SRB Technologies (Canada) Inc.

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Pembroke, Ontario
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2016 Annual Compliance and Performance Report

Reporting Period:	January 1 – December 31, 2016
Licence Number:	NSPFOL-13.00/2022
Licence Condition:	4.2

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SRB Technologies (Canada) Inc.

2016 Annual Compliance and Performance Report

Submission date: March 31, 2017

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Executive Summary

SRBT is pleased to provide this compliance and performance report to the Canadian Nuclear Safety Commission as part of our licensed activities.

Our facility continues to process tritium safely, responsibly and efficiently, and we are proud of the level of performance that was achieved in 2016 on several fronts. The ratio of the amount of tritium released to atmosphere versus the amount of tritium that we process has continued to decrease in 2016, where we once again achieved a new low value of 0.10%, meaning that for every 1,000 units of tritium that goes into our product, only one unit was eventually released as gaseous effluent.

SRBT achieved this ratio despite processing virtually the same amount of tritium in 2016 as was processed the year previous. In 2016, a total of 28,122,678 GBq of tritium was processed (vs. 27,989,832 GBq in 2015). We expect that in 2017, the ratio of tritium released to atmosphere versus processed will fall below our established target of 0.16%, and that the annualized averaged weekly gaseous release will also fall below our established target of 747 GBq/week.

The modifications to our processing strategies and several emission-reduction initiatives continue to pay dividends with respect to worker dose, public dose, and the environmental impact of our facility. The collective dose to our staff once again reached an all-time low for a full processing year at just over 2 mSv, and no staff member exceeded 1 mSv for the year – a value that represents the dose limit to the public. This is a testament to the continued diligence of our workers in maintaining radiation exposures as low as reasonably achievable (ALARA).

The calculated public dose remains far less than 1% of the prescribed limit of 1 mSv, as derived from direct sampling and monitoring of the local environment. Groundwater tritium concentrations continue to respond favorably as they recover from historical processing practices.

Our facility continues to be subjected to several independent assessments during the year, and we have in place an expanded internal compliance program to complement these audits. In 2016 CNSC Staff performed two inspections at the facility, resulting in a total of five compliance items being identified; all of these items have since been fully addressed to the satisfaction of CNSC staff.

The ways in which we manage our facility continue to evolve in response to new requirements and opportunities for continuous improvement. In 2016, SRBT provided CNSC staff revisions of several key documents associated with our licensing basis, including the Safety Analysis Report, the Training Program Manual, the Fire Protection Program and Fire Hazards Analysis, the Derived Release Limits, the Environmental Management System and Environmental Monitoring Program, and the Quality Manual.

The revision to the Quality Manual represents the culmination of a multi-year project to revise the overall SRBT management system towards compliance with CSA standard N286-12, *Management system requirements for nuclear facilities.*

As well, SRBT developed and implemented a new stand-alone program focused on integrating our requirements pertaining to effluent monitoring, as a result of the implementation plan associated with the set of CSA N288 set of standards.

Site specific requirements for payments to the decommissioning escrow account have continued to be met. This represents a completely self-funded vehicle that does not rely on insurance, letters of credit or third party resources in order to ensure funding availability for decommissioning.

In summary, 2016 represents a highly successful year of operation for SRBT; however, improvements in compliance and safety will never cease, and we will continue to strive to reduce and optimize effective doses to our workers, the public, and our impact on the environment.

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Acronyms and Abbreviations

ACR	Annual Compliance Report
ALARA	As Low As Reasonably Achievable
Bq	Becquerel
BSI	British Standards Institute
CIBC	Canadian Imperial Bank of Commerce
CLC	Canada Labour Code
CLW	Clearance Level Waste
CN	Canadian National (railway)
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
CVC	Compliance Verification Criteria
DRL	Derived Release Limits
DU	Depleted Uranium
ECR	Engineering Change Request
EMP	Environmental Monitoring Program
EMS	Environmental Management System
ESDC	Employment And Social Development Canada
FASC	Facility Access Security Clearance
FHA	Fire Hazards Analysis
FPP	Fire Protection Program
GEMS	Gaseous Emissions Monitoring System
GNSCR	General Nuclear Safety And Control Regulations
GTLS	Gaseous Tritium Light Source
GWMP	Groundwater Monitoring Program
HRSDC	Human Resources And Skills Development Canada

Acronyms and Abbreviations (cont'd)

HT	Elemental Tritium
HTO	Tritium Oxide
HVAC	Heating, Ventilation, Air Conditioning
IAEA	International Atomic Energy Agency
IATA	International Air Transportation Agency
ISO	International Organization For Standardization
IT	Information Technician
LCH	Licence Conditions Handbook
LLW	Low-Level Waste
LSC	Liquid Scintillation Counters
MDA	Minimum Detectable Activity
MSP	Management System Procedure
MW	Monitoring Well
MWC	Muskrat Watershed Council
NCR	Non-Conformance Report
NDR	National Dose Registry
NFCC	National Fire Code Of Canada
NIST	National Institute Of Standards And Technology
NPECD	Non-proliferation and Export Controls Division
NPFD	Nuclear Processing Facilities Division
NSCA	Nuclear Safety And Control Act
NSPFOL	Nuclear Substance Processing Facility Operating Licence
OBT	Organically Bound Tritium
OFI	Opportunity For Improvement
OLC	Operating Limits And Conditions
PAS	Passive Air Sampler

Acronyms and Abbreviations (cont'd)

PDAC	Prospectors and Developers Association of Canada
PDP	Preliminary Decommissioning Plan
PFD	Pembroke Fire Department
PIP	Public Information Program
PLC	Professional Loss Control
PTNSR	Packaging and Transport of Nuclear Substances Regulations
PUTT	Pyrophoric Uranium Tritium Trap
QA	Quality Assurance
QC	Quality Control
RDU	Remote Display Unit
REGDOC	Regulatory Document
RW	Residential Well
SAR	Safety Analysis Report
SAT	Systematic Approach To Training
SCA	Safety And Control Area
SEC	Society of Economic Geologists
SSC	Structure, System, And Component
SSR	Specific Safety Requirements
Sv	Sievert
TDG	Transportation Of Dangerous Goods
TSSA	Technical Standards And Safety Authority
UL	Underwriters' Laboratories
UPS	Uninterrupted Power Supply
VLLW	Very Low-Level Waste
WMP	Waste Management Program
WSIB	Workplace Safety And Insurance Board

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1. Introduction

1.1 General Introduction

For the period of January 1 – December 31, 2016, SRB Technologies (Canada) Inc. (SRBT) operated a tritium processing facility in Pembroke, Ontario, under Canadian Nuclear Safety Commission (CNSC) Nuclear Substance Processing Facility Operating Licence NSPFOL-13.00/2022[1].

The facility was operated in compliance with the regulatory requirements of the Nuclear Safety and Control Act (NSCA), our operating licences, and all other applicable federal and provincial regulations throughout the review period. Compliance was ensured by the continued implementation of our Management System and associated programs and procedures, coupled with a high level of independent internal and external oversight through audit and inspection activities.

During this period, there were no exceedances of environmental or radiation protection action levels, nor licence / regulatory limits associated with our operating licence. Two events occurred during the past year which were deemed to meet criteria for reporting to CNSC staff.

The SRBT operating licence includes conditions that require SRBT to prepare and submit an annual compliance report (ACR). This requirement is currently defined as part of the compliance verification criteria (CVC) in the Licence Conditions Handbook (LCH)[2] relating to condition 4.2 of NSPFOL-13.00/2022, which states:

> *The licensee shall submit an annual compliance report by March 31 of each year, covering the operation for the 12-month period from January 1 to December 31 of the previous year that includes at a minimum:*
>
> *a) Operational review including equipment and facility performance and changes, significant events/highlights that occurred during the year.*
> *b) Information on production including verification that limits specified in the licence was complied with.*
> *c) Modifications including changes in organization, administration and/or procedures that may affect licensed activities.*
> *d) Health physics information including operating staff radiation exposures including distributions, maxima and collective doses; review of action level or regulatory exceedance(s), if any, historical trending where appropriate.*
> *e) Environmental and radiological compliance including results from environmental and radiological monitoring, assessment of compliance with licence limits, historical trending where appropriate, and quality assurance/quality control results for the monitoring.*

f) Facility effluents including gaseous and liquid effluent releases of nuclear substances from the facility, including unplanned releases of radioactive materials and any releases of hazardous substances.
g) Waste management including types, volumes and activities of solid wastes produced, and the handling and storage or disposal of those wastes.
h) Updates regarding activities pertaining to safety, fire protection, security, quality assurance, emergency preparedness, research and development, waste management, tritium mitigation and training (as applicable).
i) Compliance with other federal and/or provincial Regulations.
j) A summary of non-radiological health and safety activities, including information on minor incidents and lost time incidents.
k) A summary of stakeholder engagement activities, public opinion and information products, as committed to in the Public Information Program.
l) Forecast for coming year(s).

The purpose of this report is therefore to report the required information in order to meet the requirements of conditions 4.2 of Licence NSPFOL-13.00/2022, and the CVC in the associated LCH.

The information is reported in a format similar to that outlined in CNSC document *Annual Compliance Monitoring and Operational Performance Reporting Requirements for Class 1B Nuclear Facilities* (CNSC e-Doc 3471152)[3], and in consideration of regulatory feedback and comments regarding previous ACRs submitted over the past several years.

Where possible, information is presented in the most appropriate section / safety and control area, in such a way as to avoid duplication in other sections.

1.2 Facility Operation – Compliance Highlights and Significant Events

SRBT conducted its licenced activities in a safe and compliant manner throughout 2016.

1.2.1 Tritium Processing

In 2016, SRBT conducted 5,031 tritium processing operations (light source filling), with a total of 28,122,678 GBq of tritium being processed into gaseous tritium light sources (GTLS).

Please refer to section 1.4, ‘Production or Utilization’ for additional details on tritium processing in 2016.

1.2.2 Production and Distribution of Self-luminous Safety Products

1,001 shipments of our self-luminous safety products were made to customers in 18 different countries, including Canada.

Please refer to section 4.8, ‘SCA – Packaging and Transport of Nuclear Substances’ for additional details on the production and shipment of our products in 2016.

1.2.3 Acceptance of Expired Products

A total of 31,667 expired (or otherwise removed from service) self-luminous safety ‘EXIT’ type signs were accepted by SRBT from Canadian and American sources in 2016, representing a total of approximately 5,854 TBq of tritium.

These signs were disassembled safely and the light sources removed, packaged and shipped to a licenced radioactive waste management service provider. A very small number of these signs were evaluated as having light sources that could be reused in other self-luminous devices.

As well, an additional 702 TBq of tritium was accepted from international origins (i.e. other than Canada and the United States) in the form of expired tritium illuminated devices, such as expired aircraft signs, dials, gauges and other smaller equipment. These were also processed for shipment to a licenced waste management facility.

Please refer to section 4.5, ‘SCA – Waste Management’ and section 4.8, ‘SCA – Packaging and Transport of Nuclear Substances’ for additional details on the acceptance of expired self-luminous safety signs in 2016.

1.2.4 External Oversight

During the year, there were a total of 10 major inspections or audits conducted by stakeholders and external parties on our operations.

CNSC staff conducted compliance inspections or promotional visits on two occasions, with one inspection being focused on Environmental Protection, while the other assessed SRBT Import and Export practices. All compliance actions associated with these activities were addressed to the full satisfaction of CNSC staff.

BSI Management Systems, on behalf of the International Organization for Standardization (ISO), conducted an audit in December 2016, concluding that SRBT continues to effectively manage our operations in a fashion that ensures the elements of the scope of our certification with ISO 9001 are effectively addressed.

A major customer of SRBT products also conducted a focused audit of our operations in July 2016, while Underwriters' Laboratories (UL) completed four quarterly audits as planned. Ontario Power Generation did not perform an audit of our facility in 2016.

Additional details on the above noted external oversight of SRBT operations can be found in section 2.1, 'SCA – Management System'.

In addition, two focused facility inspections were conducted relating to fire protection. The Pembroke Fire Department inspected the facility in June 2016, with no violations being identified, while Professional Loss Control (PLC) Fire Safety Solutions conducted a N393-13 compliant facility condition inspection in November 2016.

Details on these inspections can be found in section 4.4, 'SCA – Emergency Management and Fire Protection'.

1.2.5 Internal Oversight

Internally, there were 18 internal compliance audits conducted through the year, focused on all aspects of our operations and our organization. A total of 13 non-conformance reports (NCR) and 31 opportunities for improvement (OFI) were identified as a result of these activities, all of which having been addressed (or are in the process of being addressed) by the responsible managers.

Additional details on internal oversight of SRBT operations can be found in section 2.1, 'SCA – Management System'.

1.2.6 Reported Events

SRBT reported two events to CNSC staff in 2016 pursuant to the General Nuclear Safety and Control Regulations (GNSCR), both of which were posted to the SRBT website within five days of the report.

The first report described a false fire alarm that occurred in a non-radiological area of the facility on June 1, 2016, which resulted in the deployment of the Pembroke Fire Department (PFD) to the facility. Upon arrival, an assessment of the compressor room determined that one of two twinned drive belts on the compressor had failed, with pieces of the failed belt becoming entangled in the belt which was still intact. The friction caused by the entanglement of the failed belt resulted in the generation of sufficient smoke as to activate the sensor on the fire detection system. The compressor was shut down immediately upon determining that the unit had malfunctioned.

The deployment of the Fire Department to the facility was determined to be in line with the definition of 'activation of a contingency plan', as described in Clause 29 (2) of the GNSCR, and both a preliminary[4] and full report[5] on the event was submitted as required. CNSC staff accepted the full report on June 15, 2016[6].

The second report[7] detailed the event where, on the morning of November 28, 2016, SRBT was informed of the suspected theft of a transport trailer containing (amongst other items) expired tritium exit signs destined for our facility. The trailer had been reportedly stolen from a logistics centre in Mississauga, Ontario sometime during the night of Saturday November 26.

The carrier noted that the event had been reported to the regional police commercial auto theft unit, and that an investigation was underway. On December 15, 2016, SRBT was informed that the missing trailer was located, and that the items in question were on board and appeared in good condition.

Members of the SRBT Health Physics Team were provided access to the trailer on December 19, 2016, in order to assess the condition of the packages and the items. No damage was observed, and measurements indicated that there was no radiological hazard at any time during the period that the signs were missing.

The full report of this event[8] was provided to CNSC staff on December 19, 2016, with the report being accepted on February 7, 2017[9].

1.2.7 Summary of Significant Modifications

As included in the 2015 operating licence renewal application, in April 2016 SRBT completed the expansion project, increasing the footprint of the facility. A total of 171 m^3 has been added to the Zone 1 area of the facility, dedicated for our moulding and milling operations, as well as office and storage space. The area is not used for tritium processing-related activities.

CNSC staff reviewed the technical details on the proposed expansion prior to merging the new physical systems and space with the facility systems and space, and concluded[10] that SRBT's submissions indicated that the safety objectives and requirements of the National Building Code, National Fire Code, and Canadian Standards Association (CSA) standard N393-13 would continue to be met.

In 2016, SRBT also added new Remote Display Units (RDU) onto the gaseous emissions monitoring system. These display units provide staff with real-time measurements of the concentration of tritium in the active ventilation systems while tritium processing is being performed.

As well, the design and type of the valve used on tritium traps was changed in 2016, in order to reduce gaseous emissions and improve trap performance and life. The new valves have proven to perform remarkably well, and have contributed to lower levels of tritium emissions and worker dose.

All significant modifications to structures, systems and components associated with our licensed activities were conducted in accordance with our change control processes. Please refer to section 3.2, 'SCA – Physical Design', for more information regarding facility modifications carried out in 2016.

1.2.8 Summary of Organizational Structure and Key Personnel

The organizational structure of SRBT remained the same through most of 2016 as in 2015. At the conclusion of 2016, SRBT employed 43 full-time employees, managers and contracted staff. Please refer to section 2.1, 'SCA – Management System' for details regarding SRBT's organizational structure in 2016.

1.3 Summary of Compliance with Licence and OLCs

Throughout 2016, SRBT complied with the conditions of our operating licence, and possessed, transferred, used, processed, managed and stored all nuclear substances related to the operation of the facility in compliance with both the previous and renewed licence.

Specifically:

- All required programs have been implemented and maintained,
- The CNSC was notified as required of changes to the programs, processes and documents referenced in the management system / licensing basis,
- All required records have been established and maintained pursuant to the operating licence, the Nuclear Safety and Control Act and its regulations,
- All pertinent notifications were made, and written reports filed, within prescribed periods,
- An accepted decommissioning strategy continues to be maintained for future use,
- An accepted financial guarantee was maintained for decommissioning, and payments made in accordance with the relevant schedules,
- Cost recovery fees were paid on time and in full, and
- Limits on releases of tritium to the atmosphere and sewer, and radiation dose limits to the public and SRBT nuclear energy workers were not exceeded.

SRBT also remained in compliance with requirements of all other federal and provincial regulations as pertaining to the operation of the facility, including the Canada Labour Code and associated regulations, as well as provincial regulations with respect to the emission of gaseous hazardous substances.

The following summary report is provided respecting SRBT compliance with the Operating Limits and Conditions (OLC) established within our Safety Analysis Report (SAR) throughout the course of 2016.

Each applicable OLC is repeated below, with a statement of compliance:

1.3.1 Tritium Possession Limit

SRBT is authorized by licence to possess up to 6,000 TBq of tritium in any form.

SRBT possessed less than 6,000 TBq of tritium at all times during 2016.

Please refer to section 2.3, ‘SCA – Operating Performance’ for more details.

1.3.2 Tritium Processing – Permitted Hours of Operation

Tritium processing operations consist of filling and sealing of gaseous tritium light sources (GTLS) on processing rigs, laser cutting of GTLS, or bulk splitting operations. Tritium processing operations are restricted to 0700h – 1900h, seven days a week, unless specifically approved by senior management.

All tritium processing operations were conducted between the hours of 0700h and 1900h during 2016. No processing occurred outside of this time period.

1.3.3 Tritium Processing – Precipitation

Tritium processing shall not occur during measurable periods of precipitation, as detected by the precipitation detection system or equivalent.

Tritium processing operations were only conducted during periods of zero precipitation during 2016.

Processing operations were ceased and equipment placed into a safe state when precipitation events occurred during operating hours.

1.3.4 Tritium Releases to Atmosphere – Tritium Oxide

SRBT shall not release in excess of 6.72E+13 Bq of tritium oxide to atmosphere in any year.

The total amount of tritium oxide released to atmosphere in 2016 was equal to 6.29E+12 Bq (6,293 GBq), representing 9.4% of this licenced limit.

Please refer to section 4.3 ‘SCA – Environmental Protection’ for more details.

1.3.5 Tritium Releases to Atmosphere – Tritium Oxide + Elemental

SRBT shall not release in excess of 4.48E+14 Bq of total tritium as tritium oxide and tritium gas to atmosphere in any year.

The total amount of combined tritium oxide (HTO) and elemental tritium (HT) released to atmosphere in 2016 was equal to 2.89E+13 Bq (28,945 GBq), representing 6.5% of this licenced limit.

Please refer to section 4.3 ‘SCA – Environmental Protection’ for more details.

1.3.6 Minimum Effective Stack Height for Processing

Tritium processing operations shall not occur unless the minimum effective stack height of 27.8 metres is being achieved on the applicable stack unit.

The minimum effective stack height of 27.8 metres was met during all periods of tritium processing operations, as demonstrated by daily pre-operational checks.

1.3.7 Tritium Releases to Sewer – Water-soluble Tritium

SRBT shall not release in excess of 2.00E+11 Bq of water soluble tritium to the municipal sewer system in any year.

The total amount of water soluble tritium released to the municipal sewer in 2016 was equal to 5.18E+9 Bq, representing 2.6% of this licenced limit.

Please refer to section 4.3 ‘SCA – Environmental Protection’ for more details.

1.3.8 PUTT Filling Cycles

Any pyrophoric uranium tritium trap (PUTT) base is limited to 13 complete bulk splitter filling cycles, after which it is no longer permitted to be used for further tritium processing.

All tritium processing in 2016 was conducted using PUTTs that had been cycled 13 times or less on the bulk splitter.

A total of 11 PUTTs were decommissioned in 2016; seven of these were removed from service once reaching the 13 cycle limit, while four others were removed from service due to mechanical problems. A design change was implemented to increase the reliability and performance of these components, with very positive results.

