employment;
- has an induced impact of \$1.2 million in GDP and 11 person-years of employment;
- is the largest single employer in Area I of the Regional District of Okanagan-Similkameen and is considered a major contributor to the local economy.

The proposed SMCS bands are within the reception ranges of the majority of radio telescopes currently active or under construction on the DRAO site:

- CHIME: 400-800 MHz
- CHORD: 300-1500 MHz
- John A. Galt 26-m Telescope: 400-800 MHz + 900-1800 MHz
- DRAO Synthesis Telescope: 400-800 MHz + 900-1800 MHz
- DRAO Composite Offset Telescope: 350-1050 MHz

The continued viability of this site and its cutting-edge instruments for radio astronomy is threatened by the proposed SMCS. As noted in paragraph 124, adherence to the indicated ITU-R Recommendations for the protection of radio astronomy will be crucial in preserving the ability of DRAO to conduct world-class research and development in radio astronomy. This adherence could be geographically-limited to areas around radio-astronomy observatories such as DRAO as a way to mitigate the impact of SMCS on astronomy while bringing its benefits to the broader society.

We hope that this submission will be helpful in further informing the policy, licensing and technical framework for SMCS.

Clear skies,

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