1.3.9 PUTT / Bulk Container Tritium Loading Limit

PUTTs are limited to less than 111,000 GBq of tritium loading at any time. Bulk containers are limited to less than 925,000 GBq of tritium loading at any time.

In 2016, no PUTT was loaded with more than 111,000 GBq of tritium. No bulk container was used in the facility in excess of the 925,000 GBq loading limit.

1.3.10 Bulk Container Heating Limit

Bulk tritium containers are limited to a heating temperature of approximately 550 °C, as measured by the thermocouple placed between the heating band and the container surface. Brief and small exceedances of this value are tolerable so long as they are not sustained, and the temperature is returned below this value as soon as possible.

Bulk tritium container heating operations were conducted in strict compliance with this limit throughout 2016.

1.3.11 On-site Depleted Uranium Inventory

The on-site physical inventory of depleted uranium (virgin, in use and decommissioned bases) is limited to 10 kg.

The on-site inventory of depleted uranium (DU) did not exceed 10 kg in 2016.

Please refer to section 2.3, ‘SCA – Operating Performance’, and section 4.5 ‘SCA – Waste Management’ for more details on inventory controls of DU in 2016.

1.3.12 Facility Action Levels and Administrative Limits

There were no exceedances of radiation protection or environmental protection action levels in 2016.

1.4 Production or Utilization

1.4.1 Tritium Processing

In 2016, at total of 28,122,678 GBq of tritium was processed. This represents a very slight increase of 0.5% from the 2015 value of 27,989,832 GBq.

The following table is presented to illustrate the five-year history of tritium processing at SRBT.

TABLE 1: TRITIUM PROCESSED – FIVE-YEAR HISTORY

Calendar Year	2012	2013	2014	2015	2016
Tritium Processed (GBq)	10,224,590	30,544,759	28,714,119	27,989,832	28,122,678

A generally stable trend of processing has been established over the last four years.

1.4.2 Tritium Possession

SRBT is restricted by licence to possess no more than 6,000 TBq of tritium in any form at the facility at any time.

Throughout 2016 this possession limit was not exceeded. The maximum tritium activity possessed at any time during 2016 was 4,864 TBq, in June.

At all times, unsealed source material was stored on tritium traps or in the handling volumes of tritium processing equipment.

The monthly data of tritium activity on site during calendar year 2016 can be found in **Appendix A** of this report.

1.5 Changes in Management System Documentation

In 2016, SRBT revised several key documents associated with our licensing basis, all of which have been accepted by CNSC staff. These include:

- Safety Analysis Report,
- Training Program Manual,
- Fire Protection Program
- Fire Hazards Analysis,
- Derived Release Limits,
- Environmental Management System
- Environmental Monitoring Program, and
- Quality Manual.

The revision to the Quality Manual represents the culmination of a multi-year project to revise the overall SRBT management system towards compliance with CSA standard N286-12, Management system requirements for nuclear facilities.

As well, SRBT developed and implemented a new stand-alone program focused on integrating our requirements pertaining to effluent monitoring, as a result of the implementation plan associated with the set of CSA N288 set of standards.

SRBT also developed and implemented a formal Regulatory Reporting Program in 2016, which captures the important requirements relating to how information is reported to various regulatory bodies, including the CNSC.

Process revision and improvement continued to be a managerial focus throughout the year. In total, 69 Engineering Change Requests (ECRs) were generated to control the revision and review of programs and procedures in 2016.

Specific details on the changes in documentation can be found in section 2.1, ‘SCA – Management System’.

2. Management SCAs

2.1 SCA – Management System

Throughout 2016, the SRBT management system was effectively implemented, and ensured that our operations continued to meet the requirements detailed in our LCH, including key elements such as organization and responsibilities, capability of personnel, use of experience, work planning and control, process and change control, independent verification, non-conformance and corrective action.

A total of 63 non-conformances and 36 opportunities for improvement were raised in different areas of the company operations. By the end of 2016, 45 of these non-conformances had been addressed in full. The remaining 18 are expected to be addressed before the end of 2017.

Organizational Management reviews were conducted with the Quality Manager to review the Benchmarking and Self-assessment activities that were performed by Organizational Managers for 2015.

A Senior Management Meeting took place on April 29, 2016 to report and discuss the results of the Benchmarking and Self-assessment activities performed in the previous calendar year, and to define areas where improvements can be made in the various company safety programs. The management system was found to be effective at meeting the current requirements of the NSCA, Regulations and conditions of the licence, as well as ISO 9001:2008 and customer requirements.

The 2016 Organizational Management reviews are scheduled to take place in early 2017. With the implementation of a revised Management Review process (MSP-008), these reviews are now being routed through an assigned member of the Executive Committee, and includes all benchmarking and self-assessments performed by Organizational Managers for 2016.

2.1.1 Staffing and Organization

At the beginning of 2016, SRBT total staff complement stood at 43 employees, with a stable trend of employment being maintained through the year. As of the end of 2016, the total staff complement remains at 43 employees.

The following additions or alterations to the organization were implemented at the conclusion of 2016, commensurate with the transition to the revised management system:

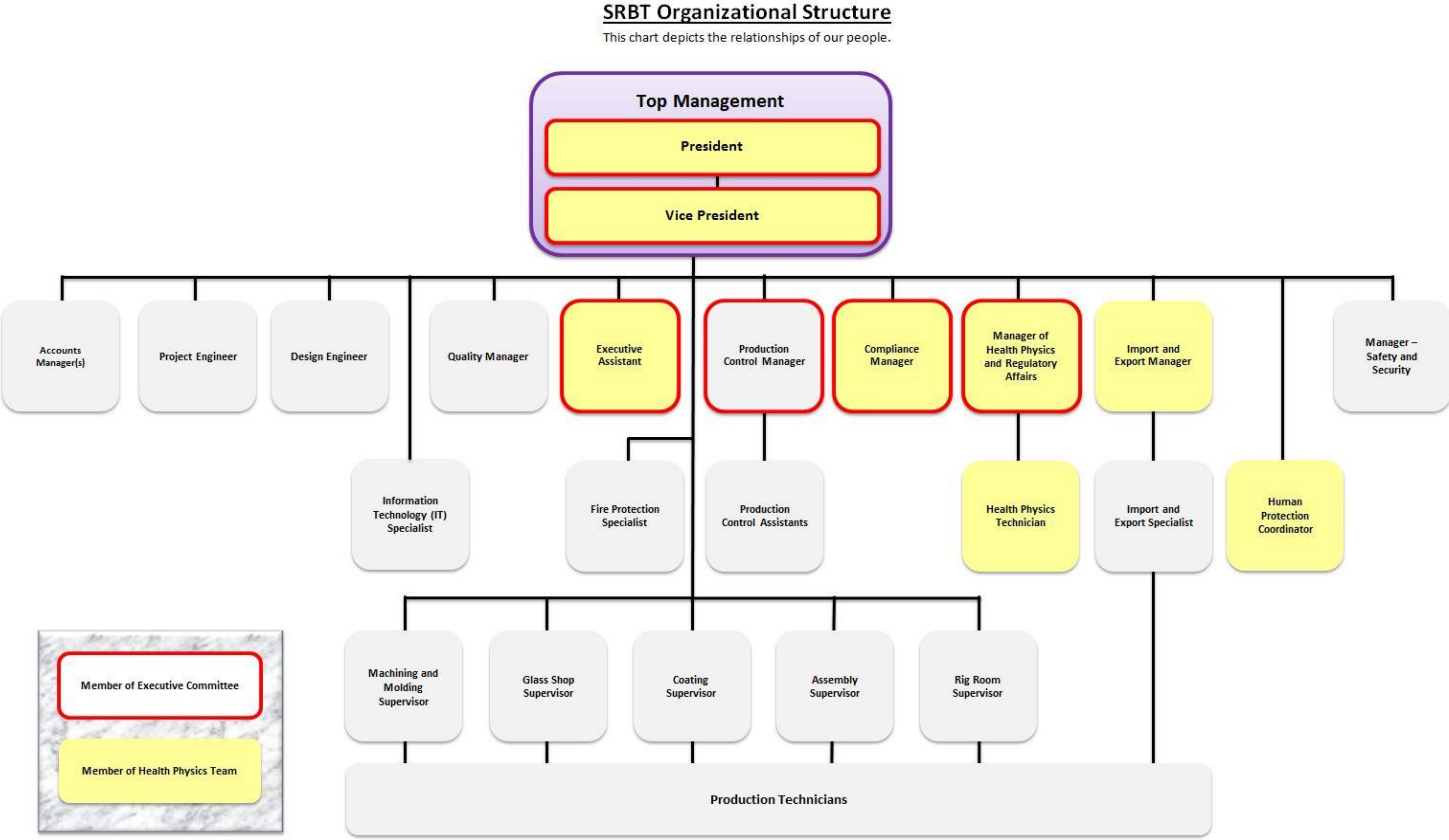
- The position of **Engineering Assistant** was changed to **Information Technology (IT) Specialist**. This position now reports directly to Top Management, and supports the computer network infrastructure of the business, as well as company promotional and public information products. The position also continues to support product research and development activities. Key responsibilities pertaining to product engineering work are now wholly assigned to the Design and Project Engineering positions.

- The position of **Health Physics Technician** was formally re-introduced into the organizational hierarchy. Directly reporting to the Manager of Health Physics and Regulatory Affairs, this individual is responsible for the execution of specific procedures associated with the Radiation Safety, Environmental Monitoring, Effluent Monitoring, and Waste Management Programs. This individual is also a member of the Health Physics Team.

- The position of **Fire Protection Specialist** was introduced into the organizational hierarchy. Directly reporting to Top Management, this individual is responsible for ensuring that the facility complies with applicable building and fire codes. This individual is also responsible for the design and implementation of the Fire Protection Program and aspects of the Emergency Plan, in close consultation with Top Management.

The following organizational chart represents the structure of the company, as of the end of 2016, that ensures SRBT meets the Nuclear Safety and Control Act, regulations and conditions of our operating licence.

FIGURE 1: ORGANIZATIONAL CHART



As of the end of 2016, a total of 43 employees work at the company including 19 administrative employees, 1 consultant and 23 production employees.

Administrative employees include two members of Top Management:

- President has the overall responsibility for the facility and ensures that all licensing requirements are met.
- Vice President assumes the full duties of the President in his absence or otherwise assists the President's in his duties.

Eleven individuals at the Management level:

- Quality Manager is mainly responsible for ensuring the quality of products, the satisfaction of customers, and adherence to the requirements of the Underwriters Laboratories (UL). They provide input ensuring that our management system meets the requirements of the ISO 9001 standard.
- Import and Export Manager is mainly responsible for the transport and receipt of radioactive materials, and the conduct of import and export activities.
- Executive Assistant is mainly responsible for providing administrative support to the President, and for ensuring meeting minutes are recorded.
- Production Control Manager is mainly responsible for all company purchasing and production planning activities.
- Project Engineer is mainly responsible for all company research and development activities, change control process, and the company maintenance program.
- Design Engineer is mainly responsible for certain key manufacturing processes, quality assurance of goods received, and developing specifications for components and material purchases.
- Account Managers (2) are mainly responsible for all company accounting activities.
- Manager – Safety and Security is mainly responsible for ensuring staff health and safety and ensuring compliance with the Occupational Health and Safety Regulations.
- Compliance Manager is mainly responsible for performing independent internal audits and further ensuring facility compliance with external and internal requirements.
- Manager of Health Physics and Regulatory Affairs is mainly responsible for oversight of all company Health Physics activities as well as communicating with CNSC staff to ensure deadlines are met.

Six employees provide program oversight and/or directly assist individuals at the Management level,

- Import and Export Specialist assists the Import and Export Manager in their duties.
- Production Control Assistant assists the Production Control Manager in their duties.
- IT Specialist manages and maintains the facility computer network.
- Human Protection Coordinator provides advice to workers and contractors to ensure they are aware of the hazards associated with tritium and the methods of protecting themselves from these hazards. This individual is also responsible for implementation and verification of the outputs of several processes relating to the Radiation Safety Program.
- Fire Protection Specialist ensures that facility fire safety procedures are implemented.
- Health Physics Technician performs duties relating to radiation and environmental protection.

SRBT also employs a full-time nuclear industry consultant who is mainly responsible for supporting Fire Protection and Emission Reduction initiatives.

The twenty-three production employees include:

Five Production Supervisors,

- Glass Shop Supervisor is responsible for all the activities within the Glass Shop Department.
- Coating Supervisor is responsible for all the activities within the Coating Department.
- Rig Room Supervisor is responsible for all the activities within the Rig Room Department.
- Assembly Supervisor is responsible for all the activities within the Assembly Department.
- Machining and Molding Supervisor is responsible for all the activities within the Machining and Molding Department.

These supervisors oversee the work of eighteen Production Technicians,

- Production Technicians who are responsible for performing production activities to company procedures.

2.1.2 Committees

In 2016, committees have continued to be instrumental in the development and refinement of company programs and procedures, identifying new safety initiatives and ensuring continuing effective communication at all organizational levels.

Committees use meeting results as an opportunity for improvement and make recommendations accordingly. In 2016, a total of 79 committee meetings took place at the company compared to 100 in 2015, a decrease of 23%.

TABLE 2: COMMITTEE MEETINGS

COMMITTEE	NUMBER OF MEETINGS
OTHER COMMITTEE / STAFF MEETINGS	22
WORKPLACE HEALTH AND SAFETY COMMITTEE	9
HEALTH PHYSICS COMMITTEE	8
FIRE PROTECTION COMMITTEE	8
MAINTENANCE COMMITTEE	6
PUBLIC INFORMATION COMMITTEE	5
MITIGATION COMMITTEE	5
EXECUTIVE COMMITTEE	5
TRAINING COMMITTEE	4
WASTE MANAGEMENT COMMITTEE	3
PRODUCTION COMMITTEE	2
SAFETY CULTURE COMMITTEE	2
TOTAL	**79**

The Maintenance and Safety Culture Committees were both created in 2016 in order to manage and support these key areas of our operations. It is fully expected that Committee Meetings will continue to be a key force to improve all aspects of our operations, and safety in general.

2.1.3 Review of N286-12 Management System Transition Activities

In 2014, SRBT conducted a comprehensive gap analysis between our management system and the requirements of CSA Standard N286-12, *Management system requirements for nuclear facilities.* An implementation plan[11] was provided to CNSC staff on September 8, 2014, detailing the path forward to close all significant gaps.

As part of the accepted implementation plan, throughout 2016 SRBT continued to build a management system framework that will ultimately be compliant with CSA Standard N286-12, in line with the timeframes indicated. Several new processes were formally documented and adopted as part of the implementation plan, including processes aimed at ensuring effective communication throughout the organization, a healthy safety culture, and augmented control of change in the facility.

CNSC staff were kept updated on the project status on a routine basis, with updates being furnished on March 31[12], July 27[13], and December 1, 2016[14]. The update furnished on December 1 represented the end of the action plan, culminating in the submission of a comprehensively revised Quality Manual as the top-tier management system document.

On December 31, 2016, SRBT formally transitioned to a newly aligned system with the closure of ECR 702, which captured and controlled the final steps in realigning the system, including the implementation of a completely new set of Management System Procedures (MSP) that addressed critical management activities that applied across the entire organization.

In addition, two new administrative descriptive documents were created in support of the new system:

- *Committee Process and Descriptions* describes the Committee process used by SRBT to support the effective and safe management of its operations, in order to ensure purpose is created; planning is conducted; resources are managed; risks and opportunities for improvement are identified and controlled; performance and objectives are monitored; and other key activities.
- *Organizational Structure and Responsibilities* describes the organizational structure implemented by SRBT to support effective and safe management of its operations, and includes all organizational job descriptions / responsibilities. These were previously included as a component of the Quality Manual; however, a stand-alone document was created as an improvement initiative.

All SRBT staff were trained and familiarized with this transition during the annual training day on December 13, 2016, with positive feedback and questions on the changes.

CNSC staff informed SRBT that the newest version of the manual was acceptable[15], and that a Management System inspection was being planned for the first calendar quarter of 2017.

The revised Quality Manual was designed to also fully meet the requirements of the 2015 version of the ISO 9001 standard. The planned audit of our adherence to ISO 9001 will next be conducted in 2017 by BSI, with the 2015 standard being the criteria against which the system will be assessed.

2.1.4 Review of Quality Assurance and Management System Effectiveness

The SRBT management system is subject to both focused periodic review, as well as continuous review and improvement.

Based upon the following factors and the information presented in this report, it is concluded that the SRBT management system has been effective throughout the year:

- No lost-time injuries or incidents,
- Highest worker dose for 2016 is less than 1% of the regulatory limit,
- Maximum calculated public dose remains less than 1% of the regulatory limit,
- Continued decrease in ratio of tritium released vs. processed,
- All conditions of operating licence(s) met throughout the year,
- Continued improvement of several key programs and processes, and
- The completion of the transition plan to a Management System that is aligned with the requirements of CSA standard N286-12, *Management system requirements for nuclear facilities.*

2.1.5 Audit Summary – Internal

The goal of SRBT's internal auditing process is to ensure that all licensed activities and company safety programs and procedures are being adhered to. Internal audits were specifically focused on the safety and control areas established by the CNSC.

The Compliance Manager implemented an audit schedule for 2016 that touched on all aspects of our operations. A total of 18 internal audits were completed focused in the following areas of our operations:

- Accounting / Financial
- Maintenance
- Security
- Tritium Laboratory
- Waste Management
- Environmental Protection
- Dosimetry Service
- Glass Shop, Coating Room, Milling and Molding
- Materials / Production Control
- Emergency Management and Fire Protection
- Quality Assurance
- Engineering
- Radiation Protection
- Training
- Rig Room and Assembly
- Public Information Program and Financial Guarantee
- Shipping and Import / Export
- Conventional Health and Safety

The audits performed resulted in 13 non-conformances (NCR) and 31 opportunities for improvement (OFI) being identified. Corrective actions have been or are being taken in each case in order to drive compliance and continuous improvement.

2.1.6 Audit Summary – External

During the year, there were a total of 10 major inspections or audits conducted by stakeholders and external parties on our operations.

2.1.6.1 CNSC Inspections (2)

CNSC staff conducted compliance inspections on two occasions, focused on specific safety and control areas relating to our operations.

In September, CNSC staff from the Non-proliferation and Export Controls Division conducted a compliance inspection (NPECD-SRB-2016-09) focused on assessing compliance against the authorizations and the licence terms and conditions of import and export licences issued to SRBT pursuant to the *Nuclear Non-proliferation Import and Export Control Regulations*, as well as section 26 of the *Nuclear Safety and Control Act.*

The inspection was a follow-up to the inspection conducted in December 2015. Apart from one finding associated with the presentation of import licences to customs officers upon importation, CNSC staff found SRBT to be in compliance with requirements, and that the actions taken to address findings from the previous inspection were effectively implemented[16].

SRBT took immediate action to address the directive issued as a result of the inspection[17], with CNSC staff closing the inspection file on October 25, 2016[18].

In October, compliance inspection SRBT-2016-01 was conducted by CNSC staff with the Nuclear Processing Facilities Division and the Environmental Compliance and Laboratory Services Division, focused on the Environmental Protection safety and control area.

The inspection resulted in one action notice being raised pertaining to specific aspects of conventional health and safety of workers and contractors during field sampling work (use of high-visibility clothing, uneven ground surface for ladder deployment when gathering samples), as well as three recommendations made (method of labelling of sample caps, use of log sheet for liquid scintillation counter maintenance activities, keeping a ‘null’ record of weeks where there was no discharges of liquid effluent to the sewer).

The report was issued on December 20, 2016[19]; SRBT subsequently responded to the report on January 26, 2017[20] with a description of the corrective measures and improvement actions taken. CNSC staff closed the inspection file on February 7, 2017[21].

2.1.6.2 ISO Certification Audits (1)

On behalf of the International Organization for Standardization (ISO), BSI Management Systems conducted an audit in December for calendar year 2016 as part of the maintenance of SRBT's ISO 9001 certification.

The audit resulted in the successful continuation of SRBT certification, with no identified opportunities for improvement being reported. BSI concluded that SRBT continues to effectively manage our operations in a fashion that ensures the elements of the scope of our certification with ISO 9001 are effectively addressed[22].

2.1.6.3 Customer-Led Audits (1)

Isolite Inc. (a customer of SRBT products) also conducted a focused audit of our operations in July 2016.

The audit concluded that SRBT is following our Quality Management System and regulatory requirements, and that the guidelines of ISO 9001 are being met.

2.1.6.4 Underwriters Laboratories (4)

Underwriters Laboratories (UL) provides safety-related certification, validation, testing, inspection, auditing, advising and training services to a wide range of clients, including manufacturers.

UL performs quarterly visits of our facility. These visits are unannounced and are to ensure compliance that the products we produce which are listed with UL are manufactured using the materials, procedures and testing parameters required under the specific UL listing.

In 2016, UL performed inspections on March 10, May 12, September 15 and November 20, resulting in one variation notice being raised which is being addressed.

2.1.6.5 Fire Protection Inspections (2)

Two focused facility inspections were conducted relating to fire protection.

The Pembroke Fire Department inspected the facility in June 2016, with no violations being identified, while Professional Loss Control (PLC) Fire Safety Solutions conducted a N393-13 compliant facility condition inspection in November 2016.

2.1.6.6 SRBT Audits of Suppliers, Manufacturers or Service Providers

SRBT did not perform any audits of suppliers, manufacturers or service providers in 2016.

An internal review of contractor third-party procedures pertaining to the execution of work under the Environmental Monitoring Program was scheduled for the end of 2016; however, the contracted party (Canadian Nuclear Laboratories) denied SRBT access to the procedures, citing restrictions laid out in the contractual terms between Atomic Energy of Canada Ltd. (AECL) who ‘own’ the procedures, and Canadian Nuclear Laboratories (CNL).

At the end of 2016, SRBT continues to make efforts to complete this review in partnership with AECL / CNL; however, it is not expected that a collaborative solution will be forthcoming. Concurrently, SRBT has initiated the process of exploring available alternative options for the conduct of field sampling and laboratory analysis activities, as required by our program.

2.1.7 Benchmarking and Self-Assessments

In 2016, individuals responsible for specific programs and procedures at SRBT regularly looked at process problems, corrective actions as well as trending and used this information to benchmark elsewhere in or out of the organization in order to improve the effectiveness of these programs and procedures and to help define where improvements could be made.

Benchmarking against other similar CNSC licensees was encouraged. Documents describing the performance of similar CNSC licensees were reviewed:

- Commission Member Documents
- Proceedings, Including Reasons for Decision
- Documents from other licensees, including annual compliance reports

Self-assessments are also performed by Organizational Managers to identify, correct and prevent problems that hinder the achievement of the company's vision, mission, goals, values and policy and to assess the adequacy and effectiveness of the Quality Management System.

Self-assessments were performed by review of:

- Analysis and trending of performance data against historical data
- Input from stakeholders (public, contractors, regulators, etc.)
- Workspace inspections or observations
- Routine communications with staff to determine whether expectations are understood
- Training and coaching results
- Corrective and preventive actions raised throughout the organization
- Internal audit results

2.1.8 Programs and Procedures

2.1.8.1 Programs

In 2016, several key management system programs and plans were revised in line with SRBT's mission of continuous improvement.

In January, a revised **Safety Analysis Report** was developed and implemented. The report was revised in line with a new Safety Analysis Review Process developed under the N286-12 implementation plan, and was revised in a graded fashion in line with the guidance of International Atomic Energy Agency (IAEA) Safety Guide GS-G-4.1, Format and Content of the Safety Analysis for Nuclear Power Plants. This revision closed Action 20 in the N286-12 implementation plan, with CNSC staff accepting the revised SAR on June 30, 2016[23].

On February 25, 2016, SRBT received a request from CNSC staff pursuant to section 12(2) of the General Nuclear Safety and Control Regulations, where SRBT was asked to review how events are reported to the CNSC, including emergencies where the Duty Officer is to be contacted; to review how events are disclosed to the public; and to modify and submit procedures, if required, to ensure that these concerns are addressed[24].

SRBT confirmed that these requests would be carried out on March 1[25], and subsequently reported on the results of this review on March 23[26]. As a result of this review, SRBT developed and finalized a new Management System program document. The SRBT **Regulatory Reporting Program** documents and defines the management policies, directions, roles and responsibilities associated with reporting key information to regulatory authorities, including the CNSC staff and Duty Officer.

A revised **Training Program Manual** was submitted to CNSC staff on May 20[27] as part of SRBT's actions to address the findings of an inspection in 2015. Revision B of the manual was accepted on May 30[28], resulting in the closure of all compliance actions associated with the inspection.

In June, SRBT submitted an addendum to the **Fire Hazards Analysis** (FHA) to account for the expansion of the facility[29]. The analysis was completed by an independent third party expert; CNSC noted that the addendum was satisfactory on January 26, 2017[30].

As well in June, SRBT provided a draft copy of a revision of our **Derived Release Limit** (DRL) document[31]. The draft was reviewed and comments received from CNSC staff on September 12[32]; SRBT incorporated these comments and addressed highlighted issues, providing a final version of the DRL on October 31[33]. In response to feedback received on January 13, 2017[34], some final minor issues were rectified by SRBT with the submission of a corrected final version of the report on January 26, 2017[35].

As part of the action plan for compliance with applicable CSA standards relating to Environmental Protection, SRBT revised the **Environmental Monitoring Program** (EMP) in 2016. The revised program was submitted to CNSC staff on June 30[36], with comments being provided on August 2[37], which SRBT summarily addressed with a finalized revision on August 15[38]. The finalized version of this program was accepted on September 12[39].

Included with this program was the implementation of a complete set of procedures for both field and laboratory work associated with the EMP. Quality control and data acceptance criteria are also addressed in a fashion that meets the requirements of N288.4-10, Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills.

A revised version of the SRBT **Fire Protection Program** was submitted to CNSC staff on August 31[40], in order to address program-related findings from the third-party audit conducted in 2015, and to incorporate information pertaining to the facility expansion. The revised program was accepted by CNSC staff on December 20, 2016[41].

On December 9, a revised **Health and Safety Policy** document was submitted to CNSC staff[42]. This policy describes the responsibilities of all employees at SRBT regarding health and safety, and ensures that the policies regarding the safety and control area of Conventional Health and Safety are well defined. CNSC staff accepted this revised policy document on December 20[43].

As well in December, SRBT continued to execute the plan for compliance with the N288-set of applicable standards with the submission of a revised **Environmental Management System** (EMS) document, as well as a new stand-alone **Effluent Monitoring Program** (EffMP).

The EMS represents the top-level document in the hierarchy of documentation that controls SRBT performance and activities relating to the Environmental Protection SCA, from which all environmental programs stem.

The EffMP captures processes that were previously under the Radiation Safety Program procedure set, and improves them to ensure compliance with

CSA standard N288.5-11, *Effluent monitoring programs for Class I nuclear facilities and uranium mines and mills*.

These documents were submitted to CNSC staff on December 30[44], in line with our CSA N288 action plan, where SRBT is putting in place an Environmental Management System which complies with several CSA standards in the area of Environmental Protection. The revision to the EMP was also conducted in accordance with this plan.

To develop the N288 action plan, SRBT submitted a comprehensive gap analysis of our environmental protection program documentation to CNSC staff. The initial version of this gap analysis and action plan was submitted in January 2016[45]; after comments were received from CNSC at the end of March[46], the plan was finalized and resubmitted on May 26, 2016[47]. The plan continues to be worked down, with additional major milestones due over the next four years.

2.1.8.2 Quality Manual and N286-12

On December 1, after the completion of a multi-year implementation plan SRBT submitted Revision I of the **Quality Manual** to CNSC staff.

The Quality Manual represents the top-level document in our Management System hierarchy, and was revised to capture the transition from the previous system to a system that complies with CSA standard N286-12, *Management system requirements for nuclear facilities.*

Previously, under the last several iterations of our operating licence, CNSC expectations with respect to the SRBT management system stemmed from several elements defined in what was once a draft regulatory document. SRBT was formally notified of these expectations in 2001, and these continued to be carried forward as part of the compliance expectations of the system until June 2014, where CNSC staff notified SRBT of the intent to include CSA standard N286-12 as the compliance verification criteria in any renewed operating licence for this safety and control area[48].

SRBT undertook a gap analysis between the management system in place at the time, and the requirements and guidance of N286-12. A formal action plan was developed and submitted for review in September of 2014[11], which was ultimately accepted by CNSC staff[49]. SRBT continued to advance this plan through 2015 and beyond, and the Commission issued a licence based upon the continued progress in this area.

During these years, several new processes were formalized and implemented, while others were modified to ensure compliance with the standard. All of these efforts were performed in a carefully controlled manner, with continuous oversight by a special committee headed by Senior Management. CNSC staff were provided periodic updates on the progress towards completing this plan; five updates were furnished with specific information on action status and process development.

SRBT employees were also kept appraised of the work towards implementing a new system, with all-staff sessions discussing the changes in both 2015 and 2016.

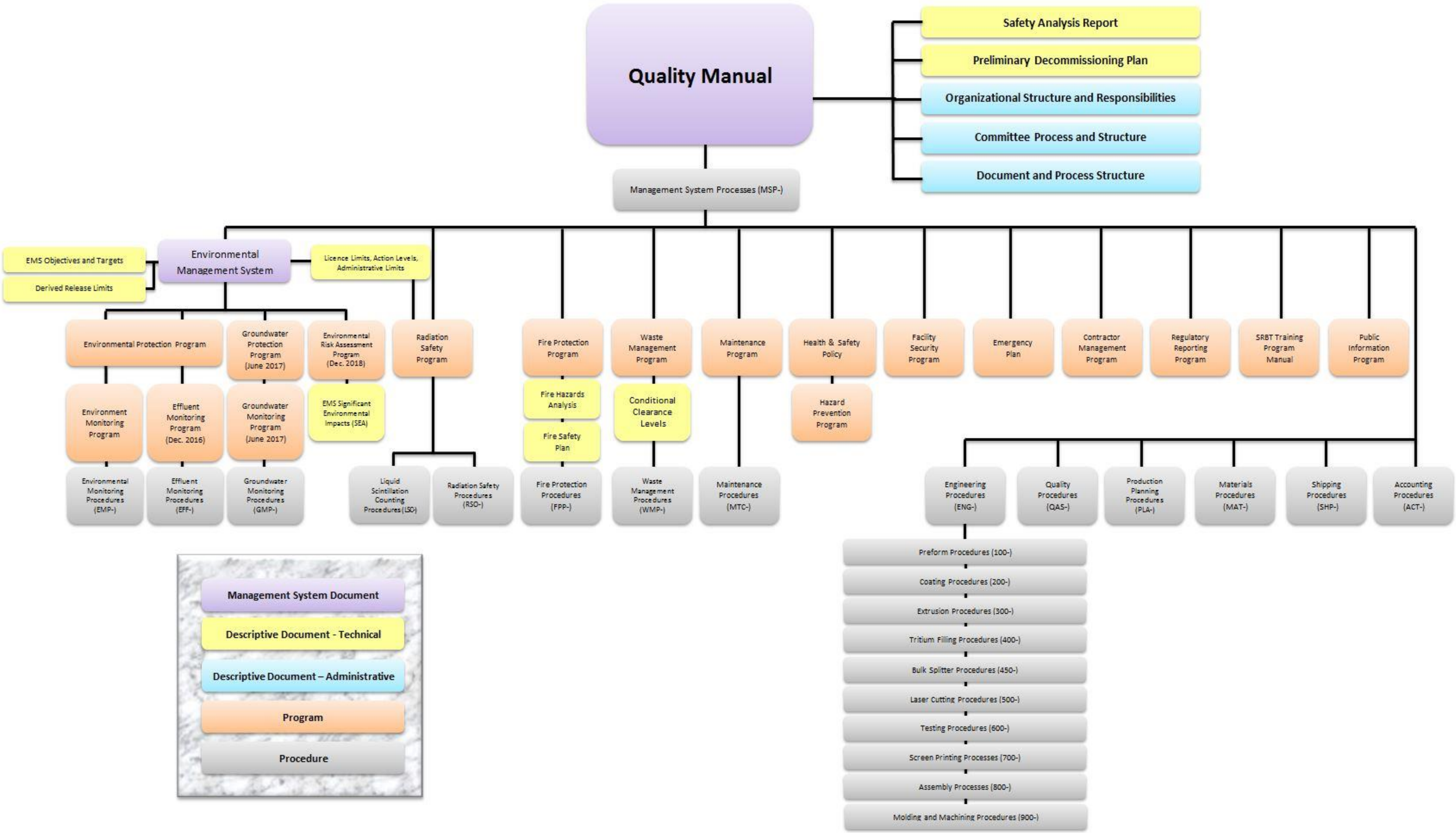
The finalized revision of the Quality Manual was completed in late November, and submitted to CNSC staff for review and acceptance[14]; commensurate with this submission, SRBT began the process of finalizing the last steps in the transition towards the new system, with the planned release of several new and improved top-level procedures and administrative descriptive documents.

On December 20, CNSC staff informed SRBT that the revised Quality Manual was acceptable for implementation and use[15], and that an inspection would be planned in early 2017 to assess the new system against the requirements of the standard.

Thirty days after submission of Revision I of the Quality Manual, SRBT formally implemented the new management system with the closure of ECR-701, which controlled and finalized the transition process. A new document hierarchy was established (see Figure 2), and several new stand-alone management system procedures (MSP-set of procedures) were implemented to ensure that key elements of N286-12 are well controlled and understood by all members of SRBT's management team.

The completion of this plan and the subsequent improvements to SRBT's management system are a source of great pride for our team. Each element within N286-12 has been incorporated in our way of doing work, thus contributing to the continued safe and effective operations of our facility.

FIGURE 2: MANAGEMENT SYSTEM DOCUMENTS



2.1.8.3 Procedures

In 2016, a total of 69 Engineering Change requests (ECR) were filed relating to procedural changes in the SRBT management system (compared to 91 in 2014). The breakdown of ECRs filed was as follows:

TABLE 3: PROCEDURAL ECR SUMMARY

PROGRAM	NUMBER OF ECRs
FIRE PROTECTION	10
ENGINEERING	9
RADIATION SAFETY PROGRAM	8
PRODUCTION	8
MAINTENANCE	7
QUALITY	4
ENVIRONMENTAL PROTECTION	4
WASTE MANAGEMENT	3
SHIPPING AND RECEIVING	3
HEALTH AND SAFETY	2
LIQUID SCINTILLATION COUNTING LAB	1
OTHER	10
TOTAL	**69**

Note that where appropriate, one ECR may encompass more than one procedural improvement. For example, a single ECR was used to initiate the review and implementation of the new set of procedures (14 procedures in total) commensurate with the latest revision of the EMP.

Procedural changes were implemented for a variety of purposes. Many improvements have been incorporated as a result of the continuing, expanded oversight provided by SRBT's internal audit processes, as well as a dedicated managerial focus on improvement initiatives in each area.

In addition, several new procedures and processes have been incorporated into the management system as a result of continuous improvement projects, including the Implementation Plan[11] for compliance with CSA Standard N286-12, *Management system requirements for nuclear facilities,* and the action plan associated with the CSA N288-standards project[47].

2.2 SCA – Human Performance Management

Throughout the course of 2016, SRBT ensured that at all times a sufficient number of qualified workers were available to carry out licenced activities in a safe manner, and in accordance with the NSCA and associated regulations.

In 2016 our staff remained stable; by the end of the year, SRBT employed a total of 43 staff members, which is the same value as was in place at the end of 2015.

The average experience of our workforce stands just over 9 years, with an average age of just over 42 years old. The Health Physics Team possesses a combined 125 years of work experience with the company, while production supervisors average 19 years of experience with SRBT.

Careful consideration continues to be taken when appointing new staff to ensure continued Nuclear Safety.

The activities of five work areas (marked in yellow in Table 4) do not involve tasks that affect Nuclear Safety. Generally employees hired as Production Technicians are first appointed to one of these five work areas. These positions do not in any way impact the company's ability to ensure that the requirements of the Nuclear Safety and Control Act, Regulations and conditions of the licence[1] and LCH[2] are met.

TABLE 4: NUCLEAR SAFETY TASKS PERFORMED PER WORK AREA

WORK AREA	AVERAGE EXPERIENCE (IN YEARS)	RESPONSIBLE FOR PROGRAMS AND PROCEDURES THAT AFFECT NUCLEAR SAFETY	PROCESS TRITIUM	HANDLE SEALED TRITIUM SOURCES
ADMINISTRATION	**13.79**	✓	-	-
RIG ROOM	**9.91**	-	✓	✓
GLASS SHOP	**9.76**	-	-	-
ASSEMBLY	**5.91**	-	-	✓
MACHINING AND MOLDING	**7.77**	-	-	-
COATING	**7.36**	-	-	-
SHIPPING	**3.10**	-	-	-
CLEANING	**2.22**	-	-	-

The Rig Room is the department where tritium processing takes place, and has the highest average work experience with the company of any production department. The average work experience of the staff within this department is just under 10 years.

The Supervisor and another employee in this department have over 25 years of experience and perform or oversee all activities that involve tritium processing or handling of tritium sources.

The Assembly Department is where tritium sources are handled by staff for assembly into products or for packaging. The tritium is contained in the source at this stage and the possibility of tritium exposure is low. The Supervisor in this department has over 17 years of experience and performs or oversees all activities of four other staff members.

2.2.1 Training

2.2.1.1 Annual All-Staff Training Session

Once per calendar year, SRBT shuts down all manufacturing operations in order to conduct an all-day, all-staff training session.

The agenda for this training traditionally incorporates a wide variety of aspects of our operations. The majority of the day is dedicated to a refresher course in radiation protection, specifically oriented at the unique type of hazard present at SRBT.

This training was conducted on December 13, 2016, and included information with respect to natural radiation exposure, anticipated health effects from radiation exposure, tritium, proper handling of tritium throughout the facility, as well as a practical contamination control exercise.

As well, training is provided to all staff on fire safety, security, and the SRBT non-conformance process. This year, an information session was also conducted focused on the transition of the SRBT Management System, and N286-12.

Specific information on the radiation safety training provided by SRBT can be found in section 4.1, ‘SCA - Radiation Protection’.

2.2.1.2 Fire Extinguisher Training

Annual fire extinguisher training was conducted with the support of the Pembroke Fire Department on September 23, 2016. The training was conducted using an electronic simulator, eliminating the risks associated with the controlled, repeated burning and extinguishing of liquid hydrocarbons as an environmentally-friendly measure.

2.2.1.3 Fire Code Administration Training

Beginning in 2016, two SRBT employees (including the Fire Protection Specialist) began a program of learning offered through Algonquin College in Ottawa, titled 'Occupational Safety and Health: Fire Code Administration'.

This program of study adds to the already considerable in-house expertise in the area of Fire Protection and Fire Safety.

2.2.1.4 Fire Responder Training

SRBT and the Pembroke Fire Chief evaluate if and when familiarization training for responders is required. The decision is based on if changes have occurred at SRBT's facility, if the training has not been performed for a number of years or if there are a number of new firefighters and/or volunteers that have not yet taken the training.

Training of fire responders occurred in two session in October 2016. The training included a tour of the facility and information with respect to the hazardous materials found on the site, with a focus on tritium and radiation protection aspects of the facility. Responders were provided with guidance on the precautions to be taken during an emergency or fire response, and on the steps that are to be taken once the response has concluded, including the provision of bioassay samples.

2.2.1.5 Management Systems Training

In April of 2016, the Compliance Manager and Quality Manager attended a training session focused on the 2015 version of the ISO 9001 standard, in order to ensure SRBT was well equipped to transition to the new version of the standard as part of certification in 2017.

2.2.1.6 TDG Training

Transportation of Dangerous Goods (TDG) training for shipping department staff is scheduled <u>every two years</u>. The training is conducted by an outside agency with expertise in the transport of dangerous goods. As the training was last held in March 2015, no training was conducted in this area in 2016; the next training session is scheduled for the first calendar quarter of 2017.

2.2.1.7 Health and Safety Training

In November, a group of fourteen employees underwent First Aid certification training. This initiative began in 2015, and helps ensure that a first aid assistance is always available to employees during operating hours.

The Manager - Safety and Security had attended a Health & Safety Training Conference in Toronto on May 5th 2016 and took part in training seminars that included:

- Employer Due Diligence
- Federal Health & Safety Committees
- Health & Safety CLC Part II Overview & Reporting Requirements
- Hazard Prevention Program

The Manager - Safety and Security had also attended another Health & Safety Training Conference in Ottawa on October 5th 2016 and took part in training seminars that included:

- Comprehensive Chemical Management
- Pedestrian Traffic Plans
- Employee Due Diligence in the Federal sector
- Five Generations in the Workplace

In the first calendar quarter of 2017, SRBT is planning on implementing comprehensive training session on the Workplace Hazardous Materials Information System (WHMIS), for all staff members and management.

2.2.2 Systematic Approach to Training Program

SRBT continues to implement a systematic approach to training (SAT) as part of our overall training program.

The Training Program Manual was revised in May 2016[27] in order to address findings from a CNSC inspection conducted in 2015, as well as findings from an internal audit. The revision was accepted by CNSC staff May 30[28], and resulted in the closure of all associated compliance actions.

SRBT continues to advance the development and implementation of the training activities that were analyzed as requiring the application of a fully systematic approach. The Training Committee actively ensures that the processes described in the Training Program Manual are managed effectively and improved.

Four activities were brought to the Training Committee for a categorization decision during the year. One new SAT-based activity was identified; the processes relating to import and export of nuclear substances was assessed as meeting the criteria for the application of a systematic approach. One other item was identified for incorporation into previously developed SAT-based activities; the addition of the remote display units to the gaseous emissions monitoring system requires integration into the three tritium processing SAT-based activities during the review and revision cycle of the process.

At the conclusion of 2016, five of the seven originally categorized activities have been fully implemented. The remaining two original activities (SAT-HP-01 and SAT-HP-04) continue to be developed for implementation in a risk-informed fashion; in the interim, only those staff qualified under the pre-SAT program are permitted to carry out these activities. It is expected that these activities will be developed and implemented before the end of the third quarter of 2017.

2.3 SCA – Operating Performance

SRBT has continued to operate the facility safely and in compliance with our operating licenses throughout 2016.

Our programs and processes have continued to evolve to meet or exceed regulatory requirements and expectations, with safety as an overriding priority in all aspects of our licensed activities.

2.3.1 Ratio of Tritium Released to Processed

In 2016 our team continued to strive to minimize the amount of tritium released to the environment for every unit of tritium processed – we refer to this as the ‘released to processed’ ratio. This ratio is an excellent indicator of the overall effectiveness of our emission-reducing initiatives.

The following table illustrates how this ratio has trended since 2010.

TABLE 5: TRITIUM RELEASED TO PROCESSED RATIO (2010-2016)

DESCRIPTION	2010	2011	2012	2013	2014	2015	2016
TOTAL TRITIUM RELEASED TO ATMOSPHERE (GBq/YEAR)	36,426	55,584	29,905	78,875	66,161	56,237	28,945
TRITIUM PROCESSED (GBq/YEAR)	6,643,732	7,342,449	10,224,590	30,544,759	28,714,119	27,989,832	28,122,678
RELEASED / PROCESSED (%)	0.55	0.76	0.29	0.26	0.23	0.20	0.10
CHANGE IN RATIO INCREASE (+) / REDUCTION (-)	-31%	+38%	-62%	-10%	-12%	-13%	-50%

2.3.2 Objectives and Targets

SRBT performance against key objectives and targets for 2016 is tabled here, as well as the targets set for 2017:

TABLE 6: 2016 OBJECTIVES AND TARGETS

DESCRIPTION	2016 OBJECTIVE	2016	2017 OBJECTIVE
MAXIMUM DOSE TO NUCLEAR ENERGY WORKER	≤ 0.83 mSv	0.34 mSv	≤ 0.75 mSv
AVERAGE DOSE TO NUCLEAR ENERGY WORKER	≤ 0.065 mSv	0.049 mSv	≤ 0.060 mSv
CALCULATED DOSE TO MEMBER OF THE PUBLIC	≤ 0.0070 mSv	0.0046 mSv	≤ 0.0063 mSv
WEEKLY AVERAGE TRITIUM RELEASES TO ATMOSPHERE	≤ 1,000 GBq	557 GBq	≤ 747 GBq
RATIO OF TRITIUM EMISSIONS VS. PROCESSED	≤ 0.19%	0.10%	≤ 0.16%
TOTAL TRITIUM EMISSIONS LIQUID EFFLUENT PATHWAY	≤ 7 GBq	5.18 GBq	≤ 6 GBq
ACTION LEVEL EXCEEDANCES ENVIRONMENTAL	≤ 2	0	≤ 1
ACTION LEVEL EXCEEDANCES RADIATION PROTECTION	≤ 2	0	≤ 1
CONTAMINATION CONTROL FACILITY-WIDE PASS RATE	≥ 95%	92.4% (see discussion in Section 4.1.6)	≥ 95%
LOST TIME INJURIES	≤ 0	0	≤ 0
MINOR INJURIES REPORTABLE TO EDHRC	≤ 3	4	≤ 20***

***NOTE: Beginning in 2017, the criteria for an injury that requires reporting to the EDHRC has been modified so as to include ALL injuries that require first aid to be administered, including minor cuts, scrapes and burns that would not have been reported before. The 2017 objective is therefore significantly higher, and as such, not directly comparable to the previously established objectives.

2.3.3 Inventory Control Measures

2.3.3.1 Tritium

SRBT has continuously possessed, transferred, used, processed, managed and stored all nuclear substances related to the operation of our facility in compliance with the requirements of our licence.

A number of Inventory Control Measures are in place to ensure that tritium on site does not exceed the possession limit prescribed by our operating licence.

The maximum amount of tritium possessed by SRBT at any one time during 2016 was 4,864 TBq, or approximately 81% of our possession limit. Tritium on site is found in:

- Bulk containers, U-beds and tritium traps
- New light sources
- The exit signs for our facility
- New product that contain light sources
- Work in progress
- Waste
- Expired light sources taken out of product
- Products that contain expired light sources
- Non-conforming product

SRBT also possesses other nuclear substances as part of our licenced activities.

2.3.3.2 Depleted Uranium

SRBT possessed 5.91 kg of depleted uranium in metallic form at the beginning of 2016. This material is used for tritium traps as part of the production of gaseous tritium light sources.

At the conclusion of 2016, SRBT remains in possession of 5.91 kg of depleted uranium. A limit of 10 kg of this material in inventory is applied as part of the operating limits and conditions in the SAR. The breakdown of this inventory is as follows:

TABLE 7: DEPLETED URANIUM INVENTORY BREAKDOWN AT THE END OF 2016

QTY	DESCRIPTION	DEPLETED URANIUM IN EACH (GRAMS)	TOTAL DEPLETED URANIUM (GRAMS)
1	LOOSE FORM	NA	2,795
9	ACTIVE P.U.T.T.	30 +/- 1 GRAM	270
20	NON-ACTIVE P.U.T.T.	30 +/- 1 GRAM	583
4	AMERSHAM CONTAINERS THAT WE OWN (0666AY)	405	1,620
2	AMERSHAM CONTAINERS THAT WE OWN (3605D)	320	640
		TOTAL	**5,908**

2.3.3.3 Exempt Sources

SRBT possesses two Ba-133 external standard sources used in liquid scintillation counters (LSC). The activity of both sources falls below the exemption quantity for Ba-133.

A Cs-137 disc check source, with an original activity of 28 kBq is stored in the LSC lab for health physics-related testing. The activity of this source falls below the exemption quantity for Cs-137.

2.3.4 Results of LSC-QA Program

2.3.4.1 Routine Performance Testing

Routine Performance Testing are performed on both LSCs as required in section 4.2.3 of CNSC Regulatory Standard S-106, *Technical and Quality Assurance Requirements for Dosimetry Services*, Revision 1.

Routine Performance Testing is performed to specifically demonstrate that the dosimetry service is operated in a predictable and consistent way.

Routine Performance Testing was carried out every 3 months as required throughout 2016 on each of the two ‘TriCarb 2910’ units, with no failure reported.

2.3.4.2 Weekly LSC Performance Check

The LSC-QA program requires weekly instrument performance checks using National Institute of Standards and Technology (NIST) traceable standards of a blank, H-3 and C-14 standards.

All tests have been performed on both TriCarb 2910 LSC units, and included an assessment of the instrument efficiency for tritium measurement, the figure of merit, the tritium background measurement, and a chi-square test. In all cases, both instruments met acceptability criteria on a weekly basis.

2.3.4.3 Batch Validity Tests

NIST traceable standards, certified to have an estimated accuracy of ± 1.2%, are prepared in-house, analyzed and checked against acceptability criteria with every batch of samples being analyzed. All tests were performed with every batch in order to ensure quality control of laboratory processes.

3. Facility and Equipment SCAs

3.1 SCA – Safety Analysis

Our operating practices and processes in 2016 have continued to be conducted in full alignment with the latest version of SRBT's Safety Analysis Report (SAR)[50].

There were no modifications or changes made to the facility which affected the safety analysis, and all preventative measures and strategies in place to ensure hazards are effectively identified and mitigated remained effective.

In early 2016, SRBT finalized a revision to the SAR as part of the safety analysis review process. The revision was implemented in line with available international guidance on format and content of safety analysis reports for nuclear power plants. SRBT does not operate a nuclear power plant; however, the guidance in IAEA GS-G-4.1, *Format and Content of the Safety Analysis Report for Nuclear Power Plants* was applied in a risk-informed fashion, as appropriate for a facility such as SRBT.

On January 15, 2016, revision 3 of the SRBT Safety Analysis Report was submitted to CNSC staff for review and acceptance[51]. This revision incorporated all the current information on SRBT, and also established a formalized set of Operating Limits and Conditions that shall be complied with in order to maintain safe operations.

SRBT's Review of Hypothetical Incident Scenarios was integrated into the SAR as an appendix in order to ensure that the entire technical safety case is now included as part of the main licensing document.

On June 30, 2016, CNSC staff notified SRBT that the revised SAR was found to be consistent with the previous version, the operating licence, and the licence conditions handbook[23]. It was also highlighted that the report did not omit any essential analyses or information found in revision 2, and that the revision was a significant improvement and extension of the technical content compared to previous versions. The SAR was accepted as complete, with CNSC providing comments to be considered during the next revision cycle.

As always, SRBT will continue to respond to events in the nuclear industry and beyond that could influence or otherwise affect our safety analysis. It is not expected that our licensed activities and processes will change over the coming years. However, should emissions-reducing initiatives identify any technical and engineered systems that could increase the level of safety if incorporated, these emissions-reducing initiatives will be thoroughly analyzed with respect to safety, in consultation with CNSC staff and the Commission if required, prior to implementation.

3.2 SCA – Physical Design

As a manufacturing company, SRBT owns and operates several pieces of equipment, several of which constitute structures, systems and components (SSCs) which have a bearing on safety and our licensed activities.

Such equipment includes the active ventilation systems and associated emissions monitoring equipment, fire detection and suppression systems, tritium processing rigs, tritium-in-air monitors, and liquid scintillation counters.

The overall facility design is also a key aspect of our operations, and must be managed and controlled safely. The SRBT change control process helps to ensure that modifications are controlled, reviewed, accepted, and recorded using an Engineering Change Request (ECR).

Four significant changes in physical design of important facility systems took place in 2016; these are described in the following sections. All changes have been controlled using SRBT change control processes, none of which were deemed to be outside of the design or licensing basis of the facility. These changes did not result in a negative impact on the ability of the facility and SSCs to meet and maintain their design function.

3.2.1 Facility Expansion

As included in the 2015 operating licence renewal application, SRBT began the process of expanding the facility footprint in 2015 in cooperation with the building landlord. An addition was built on the west side of the facility, allowing SRBT to occupy a portion of the already existing building on that side (previously occupied by another business) as well as the addition.

During this process, no physical interface was made between the SRBT facility and the new expansion until an independent review was conducted and submitted to CNSC staff on compliance with fire and building codes. The expansion was controlled as outlined in ECR 502.

CNSC staff reviewed the technical details on the proposed expansion prior to merging the new physical systems and space with the facility systems and space, and concluded that SRBT's submissions indicated that the safety objectives and requirements of the National Building Code, National Fire Code, and CSA standard N393-13 would continue to be met[10].

SRBT connected facility systems to the expansion, and took up occupancy of the space late in April 2016. The new expansion adds 171 m^2 to the facility footprint, and houses our molding and machining department, as well as three offices and space for storage of production components and materials. No radioactive materials are stored or used in this area.

CNSC also requested that the fire hazards analysis be revised accordingly in line with the integration of the new expansion with the facility[10]. This was completed in June 2016[29].

3.2.2 Remote Display Units

As noted in SRBT's submission for licence renewal in 2014/15, SRBT continues to allocate significant financial and human resources towards initiatives which will help in reducing the amount of tritium released to the environment via the gaseous effluent pathway.

In 2015-16, SRBT collaborated with a third party manufacturer of tritium monitoring equipment to design, develop and manufacture two dedicated remote display units (RDU) to be integrated into the gaseous effluent monitoring system (GEMS). The RDUs were installed in the processing areas of Zone 3, in order to display real-time tritium concentration data in both active ventilation systems.

Previous to the installation of this equipment, technician were required to look through a window and visually assess the data being displayed on the chart recorder outside of Zone 3 in order to determine the concentration of tritium in the active ventilation systems. By providing the RDUs, technicians now can directly monitor the concentration as the processing is occurring, and respond immediately if an upset condition develops.

The RDUs are equipped with both audible and visual alarms, and a two-stage alarm function (low and high-level), and are tested quarterly with the rest of the system to ensure accurate function. The equipment has performed very well, and has resulted in lower emissions by enabling a more effective and immediate response to abnormal tritium releases.

The change was implemented under ECR 579, using a comprehensive change control package that included design, testing, commissioning and installation / integration activities before full implementation on June 2, 2016.

3.2.3 LSC Power Conditioning System

In 2016, SRBT purchased and commissioned a new system for improving the quality of electrical power delivered to the liquid scintillation counters (LSC). The system consists of a voltage-regulated uninterrupted power supply (UPS) coupled in series to a dedicated power conditioner, to which both counters are connected.

The system is passive in nature, and requires no routine action or maintenance. The integration of this equipment was conducted using a change control package as part of ECR 631. The equipment was installed and fully commissioned on March 22.

This equipment has significantly improved electrical power stability and waveform being delivered to the LSC units, as is expected to reduce the frequency of false positive readings, as well as lengthening the expected service life of the counters. The UPS also ensures that during a facility power outage, the LSCs are protected from surges, and continue to function for several hours.

3.2.4 Tritium Trap Valves

As a result of the investigation into an action level exceedance in 2015, where the packing in a tritium trap was determined to have likely failed during a processing operation, SRBT took action to explore an improved design and type of manually operated valve used on each trap.

In consultation with the manufacturer of these types of valves, a custom designed bellows-sealed model was produced. Beginning in January, two valves were put into use and tested in order to ensure design and performance criteria were met. The new model of valve was accepted for full use by the Mitigation Committee on March 16, 2016 after a trial period of approximately two months where the valves exhibited excellent performance.

The design, testing, commissioning and turnover of this component change was controlled under ECR 529. The change has resulted in significant reductions in gaseous emissions during processing, in worker dose, and has eliminated the possibility of packing failure during valve operation.

3.3 SCA – Fitness for Service

All equipment, including all safety-related equipment, is kept in a condition that is fit for service through the implementation of the Maintenance Program. The facility and equipment associated with the facility were maintained and operated within all manufacturer requirements. In 2016 there were no significant equipment failures that presented a safety concern, demonstrating the effectiveness of the Maintenance Program implemented by SRBT.

Revision 6 of SRBT's Maintenance Program was subject to an internal audit for the first time in March of 2016 and numerous improvements, minor in nature, were identified and implemented in order to further improve Fitness for Service. Training records were created to identify and document all 'trained and authorized' individuals within SRBT to perform maintenance activities as per the Maintenance Program and procedures.

Documented maintenance meetings were initiated and held by the Maintenance Committee throughout 2016, while additional procedures were developed under the Maintenance Program, further expanding the scope of controlled and documented activities in a graded fashion. An annual review of 2016 activities was carried out including data pertaining to equipment failures, maintenance activity success rates, non-conformances, procedural revisions, and audit findings.

Preventative maintenance was scheduled and performed in 2016 on equipment as per **Appendix B** of this report. Maintenance records are kept on file including completed work orders of preventative maintenance activities. A maintenance schedule is created and managed by the Project Engineer, and effectively captures all safety-significant planned preventative maintenance activities, whether performed by SRBT personnel or an approved contractor, and includes maintenance inspections as required by the Fire Protection Program.

Corrective maintenance was tracked and trended and reviewed to assess the performance of preventative activities.

The fitness for service of key individual structures, systems and components are summarized below:

3.3.1 Ventilation

The ventilation of the facility is such that the air from the facility flows to the area with greatest negative pressure in Zone 3 which has the highest potential for tritium contamination where all tritium processing takes place. This area and part of Zone 2 are kept at high negative pressure with the use of two air handling units which combined provide airflow of approximately 10,000 cubic feet per minute.

The air handling units are connected to a series of galvanized and stainless steel ducts. In addition to providing ventilation for the facility these air handling units also provide local ventilation to a number of fume hoods which are used to perform activities that have a potential for tritium contamination and exposure.

All ventilation systems were maintained with high fitness for service in 2016. Corrective maintenance was identified through preventative activities and performed according to the requirements of our Maintenance Program and operational procedures. Equipment is maintained on a quarterly or semi-annually basis. Equipment maintenance was performed under contract with a fully licensed maintenance and TSSA-certified local HVAC contract provider. All records of the maintenance are kept on file. Ventilation equipment maintained in calendar year 2016 can be found in **Appendix C** of this report.

3.3.2 Stack Flow Performance

Stack maintenance is performed by a third party, in order to ensure effective performance of the ventilation system and minimize airflow reductions from the beginning to the end of the maintenance cycle to ensure accuracy of results.

Pitot tubes that were installed in the stacks are maintained by a third party to ensure stack airflow are at design requirements. This essentially allows for daily stack flow verification in addition to more detailed annual stack flow verification performed by a third party.

Stack flow performance verification was performed on October 7, 2016 by a third party. The inspection confirmed that the stacks were performing to design requirements, and that the airflow on both air handling units has remained consistent through the last several years.

SRBT continues to monitor and trend the results of the yearly Stack Performance Verification. No further action is required at this time other than continuing to perform the daily readings of the stack height and the monthly airflow checks of fume hoods. All records are kept on file.

3.3.3 Liquid Scintillation Counters

The two TriCarb 2910 liquid scintillation counters were subjected to an annual preventive maintenance procedure on November 8, 2016. No significant concerns or issues were identified during the maintenance activity.

Both systems will continue to be maintained and calibrated on an annual basis by a qualified service representative from the manufacturer of the equipment, to ensure their functionality, accuracy and reliability.

3.3.4 Portable Tritium-in-Air Monitors

Portable tritium-in-air monitors are maintained and made available throughout the facility. The portable units are used to determine the source of tritium that might cause an alarm threshold to be breached.

In 2016, three of the eight available units were taken out of service due to reaching the end of their expected life span, or due to damage beyond reasonably cost-effective repair.

All three of the units removed from service were of the older ‘Scintrex’ model, and had been in service for several years. Since 2014, SRBT has been purchasing and maintaining new Overhoff 200SB units as the portable tritium-in-air monitor of choice.

The removal of the three older style units did not present a significant risk, as these were primarily being used as a back-up to the newer models available; however, in late 2016, SRBT purchased an additional Overhoff 200SB to bring the total available monitors to six.

Five of these monitors are used at the facility (one in Zone 1, one in Zone 2 and three in Zone 3), while the sixth is kept on emergency standby at the Pembroke Fire Hall as part of an emergency preparedness kit.

As required by our Radiation Safety Program, all in-service tritium-in-air monitors were calibrated and maintained at least once during 2016. All records of the maintenance are kept on file.

3.3.5 Stationary Tritium-in-Air Monitors

The ambient air in selected key areas of the facility is continuously monitored using stationary tritium-in-air monitors.

There continues to be five stationary tritium-in-air monitors available for airborne tritium monitoring at the facility, with an additional unit available on standby as a spare.

Three monitors are strategically located in Zone 3; one in the Rig Room where gaseous tritium light sources are filled and sealed, one in the Laser Room where a laser is used to cut and seal small gaseous tritium light sources and inspected, and one in the Tritium Laboratory where tritium is transferred from bulk supply containers to filling containers.

One stationary tritium-in-air monitor is located in Zone 2 in the Assembly Area, where gaseous tritium light sources are pre-packed in preparation for shipping or installed into device housings.

A stationary tritium-in-air monitor is located in the shipping area in order to provide an early warning signal of a problem should a light or device be damaged during packaging activities.

As required by our Radiation Safety Program all tritium-in-air monitors were calibrated and maintained at least once during 2016. All five facility monitors functioned effectively and continuously throughout the year. All records of the maintenance are retained on file.

3.3.6 Stack Monitoring Equipment

Stack monitoring equipment is incorporated for each of two main air-handling units. For each air-handling unit, the monitoring equipment includes:

- A tritium-in-air monitor connected to a real-time recording device,
- An alarming remote display unit (RDU) in Zone 3,
- A bubbler system for discriminately collecting HTO and HT,
- A flow measurement device with elapsed time, flow rate and volume, and
- A dedicated back-up power supply servicing the monitors, bubbler systems and flow meters, capable of providing several hours of uninterrupted power to the equipment during a power failure.

Each tritium-in-air monitor is connected to real-time recording devices (chart recorders) and was calibrated and maintained at least once in 2016. Both of the chart recorders (analog and digital) and RDUs are included in calibration verification activities on a quarterly basis. All records of the maintenance are kept on file.

Bubbler systems (and spare systems) were also maintained throughout the year, with a bi-monthly maintenance cycle being implemented on all stack monitoring equipment.

As the calibration of the bubbler sample flow measurement device is only valid for one year, each device is replaced with a newly calibrated unit on an annual basis. Four newly calibrated units were placed into service on June 7, with the four units with expiring calibration validity being removed from service, and scheduled to be sent for calibration in early 2017.

3.3.7 Stack Monitoring Verification Activities

The annual verification activity for the bubbler systems was performed in February 2016, where independent third party measurements provided validation that SRBT bubblers continue to effectively measure weekly gaseous tritium emissions (both HTO and HT).

All results measured and derived by the third party were within the acceptance criteria of +/- 30% of SRBT measurements for both tritium forms, from both active ventilation trains.

3.3.8 Weather Station

Maintenance of the weather station is performed as per the manufacturer's recommendation, every two years.

On March 1, 2016, the weather station ceased transmitting data to the online server. This fault was discovered when attempting to download data for the March – April period. Investigation determined that the station battery had failed after more than six years of service; as a result, a non-conformance report was raised (NCR-530) to drive corrective action to prevent recurrence of this failure. The replacement of the battery has now been incorporated as a preventive maintenance activity on a four-year cycle.

Maintenance of the weather station was performed on June 6, 2016. It is scheduled to be performed next in 2018. All records of the maintenance are kept on file.

3.3.9 Air Compressor

Process tasks at SRBT require the use of a compressed air system. The air compressor is subject to quarterly preventative maintenance activities. A belt failure on the air compressor in 2016 resulted in an NCR being raised and to the review of the preventative activities on the compressor. This led to the establishment of a requirement where the frequency of the belt change is to be carried out semi-annually rather than annually.

4. Core Control Processes SCAs

4.1 SCA – Radiation Protection

4.1.1 Dosimetry Services

During 2016, SRBT maintained a Dosimetry Service License[52], for the purpose of providing in-house dosimetry services for the staff of SRBT and contract workers performing services for SRBT where there existed potential exposure for uptake of tritium.

All dosimetry results were submitted on a quarterly basis to Health Canada in a timely fashion for input to the National Dose Registry. A final annual report was also submitted as required. A total of 45 individual staff members were included in National Dose Registry (NDR) reports at some point in 2016.

SRBT participated in the annual Tritium Urinalysis Performance Test sponsored by the National Calibration Reference Centre for Bioassay, Radiation Surveillance and Health Assessment Division, Radiation Protection Bureau of Health Canada. The participation is a regulatory requirement for Dosimetry Service Providers.

SRBT received the Certificate of Achievement for successful participation in the Tritium Urinalysis Performance Test from the National Calibration Reference Centre for Bioassay and In Vivo Monitoring for the year 2016[53].

SRBT also submitted to the CNSC an Annual Compliance Report for the Dosimetry Service License[54].

4.1.2 Staff Radiation Exposures and Trends

Through the Dosimetry Service License 11341-3-18.1, SRBT assesses the radiation dose to its employees and to contract workers who may have exposure to tritium.

All SRBT staff members are classified as Nuclear Energy Workers and participate in the dosimetry program.

Persons who work in Zones 1 and 2 provide bioassay samples for tritium concentration assessment on a bi-weekly frequency due to the very low probability of uptake of tritium. Persons assigned to work in Zone 3 provide bioassay samples on a weekly frequency due to the higher probability of chronic uptake of tritium.

There were no occurrences of any personnel contamination events in 2016.

The assessment of dose to personnel, due to tritium uptake, is performed in accordance with the Health Canada Guidelines for Tritium Bioassay and CNSC Regulatory Standard S-106, *Technical and Quality Assurance Requirements for Dosimetry Services*, revision 1.

The maximum effective dose received by any person employed by SRBT in 2016 was 0.34 mSv, a value which is well within the regulatory limit for a nuclear energy worker of 50.0 mSv per calendar year.

The average effective dose all staff was calculated to be 0.05 mSv, while the collective dose continued to be extremely low at 2.21 mSv (45 persons total).

The tables found in **Appendix D** of this report provide the radiological dose data for workers at SRBT for 2016, as well as a comparison of dosimetry results for the years 1997 to 2016.

Note that direct comparison of the dose in 2007 and 2008 to other years may not be informative or appropriate as the facility only processed tritium until January 31, 2007, and only resumed processing tritium in July of 2008.

4.1.3 Action Levels for Dose and Bioassay Level

Dose and bioassay tritium concentration action levels are defined in SRBT's 'Licence Limits, Action Levels and Administrative Limits document[55]. They are as follows:

TABLE 8: ACTION LEVELS FOR RADIATION PROTECTION

PERSON	PERIOD	ACTION LEVEL
NUCLEAR ENERGY WORKER	CALENDAR QUARTER	1.0 mSv
	1 YEAR	3.0 mSv
	5 YEAR	15.0 mSv
PREGNANT NUCLEAR ENERGY WORKER	BALANCE OF THE PREGNANCY	2.0 mSv

PARAMETER	ACTION LEVEL
BIOASSAY RESULT	1,000 Bq / ml FOR ANY PERIOD

In 2016 there were no exceedances of an action level for dose or bioassay tritium concentration at SRBT.

4.1.4 Administrative Limits for Dose and Bioassay Level

Dose and bioassay tritium concentration administrative limits are defined in SRBT's 'Licence Limits, Action Levels and Administrative Limits document[55]. They are as follows:

TABLE 9: ADMINISTRATIVE LIMITS FOR RADIATION PROTECTION

PERSON	PERIOD	ADMINISTRATIVE LIMIT
NUCLEAR ENERGY WORKER	CALENDAR QUARTER	0.75 mSv
	1 YEAR	2.25 mSv

PARAMETER	ADMINISTRATIVE LIMIT
BIOASSAY RESULT	500 Bq / ml FOR ANY PERIOD IN ZONE 3 100 Bq / ml FOR ANY PERIOD IN ZONE 1 OR 2.

In 2016 there were no exceedances of an administrative limit relating to the bioassay tritium concentration measured in any staff member.

4.1.5 Discussion of Significance of Dose Control Data

A tabular summary of effective dose metrics for 2016 is provided in **Appendix D.**

4.1.5.1 Maximum Dose

The maximum effective dose to any staff member in 2016 was 0.34 mSv. This individual works in Zone 3 and performs tritium processing operations in Zone 3 as their primary duty. In 2015 the maximum dose to a staff member was 0.87 mSv; thus once again SRBT has achieved another significant drop in this metric (a reduction of 61%) for maximum dose in 2016.

A maximum dose of 0.34 mSv also represents the achievement of our internal target for 2016 of less than 0.83 mSv, and thus supports the conclusion that the Radiation Safety Program and the Health Physics Team are achieving a high level of performance, and that workers are properly and adequately trained in safely conducting activities that may pose a radiation hazard.

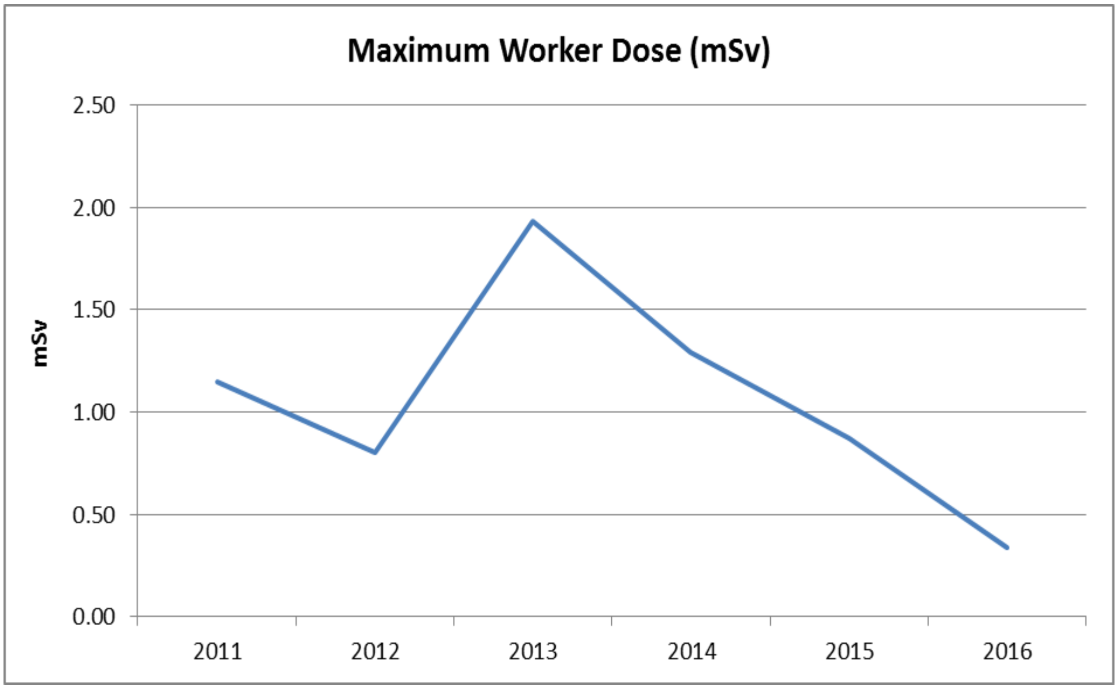
The continued reduction in maximum dose is attributable to several ongoing initiatives, including ensuring that no one worker exclusively performs dose-intensive activities, and increased use of portable tritium in air monitors during routine operations. The new valve design on SRBT tritium traps (as described in section 3.2, ‘SCA – Physical Design’) also contributed significantly to low worker exposures. Finally, the continuous oversight of the Health Physics Team during key activities on the shop floor, as well as expanded and improved Radiation Safety training for staff have helped us to achieve these low levels of exposures for a Class I nuclear facility.

In 2016, the maximum dose to an employee working primarily in Zone 2 was 0.08 mSv, a value which is 0.05 mSv lower than the maximum dose to an employee working primarily in Zone 2 in 2015. This decrease is not viewed as a significant change year over year for the type of operations conducted in Zone 2.

The maximum dose to an employee working primarily in Zone 1 was 0.04 mSv and is 0.02 mSv more than the maximum dose to an employee working primarily in Zone 1 in 2015. This is again not viewed as a significant change year over year based upon the magnitude of the actual dose being extremely low as expected.

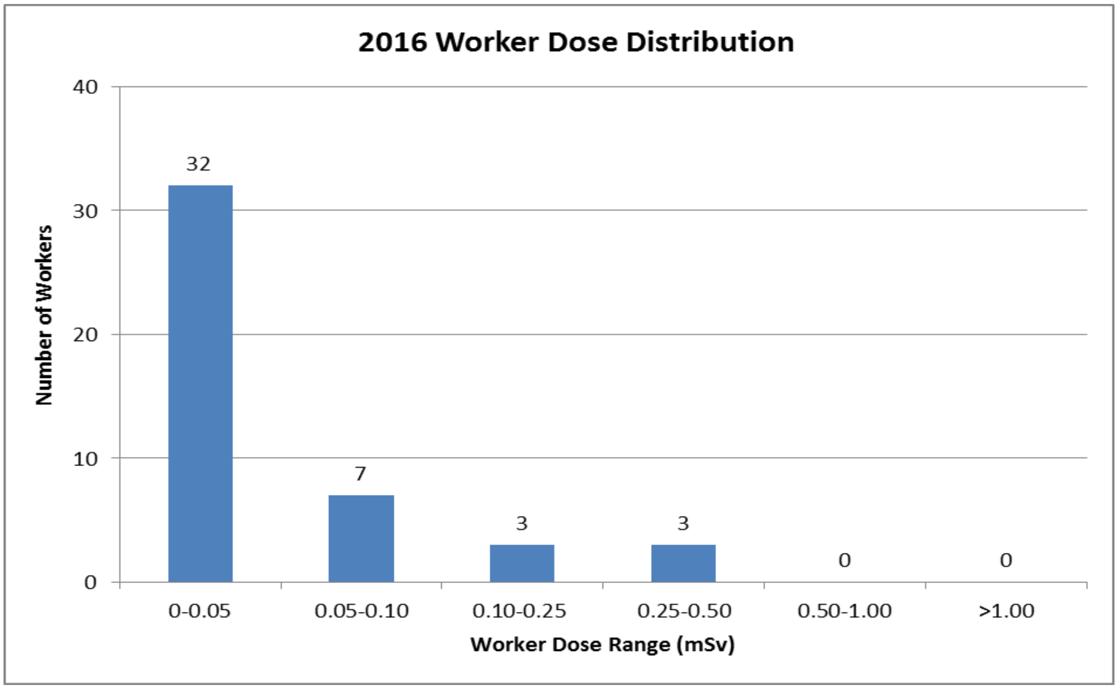
In 2016, the maximum dose to an employee working primarily in administration was 0.06 mSv, a value which is 0.02 mSv lower than 2015. This is once more not viewed as a significant change year over year based upon the magnitude of the actual dose being extremely low as expected. The maximum dose to any worker at SRBT over the past six years is trended below for comparison:

FIGURE 3: MAXIMUM ANNUAL WORKER DOSE TREND



A distribution of maximum worker doses in 2016 is provided here:

FIGURE 4: WORKER DOSE DISTRIBUTION



4.1.5.2 Average Dose

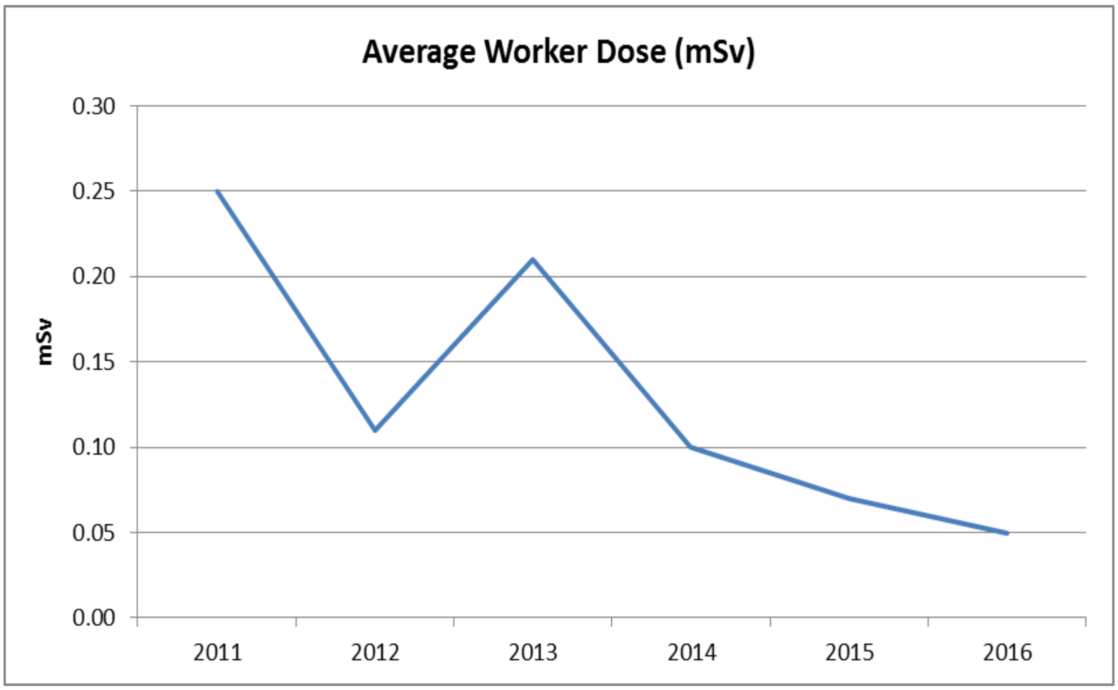
The average dose to workers at SRBT in 2016 was 0.05 mSv. In 2015, the average was 0.07 mSv, thus 2016 represents approximately a 29% reduction in the average dose to staff.

This dose value is somewhat significant, as it is reliant not only on the radiation doses of individuals, but also the number of individuals working at SRBT.

A general trend can be taken over the past three years of data, as the total number of employees having worked or are working as NEWs during this time has been relatively stable, allowing for a direct comparison.

The average dose to workers at SRBT over the past six years is trended below for comparison:

FIGURE 5: AVERAGE ANNUAL WORKER DOSE TREND



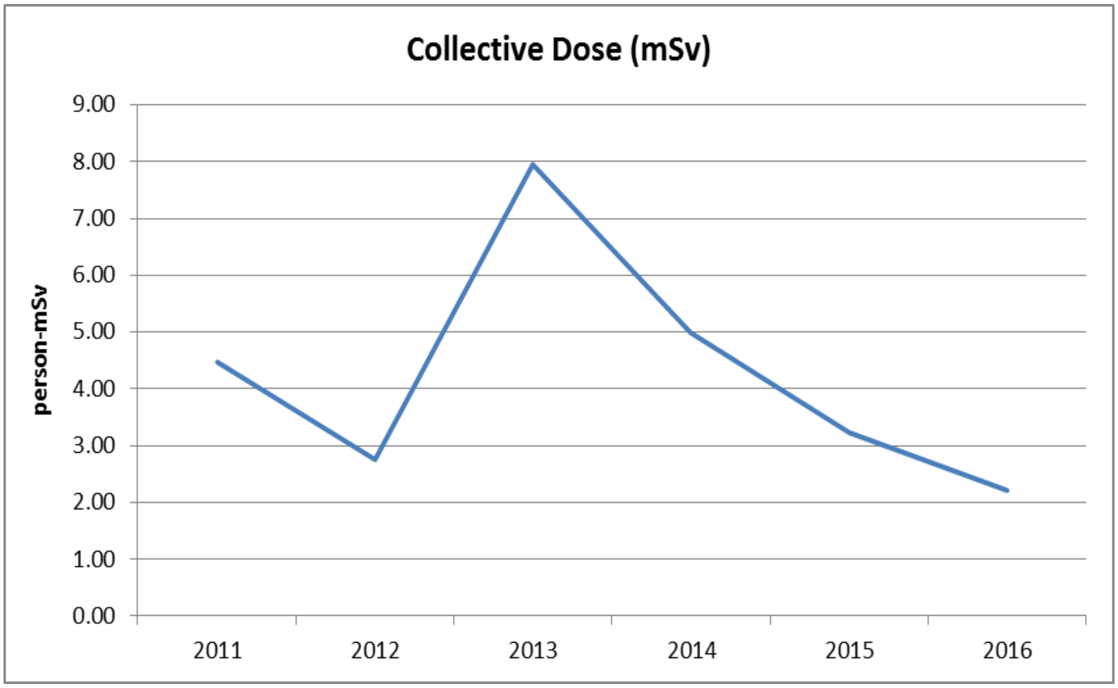
4.1.5.3 Collective Dose

The collective dose to workers at SRBT in 2016 was 2.21 mSv. In 2015, the collective dose was 3.22 mSv; the 2015 collective dose is thus approximately 31% less than the year previous.

As both the number of employees that were exposed to radiation hazards and the amount of tritium processed has remained relatively consistent between 2014 and 2016, the drop in collective dose is viewed as another significant data point that demonstrates the continued effectiveness of the Radiation Safety Program to protect workers and maintain radiation doses as low as reasonably achievable.

The collective dose to workers at SRBT over the past six years is trended below for comparison:

FIGURE 6: COLLECTIVE DOSE TREND



The average quarterly collective dose to workers in Zone 3 in 2016 was 0.38 mSv, a value which is 0.27 mSv lower than in 2015.

The average quarterly collective dose to workers in Zone 2 in 2016 was 0.07 mSv, a value that is 0.01 mSv lower than in 2015.

The average quarterly collective dose to workers in Zone 1 in 2016 was 0.05 mSv, a value that is 0.02 mSv higher than in 2015.

The average quarterly collective dose to workers in administration in 2016 was 0.06 mSv, a value that is the same as in 2015.

4.1.6 Contamination Control and Facility Radiological Conditions

Tritium contamination control is maintained by assessment of non-fixed tritium contamination levels throughout the facility by means of swipe method and liquid scintillation counting of the swipe material. SRBT has in place the following administrative surface contamination limits:

TABLE 10: ADMINISTRATIVE LIMITS FOR SURFACE CONTAMINATION

ZONE	SURFACES	ADMINISTRATIVE SURFACE CONTAMINATION LIMITS
1	ALL SURFACES	4.0 Bq/cm^2
2	ALL SURFACES	4.0 Bq/cm^2
3	ALL SURFACES	40.0 Bq/cm^2

An overview of contamination monitoring results for 2016 has been tabulated and is included in **Appendix E** of this report. A total of 8,163 assessments were performed in various work areas in 2016.

The data collected shows that 450 swipes were taken in Zone 1 resulting in a pass rate of 98.4% below the administrative level of 4 Bq/cm^2.

The data collected shows that 1,784 swipes were taken in Zone 2 resulting in a pass rate of 94.7% below the administrative level of 4 Bq/cm^2.

The data collected shows that 5,929 swipes were taken in Zone 3 resulting in a pass rate of 91.3% below the administrative level of 40 Bq/cm^2.

All swipe results are reported to the area supervisors. The area supervisor and the Health Physics Team reviews the results to determine where extra cleaning effort is necessary. A comparison of the data for the last three years is presented:

TABLE 11: PASS RATE FOR CONTAMINATION ASSESSMENTS

ZONE	2014 PASS RATE	2015 PASS RATE	2016 PASS RATE
1	97.8%	96.9%	98.4%
2	93.5%	96.6%	94.7%
3	93.7%	93.4%	91.3%

Overall, routine contamination measurements conducted throughout the facility in 2016 fell below the administrative limits 92.4% of the time, missing the 2016 internal target of ≥95%.

This is not viewed as a risk-significant issue; rather, it is viewed as a validation of the quarterly modification to the contamination monitoring routines, where the Health Physics Team actively seeks out areas to assess routinely that could present a contamination hazard. The missed target was highlighted to workers in key areas of the facility in early 2017, with the aim at improving the pass rate.

4.1.7 Discussion on the Effectiveness of Radiation Protection Program

Based upon the following factors and the overall evidence presented in this report, it is concluded that the SRBT radiation protection program has been effective throughout the year:

- Highest worker dose for 2016 is <1% of regulatory limit, and was for the second year in a row less than the regulatory limit for a member of the general public (0.34 mSv).
- Collective dose and average dose continue to trend positively (i.e. a decrease compared to the previous year).
- Contamination control data demonstrates a high level of control and an intolerance for contamination in excess of administrative limits; however, the 2016 internally set annual target for contamination control was missed.
- Radiation protection equipment issues are minimal, with an continuing investment in new equipment leading to an excellent track record of maintenance and fitness for service.
- Radiation protection training results demonstrate that staff has a good appreciation and knowledge of how to protect themselves from hazards.

4.1.8 Occupational Dose Targets

As described in the 2015 annual compliance report, the occupational dose targets for 2016 were set as 0.83 mSv (maximum dose to staff member) and 0.07 mSv (average dose to all staff).

Both of these targets were achieved, as described above. The maximum dose to any worker was 0.34 mSv, while the average dose to all workers was 0.05 mSv.

SRBT believes that in 2017 both the maximum and average dose to workers will remain stable, or may rise slightly as production increases of 15% are projected. As a result, in consideration of the low doses achieved in 2016, and the projected production increase, the occupational dose targets are set for 2017 as follows:

- Maximum dose: ≤ 0.75 mSv, and
- Average dose: ≤ 0.060 mSv

4.1.9 Summary of Radiation Protection Training and Effectiveness

All new staff members receive introductory training in radiation safety, even if they are not expected to handle nuclear substances as part of their responsibilities.

In 2016, two employees were hired and were provided with this initial indoctrination training that is required for declaration as a nuclear energy worker. Personnel performed well on the associated test, with no instances of remedial testing required.

On December 13, 2016, SRBT held its annual all-staff training session, which includes a comprehensive training presentation specifically regarding radiation protection concepts and requirements, specifically tailored to the type of hazard at SRBT.

The training session was augmented with a practical demonstration of several concepts relating to contamination control practices, including transition practice over zone barriers, protective clothing, the removal of protective clothing, and good work practices in contaminated environments.

Open dialogue was encouraged with a question and answer session, and a closed-book written test was provided to all participants.

A test is administered at the conclusion of the course; in 2016, all participants successfully challenged the test. Results averaged 94.9% with no marks below the pass criterion of 70%. Any wrong answer on the test was also discussed in detail with all employees individually to ensure full understanding in the days following the training.

4.1.10 Summary of Radiation Device and Instrument Performance

With one area of exception, all equipment associated with radiation protection at SRBT performed acceptably in 2016, and all maintenance activities (including instrument calibration) was performed as required. This includes:

- Liquid scintillation counters
- Portable tritium in air monitors
- Stationary tritium in air monitors
- Portable radiation detectors (‘RadEye’ type alpha/beta and gamma detectors)

In 2016, three of the eight available portable tritium-in-air monitors units were taken out of service due to either reaching the end of their expected life span, or due to damage beyond reasonably cost-effective repair.

All three of the units removed from service were of the older ‘Scintrex’ style or model, and had been in service at the facility for several years. Since 2014, SRBT has been purchasing and maintaining new Overhoff 200SB units as the portable tritium-in-air monitor of choice.

The removal of the three older style units did not present a significant risk, as these were primarily being used as a back-up to the newer models available; however, in late 2016, SRBT purchased an additional Overhoff 200SB to bring the total available monitors to six. All portable monitors are now of an identical design, and every employee is provided with training on basic operation of these instruments as part of their qualification as a nuclear energy worker at SRBT.

SRBT continues to ensure that all equipment relating to the protection of workers from the hazards associated with tritium are kept fit for service, as required by the Maintenance Program.

4.2 SCA – Conventional Health and Safety

4.2.1 Jurisdiction

SRBT is subject to Federal Jurisdiction thus, the Canada Labour Code Part II (CLC Part II) and the Canada Occupational Health and Safety regulations.

4.2.2 Industrial Health and Safety Program

Being under federal jurisdiction in 2016, the Health and Safety Program for the SRBT facility was compliant with the requirements of the CLC Part II & Canada Occupational Health and Safety regulations.

4.2.3 Workplace Health and Safety Committee

In accordance with Section 135(1) of the CLC Part II, SRBT maintains a Workplace Health and Safety Committee.

The Committee is comprised of four representatives. Under section 135(10) of the CLC Part II the Committee is required to meet no less than 9 times per year. The Committee met 9 times in 2016, with all meeting minutes kept on file.

4.2.4 Minor Incidents

There were 3 minor injuries where an employee only required first aid treatment, and 1 injury that medical care was needed at the local hospital in 2016, for a total of 4 minor injuries.

Of the 3 minor injuries treated with first aid, 2 were slight burns to a hand and a finger, 1 was a glass sliver in a finger.

In the injury that required hospital care, a worker suffered a laceration when a box cutter he was using to remove a label slipped suddenly causing him to lose control and the blade to pierce his lower abdomen. Although there was very little bleeding, he was sent immediately for medical treatment at the local hospital. The laceration turned out to be minor and the worker returned the same day.

The laceration incident was reported to Workplace Safety and Insurance Board (WSIB) as required. No lost time was reported.

The incident was investigated and examined, and new cut resistant aprons have been purchased and are mandatory to be worn by any employee doing similar work.

4.2.5 Lost Time Incidents

There were no major conventional health and safety related incidents to report in 2016, and no lost-time injuries occurred.

4.2.6 Visits from Employment and Social Development Canada

In 2016, there were no facility visits conducted by representatives of Employment and Social Development Canada (ESDC).

4.2.7 Reporting

In accordance with Section 15.10 (1) of Part XV of the Canada Occupational Health and Safety Regulations the Employer's Annual Hazardous Occurrence Report was submitted to Human Resources and Skills Development Canada (HRSDC) as required.

In accordance with Section 10 of the Safety and Health Committees and Representatives Regulations, the Work Place Committee Report was submitted to the Regional Safety Officer at Canada Labour prior to March 1, 2016, as required.

4.2.8 Health and Safety Training

The Manager - Safety and Security had attended a Health & Safety Training Conference in Toronto on May 5th 2016 and took part in training seminars that included:

- Employer Due Diligence
- Federal Health & Safety Committees
- Health & Safety CLC Part II Overview & Reporting Requirements
- Hazard Prevention Program

The Manager - Safety and Security had also attended another Health & Safety Training Conference in Ottawa on October 5th 2016 and took part in training seminars that included:

- Comprehensive Chemical Management
- Pedestrian Traffic Plans
- Employee Due Diligence in the Federal sector
- Five Generations in the Workplace

In the first calendar quarter of 2017, SRBT is planning on implementing comprehensive training session on the Workplace Hazardous Materials Information System (WHMIS), for all staff members and management.

4.3 SCA – Environmental Protection

This section of the report will provide environmental and radiological compliance including results from environmental, effluent and groundwater monitoring, an assessment of compliance with any licence limits, historical trending where appropriate, and quality assurance/quality control results for the monitoring.

As part of ensuring compliance with the reporting requirements of several N288-series of standards[45], SRBT has committed to ensuring that the information required by each applicable in-force standard to be reported annually pertaining to the environmental monitoring, effluent monitoring and groundwater monitoring programs is included our annual compliance report.

A summary of the requirements of each of the applicable standards is provided here.

N288.4-10: Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills: Section 11.2.2 – "The report shall include":

TABLE 12: REPORTING REQUIREMENTS (N288.4-10)

	REQUIREMENT	REPORT SECTION
a	The results of the EMP, including measurements of the monitored hazardous and/or nuclear substances, physical stressors, and physical and biological parameters, including their statistical analyses (i.e. assessment of changes through space and time).	4.3.1 **Appendices F through N**
	Radiation doses calculated as doses to receptors where this is required.	4.3.5 **Appendix S**
	An assessment of the EMP results compared with the previous performance indicator targets.	4.3 Reference is made to previous years for performance indication.
	Documentation and justification of any deviations from field sampling, and analytical and data management procedures.	4.3.1.9 4.3.1.10
b	A summary and assessment of the field and laboratory QA/QC results including any non-conformances.	4.3.1.11
c	A summary of the audit and review results and subsequent corrective actions.	4.3.7
d	A summary of any proposed modifications to the EMP.	4.3.8
e	Documentation, assessment and review of any supplementary studies that have been initiated, completed, or both.	4.3.1.12

N288.5-11: Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills: Section 11.2.2 – "The report shall include the results of the effluent monitoring program, including at least":

TABLE 13: REPORTING REQUIREMENTS (N288.5-11)

	REQUIREMENT	REPORT SECTION
a	The amount or concentration of radioactive nuclear substances and hazardous substances released, as required to demonstrate compliance with regulatory limits and performance with respect to any other release target (e.g., action levels).	4.3.2 Action levels and other targets: 4.3.2.4 and 4.3.2.5 **Appendices O and P**
b	The characteristics of the effluents.	4.3.2
c	The results of any toxicity testing conducted (if required).	Not applicable
d	A summary and assessment of the field and laboratory QA/QC results, including any non-conformance.	4.3.2.6
e	A statement of uncertainties inherent in the monitoring results and any dose estimates derived from them.	4.3.2.7 Dose estimates are derived using EMP data
f	A summary of the audit and review results and subsequent corrective actions.	4.3.7
g	A summary of any proposed modifications to the effluent monitoring program.	4.3.8
h	Documentation, assessment, and review of any supplementary studies that have been initiated or completed, or both.	4.3.2.8

N288.7-15: Groundwater protection programs at Class I nuclear facilities and uranium mines and mills: Section 11.1 – "A facility should prepare annual monitoring reports documenting the groundwater monitoring program (GWMP), which include the following":

TABLE 14: REPORTING REQUIREMENTS (N288.7-15)

	REQUIREMENT	REPORT SECTION
a	The results of the GWMP including i) completeness of monitoring activities (identify if all planned activities were accomplished); ii) measurements of the monitored substances, biological, and hydrogeological parameters based on program objectives; and iii) data analysis and interpretations.	4.3.3 **Appendix Q**
b	Relevant groundwater and hydrogeological characteristics.	4.3.3 **Appendix R**
c	Doses calculated for the identified receptors (if doses have been calculated to aid in interpreting GWMP results).	4.3.5 **Appendix S**
d	A summary and assessment of the field and laboratory QA results, including any non-conformances.	4.3.3.3
e	A statement of uncertainties inherent in the monitoring results and any dose estimates derived from them (where applicable).	4.3.3.4 4.3.5
f	Documentation of any supplementary studies that have been initiated, completed, or both (with references to the original studies).	4.3.3.5
g	An overall statement of data quality and discussion of results in terms of data performance and acceptance criteria.	4.3.3.6
h	Discussion of monitoring results in terms of program objectives and the conceptual site model.	4.3.3.7
Note 1	A summary of any audits performed, their results, and any corrective actions taken as a result of the audit's findings may also be included in the reporting.	4.3.7

4.3.1 Environmental Monitoring

SRB Technologies (Canada) Inc. implements a comprehensive Environmental Monitoring Program (EMP)[56] that provides data for site-specific determination of tritium concentrations along the various pathways for exposure probabilities to the public due to the activities of the operations. Most samples are collected and analyzed by a third party contracted by SRBT.

4.3.1.1 Passive Air Monitoring

A total of 40 passive air samplers (PAS) are located throughout a two kilometer radius from the SRBT facility, in eight sectors, ranging in distance at 250, 500, 1,000, and 2,000 meters.

The samples were collected on a monthly basis by a third party laboratory for tritium concentration assessment by the third party laboratory.

Several duplicate samplers are included for quality assurance purposes. Several samplers are also located specifically to provide data for assessment of the defined critical group members. PAS results for 2016 can be found in the table in **Appendix F** of this report.

The table shows the tritium oxide (HTO) concentrations for the samplers located in each of the eight compass sectors. Tritium oxide in air concentrations for each month of 2016 are graphically represented for each of eight compass sectors and for each of the distances from the facility and are found in **Appendix G** of this report.

The PAS array represents the tritium exposure pathways for inhalation and skin absorption; results are used in the calculations for critical group annual estimated dose for 2016.

The sum of the average concentration for all 40 passive air samplers in 2016 was 33.44 Bq/m^3 a value that is significantly lower than the value observed in 2015 (54.74 Bq/m^3).

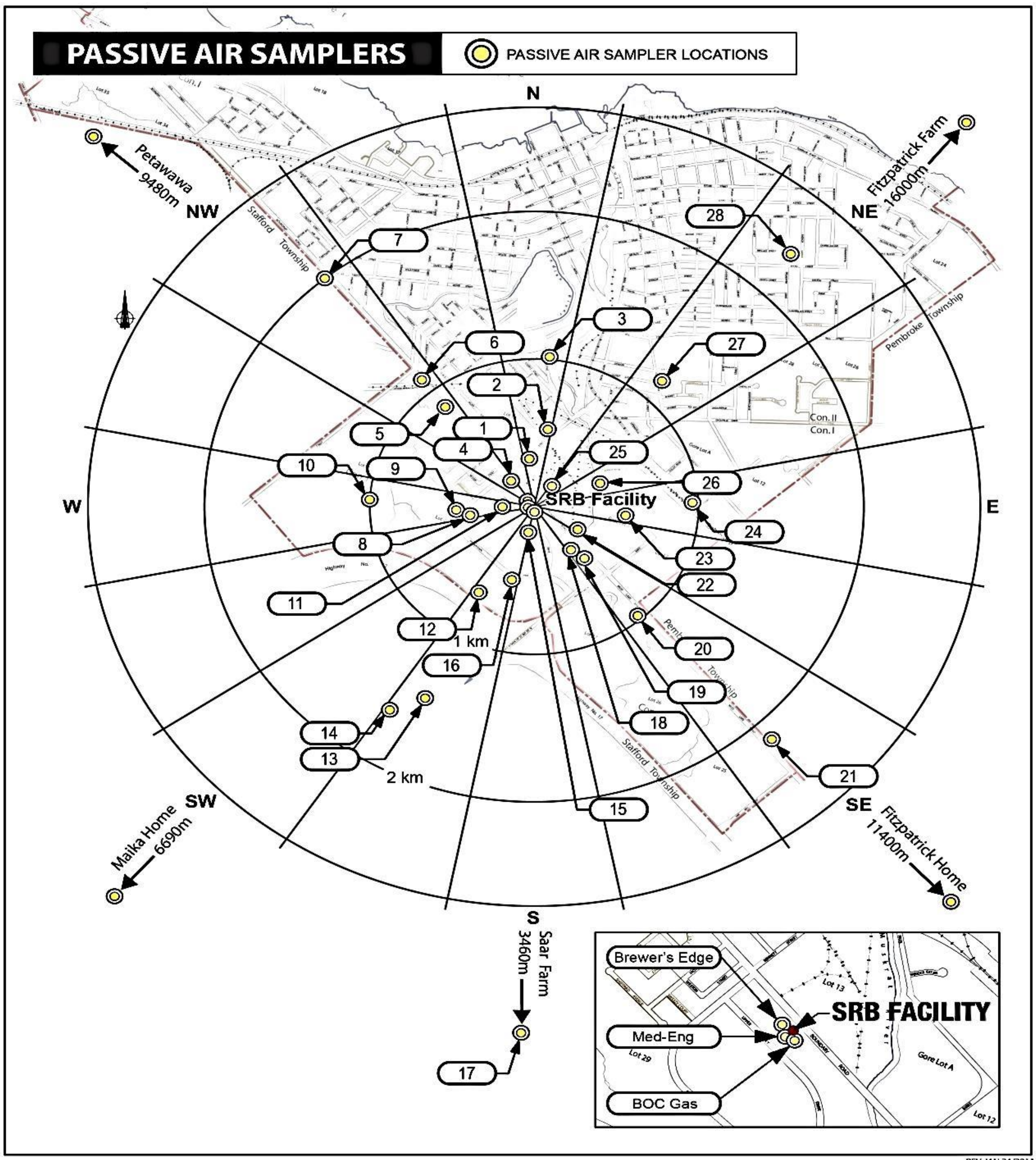
Total tritium emissions in 2016 were 28,945 GBq, or approximately 51% of the emissions in 2015 (56,237 GBq). The reduction in total emissions is due to several continuing initiatives that are discussed later in this section.

Facility emissions of HTO were lowered in 2016 (6,293 GBq) versus 2015 (11,554 GBq). The percentage decrease of HTO emissions (a reduction of approximately 46%) correlates very well with the observed decrease in cumulative average of all PAS data (-40%), suggesting excellent correlation between these two parameters.

The data relating to PAS in 2016 continues to demonstrate that the environmental monitoring program collects data that consistently reflects the emissions from the facility.

The relative positioning of the PAS array used as part of the EMP is provided here:

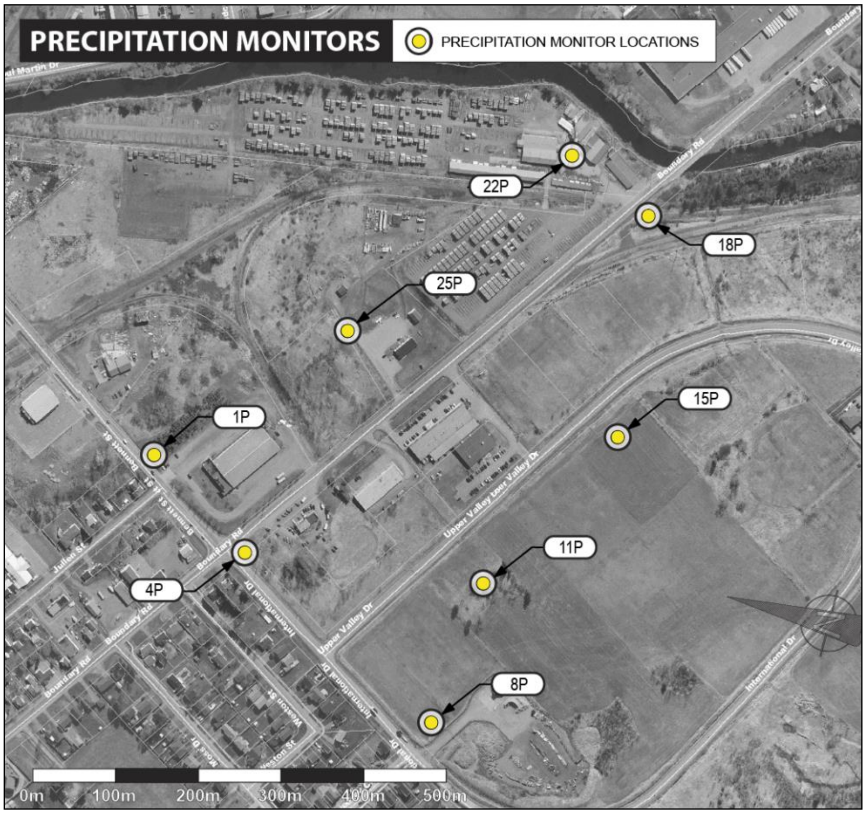
FIGURE 7: LOCATION OF PASSIVE AIR SAMPLERS



4.3.1.2 Precipitation Monitoring

Eight precipitation monitors are installed near existing air monitoring stations that are located approximately 250 m from the facility.

FIGURE 8: LOCATION OF PRECIPITATION MONITORS



The samples were collected on a monthly basis by SRBT and a third party laboratory for tritium concentration assessment by the third party laboratory. Average results in 2016 ranged between 9 Bq/L (sampler 15P) and 43 Bq/L (sampler 18P).

The average tritium concentration for all eight precipitation monitors in 2016 was 25 Bq/L, an decrease when compared to the 2015 average of 70 Bq/L.

Precipitation monitoring results for 2016 and comparisons can be found in **Appendix H** of this report.

4.3.1.3 Receiving Waters Monitoring

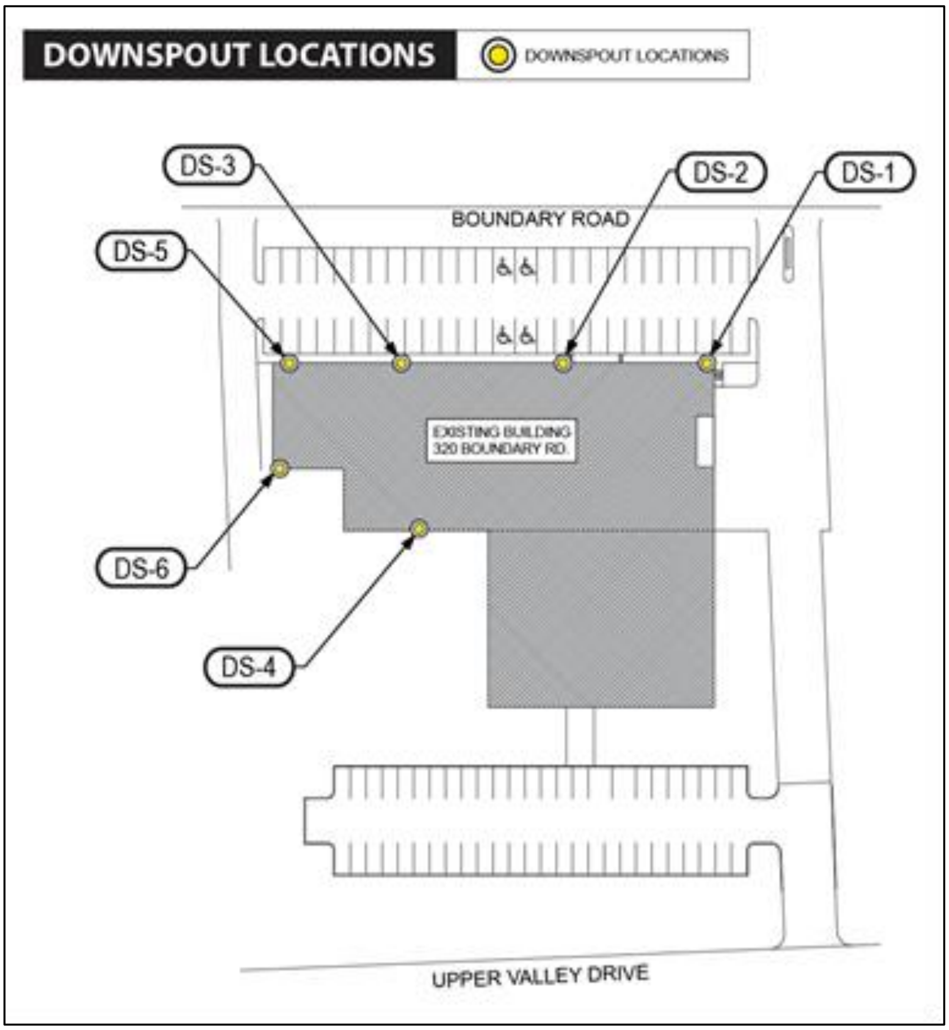
Samples of receiving waters downstream from SRBT in the Muskrat River were collected regularly. Samples were collected by SRBT and a third party laboratory for tritium concentration assessment by the third party laboratory.

All obtained samples of receiving waters in 2016 fell below the minimum detectable activity (MDA) for tritium concentration, (between 4-5 Bq/L), with one exception where a duplicate sample was measured at 6 Bq/L (+/- 2 Bq/L) in November. Receiving waters monitoring results for can be found in **Appendix I** of this report

4.3.1.4 Downspout Runoff Monitoring

Tritium concentrations are measured in all facility downspouts. The samples were collected periodically by SRBT for tritium concentration assessment.

FIGURE 9: LOCATION OF FACILITY DOWNSPOUTS



Runoff from downspouts was collected during three precipitation events throughout 2016, with all but two measurements falling below 100 Bq/L. The average tritium concentration for downspouts in 2016 was 120 Bq/L.

Runoff monitoring results can be found in **Appendix J** of this report.

4.3.1.5 Produce Monitoring

Produce from a local market and from five local residential gardens were sampled in 2016.

As a result of the number of volunteer gardens decreasing over the past few years, action was taken to recruit other residents with gardens in the critical group area near the facility to participate this year. This resulted in two new participants in the program, to go along with two gardens that participated last year, and one garden that had participated in earlier years but did not in 2015.

The samples were collected and assessed by a third party laboratory to establish free-water tritium concentration.

The official results were derived from the traditionally used third party, and reported to the members of the public and posted on the web site. This data is also used in the calculations for critical group annual estimated dose for 2016.

The average free water tritium concentration in produce offered by local residents in 2016 was 72 Bq/kg, a value that is on par with the 2015 figure of 91 Bq/kg.

The average free water tritium concentration in produce offered by the local market was 7.7 Bq/kg, a measurement consistent with the 2015 value of 7.7 Bq/kg.

As well as performing measurements of free water tritium in the sampled produce, an assessment of concentrations of organically-bound tritium (OBT) was also undertaken for samples where sufficient material was obtained to permit such analysis.

Samples of tomatoes from a nearby residential garden showed 4 Bq/kg, while tomatoes from the commercial garden were measured at 2 Bq/kg. A sample of carrots from a residential garden were measured as 13 Bq/kg.

These OBT values are incorporated into the calculation of public dose later in this section, in lieu of the previous practice of applying isotopic discrimination and transfer factors to derive an acceptable OBT value for this purpose.

Produce monitoring results and locations for calendar year 2016 can be found in **Appendix K** of this report with graphs comparing 2006 to 2016 results.

4.3.1.6 Milk Monitoring

Milk from a local producer and from a local distributor is sampled every four months. The samples were collected by SRBT and a third party laboratory for tritium concentration assessment by the third party laboratory. This data is also used in the calculations for critical group annual estimated dose for 2016.

Milk monitoring results and locations for 2016 can be found in **Appendix L** of this report. Tritium concentrations in milk for 2016 remained very low, with all samples falling below the MDA of 3-4 Bq/L.

4.3.1.7 Wine Monitoring

Wine from a local producer is sampled once a year. The sample was collected by a third party laboratory for tritium concentration assessment by the third party laboratory.

Wine monitoring results for 2016 remains low at 10 Bq/L; annual data can be found in **Appendix M** of this report with a graph comparing results from 2006 to 2016.

4.3.1.8 Weather Data

A weather station near the facility collects data on a continuous basis. See weather data for 2016 in **Appendix N**.

4.3.1.9 Deviations from Field Sampling Procedures

In 2016, there was one internally noted deviations from field sampling procedures and protocols by our third party independent laboratories conducting all field work.

Procedure EMP-005, *Commercial Produce Monitoring – Field Sampling* requires that SRBT should ensure that at least five different types of vegetables / fruit are obtained if possible during this work.

During the 2016 produce sampling campaign, only three different types of produce were on offer by the nearby commercial garden. A non-conformance report was raised, with an action to explore additional sources of commercial produce in 2017 during the harvest season, in order to ensure a variety of types of produce is assessed. This deviation is not viewed as significant with respect to the adequacy of the data gathered for the purposes of the EMP.

As well, one recommendation was made by CNSC staff as a result of an inspection conducted in October, where it was identified that the labelling of the cap of certain sample vials was being performed in the field, rather than in advance of field work; this practice was not as described in the procedure. SRBT took measures to clarify the procedure to allow either practice to be performed.

4.3.1.10 Deviations from Analytical and Data Management Procedures

In 2016, there were no internally noted deviations from EMP analytical and data management procedures.

As a result of the October inspection, CNSC staff made a recommendation pertaining to records relating to calibration and maintenance of the liquid scintillation counting equipment used by SRBT. This recommendation was accepted and action taken to ensure compliance with procedural requirements in this area.

4.3.1.11 Field and Laboratory QA/QC Results and Non-conformances

Field and laboratory operations conducted by the independent third party laboratory include several quality assurance and quality control activities.

Field QA/QC activities include duplicate sampling of five passive air sampler stations, duplicate sampling of the Muskrat River, and the use of trip / method blanks for each type of sample obtained in the field.

Laboratory QA/QC activities include tritium spiking of certain collected samples and blanks, as well as laboratory reference standards for low and high activity concentrations. Sample QC is tested using spike recovery and relative percent difference tests.

In 2016 there were no reported non-conformances relating to EMP field and laboratory QA/QC activities, and none were raised by SRBT after further assessment of raw data from the independent laboratory.

Beginning in July, with the release of the new revision of the EMP, SRBT began to execute an internal data acceptance process under new procedure EMP-013, *Acceptance Criteria for EMP.* No non-conformances were identified as a result of these checks.

4.3.1.12 Supplementary Studies – 2016

There were no supplementary studies initiated or completed relating to the SRBT EMP in 2016.

4.3.2 Effluent Monitoring

SRBT monitors two main effluent streams from the facility for tritium.

Tritium releases via the gaseous effluent pathway (active ventilation) are monitored in real time, with integrated measurements being conducted weekly to determine total emissions and verify compliance with licence limits and action levels.

Liquid effluent is retained in batches and analyzed for tritium concentration prior to being released to sewer.

4.3.2.1 Gaseous Effluent

In 2016, SRBT operated well within release limits to atmosphere that are prescribed as part of the operating licence of the facility. The operating licence (NSPFOL-13.00/2022)[1] references release limits defined in Appendix E of the Licence Conditions Handbook[2].

A summary of the releases of tritium oxide and total tritium in 2016 is tabulated below:

TABLE 15: GASEOUS EFFLUENT DATA (2016)

NUCLEAR SUBSTANCE AND FORM	ANNUAL LIMIT (GBq)	2016 RELEASED (GBq)	% LIMIT	WEEKLY AVERAGE (GBq)	MAXIMUM WEEKLY RELEASE (GBq)
TRITIUM AS TRITIUM OXIDE (HTO)	67,200	6,293	9.36%	121	242
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	448,000	28,945	6.46%	557	7,543

Please refer to **Appendix O** for a complete data set on tritium releases to atmosphere in 2016.

For comparison, in 2015 HTO emissions were 17.19% of the licence limit, while total tritium emissions were 12.55% of the licence limit.

Total air emissions in 2016 decreased by nearly 49% of what they were in 2015, while tritium processed in fact increased very slightly. This is indicative of continued success in reducing process-based emissions as part of SRBT's Emissions Reduction Initiative.

Details on the past five years of gaseous effluent data are provided below for ease of trend analysis:

TABLE 16: GASEOUS EFFLUENT DATA (2012-2016)

NUCLEAR SUBSTANCE AND FORM	RELEASED 2012 (GBq)	RELEASED 2013 (GBq)	RELEASED 2014 (GBq)	RELEASED 2015 (GBq)	RELEASED 2016 (GBq)
TRITIUM AS TRITIUM OXIDE (HTO)	8,356	17,824	10,712	11,554	6,293
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	29,905	78,875	66,161	56,237	28,945

When analyzing the operation's performance at reducing emissions it is important to analyze the releases to atmosphere against the tritium processed. This provides an indication at how effective emission reduction initiatives have been successful in reducing emissions. The following table defines the ratio of tritium released to atmosphere against tritium processed from 2008:

TABLE 17: TRITIUM RELEASED TO ATMOSPHERE vs PROCESSED (2008-2016)

YEAR	TRITIUM RELEASED TO ATMOSPHERE (GBq/YEAR)	TRITIUM PROCESSED (GBq/YEAR)	% RELEASED TO PROCESSED	% INCREASE (+) REDUCTION (-)
2008	40,100	2,356,979	1.70	N/A
2009	40,547	5,045,720	0.80	- 53%
2010	36,426	6,643,732	0.55	- 31%
2011	55,584	7,342,449	0.76	+ 38%
2012	29,905	10,224,590	0.29	- 62%
2013	78,875	30,544,759	0.26	- 10%
2014	66,161	28,714,119	0.23	-12%
2015	56,237	27,989,832	0.20	-13%
2016	28,945	28,122,678	0.10	-50%

SRBT was once again able to achieve an overall reduction in the amount of tritium emitted from the facility for every unit of tritium processed; in 2016, this ratio was 17 times lower in 2016 than the ratio in 2008. Expressed differently, in 2016 SRBT released less than three-quarters of what was released in 2008 while processing nearly twelve times the amount of tritium.

4.3.2.2 Air Emission Target

SRBT set an annualized total tritium emission target at the beginning of 2016 of ≤ 1,000 GBq / week (averaged over the year), and was successful in meeting this target (557 GBq / week).

During the course of the calendar year, the weekly target was exceeded on only two occasions (Weeks 25 and 30). In 2015, the weekly target of 1,272 GBq / week was exceeded on nine occasions.

For calendar year 2017, SRBT has set a total tritium emission target of **747 GBq / week or less,** on average, based upon projected production increases and the value achieved in 2016.

The 2016 targeted tritium released to processed ratio of ≤ 0.19% for 2016 was achieved (0.10%).

4.3.2.3 Liquid Effluent

In 2016, SRBT operated well within release limits to sewer that are prescribed as part of the operating licence of the facility, as defined in Appendix E of the Licence Conditions Handbook[2].

TABLE 18: LIQUID EFFLUENT DATA (2016)

NUCLEAR SUBSTANCE AND FORM	LIMIT (GBq/YEAR)	RELEASED (GBq/YEAR)	% OF LIMIT
TRITIUM – WATER SOLUBLE	200	5.18	2.59%

Total liquid effluent releases in 2016 decreased when compared to 2015 values (5.18 GBq in 2016 vs. 6.5 GBq in 2015). This is likely due to several factors, including a continued reduction in the amount of failed leak tests of manufactured light sources, and process improvements leading to a lower tritium in air concentration during the summer, thus reducing the concentration of tritium in air conditioner and dehumidifier drain water.

Details on the past five years of liquid effluent data are provided below for ease of trend analysis:

TABLE 19: LIQUID EFFLUENT DATA (2012-2016)

NUCLEAR SUBSTANCE AND FORM	RELEASED 2012 (GBq)	RELEASED 2013 (GBq)	RELEASED 2014 (GBq)	RELEASED 2015 (GBq)	RELEASED 2016 (GBq)
TRITIUM – WATER SOLUBLE	12.0	9.1	12.5	6.5	5.18

Please refer to **Appendix P** for a complete data set of releases to sewer in calendar year 2016.

4.3.2.4 Liquid Effluent Target

SRBT set a total tritium release target at the beginning of 2016 of ≤ 7 GBq for the year, and was successful in meeting this target (5.18 GBq).

4.3.2.5 Action Level Exceedances

In 2016, there were no instances of an action level exceedance related to gaseous or liquid effluent monitoring at SRBT.

4.3.2.6 Summary of Field and Laboratory QA/QC

Effluent monitoring activities include several procedural steps that ensure acceptable quality assurance and control, including duplicate / triplicate sample acquisition and measurement, the use of process blanks, and the measurement of known reference standards as part of the assay of activity in collected sample media.

All QA/QC results obtained in 2016 were acceptable with no non-conformances were identified.

4.3.2.7 Statement of Uncertainties Inherent in Monitoring Results

Uncertainties associated with effluent monitoring at SRBT may be present at several points in the process.

For gaseous effluent, such uncertainties include: sampling representativeness, total airflow collected, catalytic efficiency of HT to HTO conversion, capture efficiency of sample media, standard measurement errors associated with liquid scintillation counting, sample acquisition errors such as volume of drawn sample for analysis, and errors in stack flow rate and differential pressure measurement.

For liquid effluent, such uncertainties include: sample volume, liquid effluent volume, standard measurement errors associated with liquid scintillation counting, and sample acquisition errors such as volume of drawn sample for analysis.

In order to ensure that the uncertainties inherent in monitoring results are kept acceptably low, SRBT ensures that a third party laboratory conducts independent verification procedures on the gaseous effluent monitoring system on an annual basis. Allowable deviation between the assessed measurement of gaseous emissions is +/- 30%; in 2016, results were well within this acceptance criteria.

The QA/QC processes associated with gaseous effluent monitoring contribute to the confidence in the results. This includes independent verification of the assessment of gaseous releases at several levels. As well, the data gathered from the EMP is assessed against the data from the gaseous effluent monitoring process on a frequent basis to verify that results are relatively consistent with each other.

For liquid effluent, uncertainties inherent in monitoring results are addressed by QA/QC processes associated with liquid effluent monitoring, as well as independent verification of the assessment of releases.

The inherent uncertainties associated with effluent monitoring are well within acceptable bounds when contrasted against the measured releases, and the licenced limits for releases by each pathway.

4.3.2.8 Supplementary Studies

In 2016, no supplementary studies were conducted relating to effluent monitoring at SRBT.

4.3.2.9 Hazardous Substance Releases to Air

In 2016 SRBT continued to make releases of hazardous substances to the air under a Certificate of Approval (Air), number 5310-4NJQE2[57], issued by the Ontario Ministry of the Environment in accordance with section 9 of the Ontario Environmental Protection Act.

4.3.3 Groundwater Monitoring

Based on our groundwater studies[58] and ensuing reports, SRBT maintains a comprehensive groundwater monitoring program as part of our overall Environmental Monitoring Program.

Groundwater data is reported to CNSC staff on a monthly basis, within 30 days of sampling, as required by Licence Conditions Handbook section 4.2, clause 2.

Dedicated, engineered sampling wells are used to establish tritium concentrations in the groundwater each month at various depths and in differing geologic strata. Variations are trended over time to measure the response of historical contamination of the local aquifer.

Since the program was established, groundwater measurements have been in very good agreement with established hydrogeological modelling predictions.

While most of the released tritium in the air is dispersed, some of it will reach the soil through dry and wet deposition. Infiltrated precipitation brings tritium into the groundwater below it. The deposition of tritium on and around the facility from air emissions and resulting soil moisture and standing water are the sole direct contributor to tritium found in groundwater.

Groundwater is affected by the percolation of soil moisture and standing water from the surface. Current concentrations in the wells are expected to gradually decrease once all historical emissions have flushed through the system and/or decayed with some influence of higher concentrations in nearby wells from lateral underground water flow.

This will be confirmed by continuous monitoring of the existing network of wells. The rate at which this decrease will occur is dependent on the level and speed of recharge of the groundwater on and around the SRBT facility.

In 2016, 399 samples of groundwater were obtained and analyzed, with all planned groundwater monitoring activities being accomplished, except for the following:

- 2 residential wells were not sampled as the resident was not home at the time sampling was attempted, and there was no access to an external source of well water. In both cases, a sample was successfully acquired the following month.
- 3 attempts at sampling business well B-1 were unsuccessful, as this office has undergone a change in occupancy, and on these three occasions, the office was closed for business or vacant.

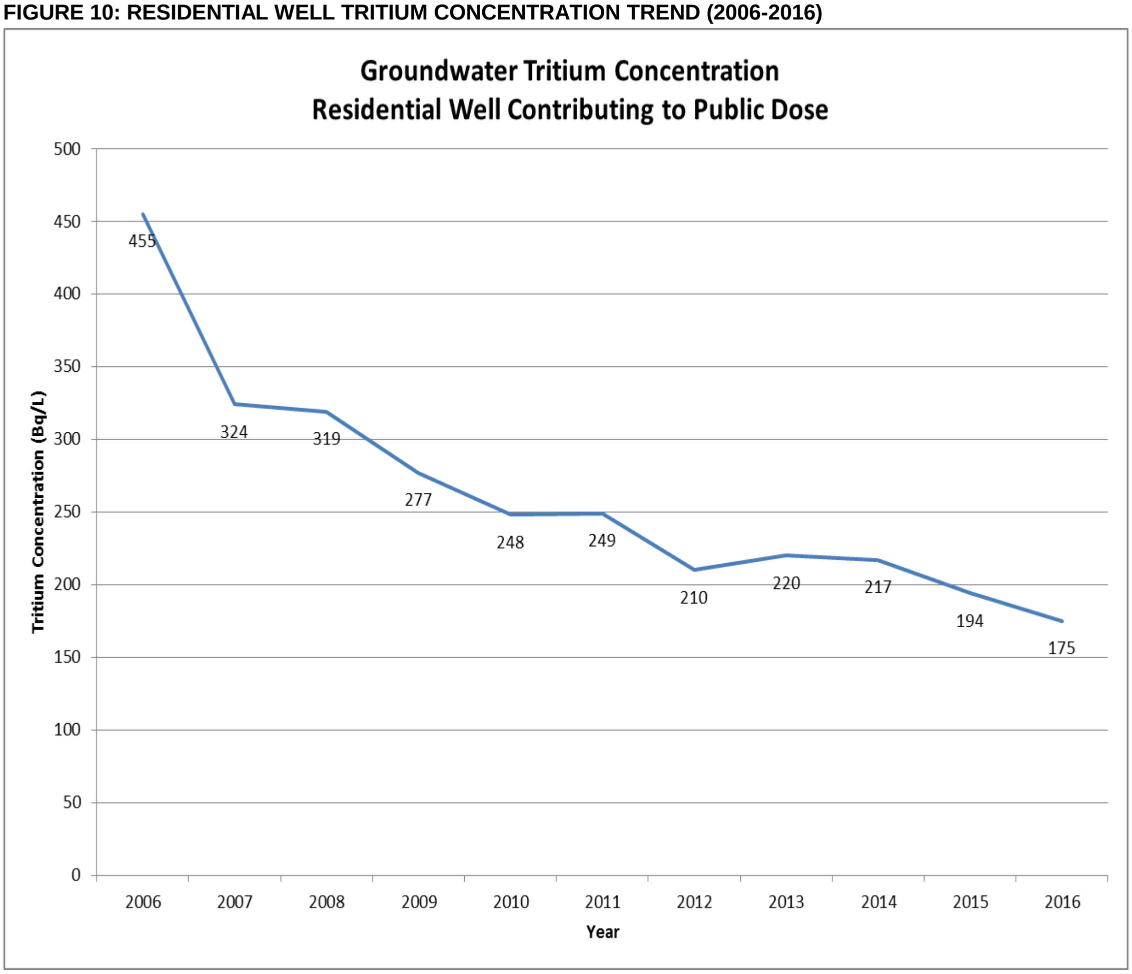
- 13 attempts at sampling CN wells failed either due to frozen conditions, a dry well, or snow burial.
- 6 instances of dry or frozen groundwater monitoring wells in the SRBT array resulted in a failure to acquire a sample.

4.3.3.1 Groundwater Tritium Concentration

In 2016 SRBT has continued to provide a compilation of the entire set of groundwater monitoring data to CNSC staff on a monthly basis. Well monitoring results can be found in **Appendix Q** of this report.

Several local residences permit SRBT to acquire samples three times annually, to provide additional data for our program. In 2016, the highest average residential well tritium concentration value was RW-08, measured at 175 Bq/L, a value that continues trend downward, and remains far below the Ontario Drinking Water Quality Standard of 7,000 Bq/L.

FIGURE 10: RESIDENTIAL WELL TRITIUM CONCENTRATION TREND (2006-2016)

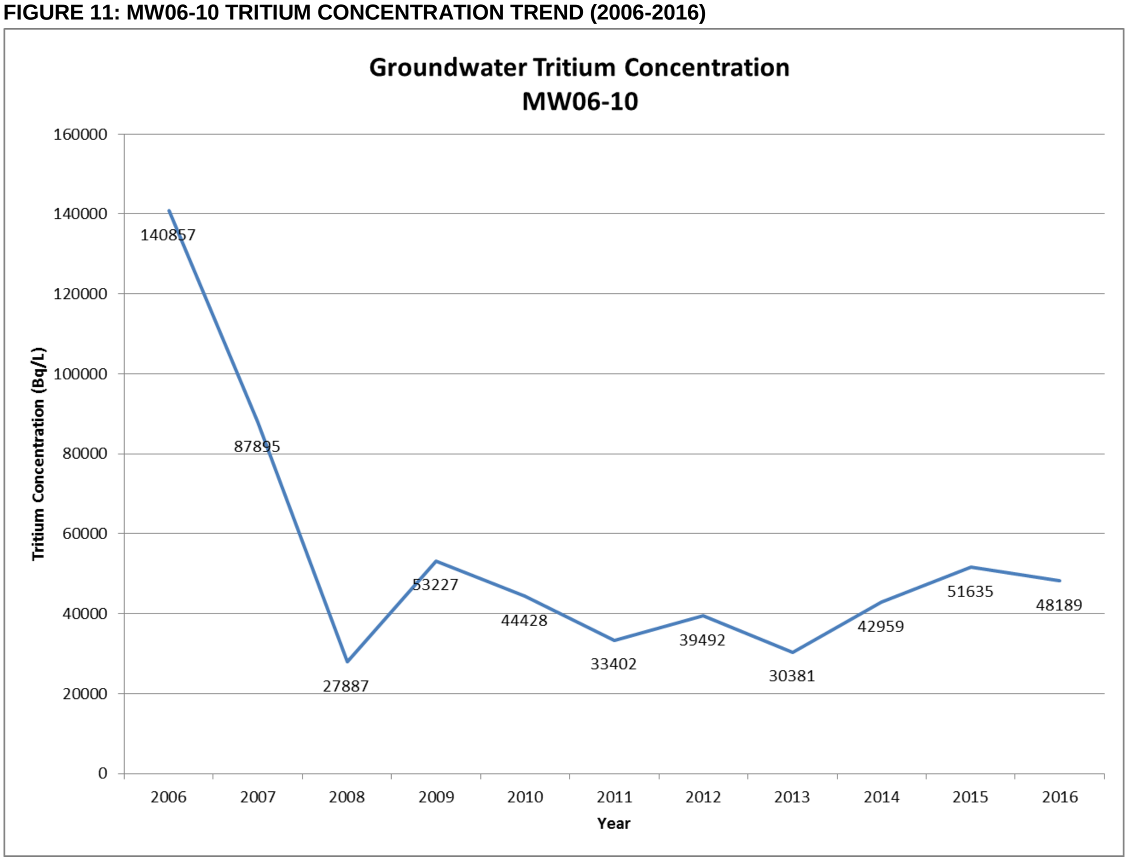


More importantly, public dose values attributed to groundwater consumption have decreased significantly over the past several years as a direct result of our efforts to minimize our environmental impact.

As of the end of 2016, the concentrations of two of the 34 non-residential groundwater monitoring wells surrounding the facility exceed the Ontario Drinking Water Guideline of 7,000 Bq/L. These two wells (MW06-10 and MW07-13) are located on the SRBT site within 50 meters of the stacks. In 2007, the concentration of 8 wells exceeded 7,000 Bq/L.

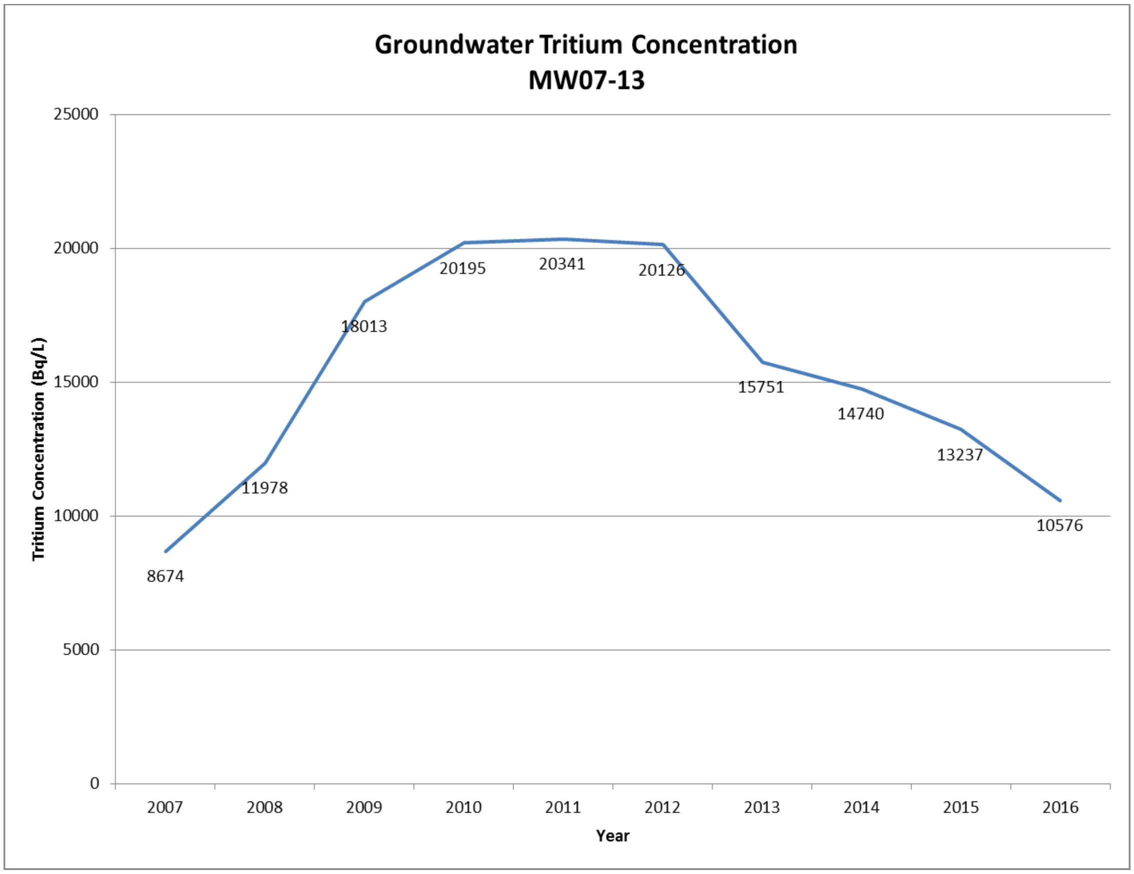
The highest average tritium concentration in any well remains in monitoring well MW06-10 which is located directly beneath the area where the stacks are located. The average concentration of tritium measured in MW06-10 declined slightly to 48,189 Bq/L, compared to the 2015 value of 51,635 Bq/L.

FIGURE 11: MW06-10 TRITIUM CONCENTRATION TREND (2006-2016)



The average concentration of MW07-13 in 2016 was 10,576 Bq/L, a decrease compared to the 2015 value of 13,237 Bq/L.

FIGURE 12: MW07-13 TRITIUM CONCENTRATION TREND (2007-2016)



Based upon the last three years, if current trends continue as expected, MW07-13 is projected to fall below the guideline value before the end of 2019.

The average concentrations in the vast majority of the monitoring wells continue to decrease since being drilled, a trend that is expected to continue over time. Only three of the dedicated, SRBT-installed groundwater monitoring wells exhibited an average tritium concentration that was higher in 2016 when compared with 2015:

- MW07-12 rose 6 Bq/L on average, from 463 Bq/L in 2015 to 469 Bq/L in 2016, a negligible difference (+1.2%).
- MW07-15 rose 130 Bq/L on average, from 1,680 Bq/L in 2015 to 1,810 Bq/L in 2016, a rise of 7.8%.
- MW07-32 rose 27 Bq/L on average, from 128 Bq/L in 2015 to 155 Bq/L in 2016, an increase of 21.2%.

The following table compares the 2015 and 2016 annual average tritium concentration of the 29 dedicated, SRBT-installed groundwater monitoring wells.

TABLE 20: 2015-16 AVERAGE TRITIUM CONCENTRATION IN ACTIVE MW

	2016 (Bq/L)	2015 (Bq/L)	2016 / 2015 (%)
MW06-1	2,753	4,338	63.5
MW06-2	1,467	1,965	74.7
MW06-3	1,029	1,218	84.5
MW06-8	848	906	93.6
MW06-9	2,476	2,731	90.7
MW06-10	48,189	51,635	93.3
MW07-11	1,344	1,521	88.4
MW07-12	469	463	101.2
MW07-13	10,576	13,237	79.9
MW07-15	1,810	1,680	107.8
MW07-16	1,879	2,188	85.9
MW07-17	602	780	77.2
MW07-18	3,690	5,491	67.2
MW07-19	2,500	3,222	77.6
MW07-20	670	775	86.4
MW07-21	1,009	1,121	90.0
MW07-22	1,131	1,171	96.6
MW07-23	1,929	2,206	87.4
MW07-24	2,206	2,314	95.3
MW07-26	1,491	1,941	76.8
MW07-27	4,292	4,869	88.1
MW07-28	1,311	1,446	90.7
MW07-29	3,395	3,950	86.0
MW07-31	440	756	58.2
MW07-32	155	128	121.2
MW07-34	2,822	3,312	85.2
MW07-35	3,448	3,945	87.4
MW07-36	2,618	2,892	90.5
MW07-37	989	1,009	98.0
	Average 2016 vs. 2015 (%)		87.0

4.3.3.2 Groundwater Level Measurements

The water levels are measured in monitoring wells on a monthly basis prior to purge and sampling. Analysis of this data shows consistent trends from year to year when comparing season to season.

A compilation of groundwater level measurements for 2016 can be found in **Appendix R** of this report.

4.3.3.3 Summary of Field and Laboratory QA/QC

Field and laboratory operations pertaining to groundwater monitoring conducted by the independent third party laboratory include several quality assurance and quality control activities.

Field QA/QC activities include duplicate sampling of certain wells, and the use of trip / method blanks for each type of sample obtained in the field.

Laboratory QA/QC activities include tritium spiking of certain collected samples and blanks, as well as laboratory reference standards for low and high activity concentrations. Sample QC is tested using spike recovery and relative percent difference tests.

In 2016 there were no reported non-conformances relating to groundwater monitoring field and laboratory QA/QC activities, and none were raised by SRBT after further assessment of raw data from the independent laboratory.

4.3.3.4 Statement of Uncertainties Inherent in Monitoring Results

Uncertainties associated with SRBT groundwater monitoring may be present at certain points in the process.

The main uncertainties relate to standard measurement errors associated with liquid scintillation counting, and sample acquisition errors such as volume of drawn sample for analysis. In order to ensure that the uncertainties inherent in groundwater monitoring results are kept acceptably low, SRBT ensures that the third party laboratory includes all QA/QC data associated with the monitoring as part of the final reports provided.

In addition, during five sampling months in 2016, SRBT contracted an additional independent laboratory to perform samples of groundwater in duplicate. Results between the two laboratories continued to be very similar, and well within expectations considering the uncertainties that may impact the final result.

SRBT also performed an intercomparison sampling and analysis activity with our primary contracted third party in November. Ten wells were sampled and measured by SRBT, with results averaging 100.9% of those obtained by the contracted service provider; we plan to expand on this practice in 2017.

The inherent uncertainties associated with groundwater monitoring are well within acceptable bounds when contrasted against the tritium concentrations that may present an unacceptable risk to the public.

4.3.3.5 Supplementary Studies

In 2016, staff and students with the department of Earth and Environmental Sciences with the University of Ottawa contacted SRBT with a proposal to study the measurement of Helium-3 (He-3), ingrown as the progeny of the tritium decay reaction, as a tool to quantify the rate of migration of a tritium plume, and to predict its potential time of impact on local surface waters.

This innovative proposal was accepted by SRBT in the fall of 2016, and work began shortly thereafter in partnership with university representatives.

Gas collecting diffusion samplers were installed at the bottom of twenty dedicated SRBT groundwater monitoring wells on the perimeter of the facility property. After a period of residence, the samplers were removed and taken back to the university. The captured gas was analyzed using the University of Ottawa Helix Split Flight Tube Noble Gas Mass Spectrometer for tritiogenic He-3.

University representatives have continued to analyze the data generated from this experiment, in the hopes of determining the rate of movement of the tritium plume, and comparing previously obtained tritium concentrations to model the tritium plume over time.

SRBT supported this work by providing access to the wells, as well as data on our gaseous emissions, historical groundwater concentration data, and information pertaining to the geological characteristics of the earth surrounding the facility.

The results of the study are to be presented at the Prospectors and Developers Association of Canada (PDAC) / Society of Economic Geologists (SEC) Student Mineral Colloquium in March of 2017.

4.3.3.6 Data Quality, Performance and Acceptance Criteria

Overall, the quality of data gathered as part of SRBT groundwater monitoring activities is successful in ensuring a high level of performance in monitoring, and in demonstrating that acceptance criteria (such as the limits on dose to the public) continue to be met.

4.3.3.7 Program Objectives and Conceptual Site Model

The overall objective of the continued groundwater monitoring activities conducted by SRBT is to assess and evaluate the effects of SRBT operations on the local groundwater resources, and ultimately to determine if the risk to the environment and the public from SRBT operations remains acceptably low.

Only two wells monitored on a regular basis exceed the Ontario Drinking Water Guideline value of 7,000 Bq/L. Both of these wells are dedicated, engineered groundwater monitoring wells very near to the facility, and are not available to be used as a source of water consumption.

The highest average concentration in a residential well continues to show a trend downward over time.

SRBT concludes that the comprehensive array of groundwater monitoring activities conducted continue to meet objectives and expectations.

4.3.4 Other Monitoring

On occasion SRBT conducts monitoring of other environmental media in order to provide continued assurance of the safety of our operations.

4.3.4.1 Soil Monitoring

There were no instances of soil sampling in 2016. This analysis is not a routine component of the SRBT environmental protection program, and is typically performed when digging operations are conducted in proximity to the facility property.

4.3.4.2 Sludge Monitoring

In April 2016 and September 2016, SRBT collected samples of sludge cake from the Pembroke Pollution Control Centre.

All samples were collected and analyzed by an independent laboratory, with the September sample set being analyzed in duplicate by another independent laboratory for confirmation purposes.

The results obtained are tabled below:

TABLE 21: SLUDGE MONITORING

SAMPLE TYPE	APRIL 2016	SEPTEMBER 2016
FREE-WATER TRITIUM (Bq/L)	29 (+/-3)	25 (+/-3)
OBT FRESH WEIGHT (Bq/kg)	836 (+/-20)	301 (+/-5)

The sludge data does not enter into calculation of public dose; however, given the interest in the subject demonstrated by some stakeholders during the licence renewal process, SRBT has integrated sludge cake monitoring as part of the routine EMP activities. This monitoring will take place twice a year, in March and September of each year.

4.3.5 Public Dose

The calculation method used to determine the dose to the 'Critical Group' as defined in the SRBT Environment Monitoring Program (EMP) is described in the EMP document. All data and tables relating to the calculation of the dose to the public can be found in **Appendix S**.

For 2016, the dose has been calculated using the effective dose coefficients found in CSA Guideline N288.1-14[59].

TABLE 22: CSA GUIDELINE N288.1-14 EFFECTIVE DOSE COEFFICIENTS FOR H-3

AGE GROUP	EFFECTIVE DOSE COEFFICIENT – INHALATION (HTO) (μSv/Bq)	EFFECTIVE DOSE COEFFICIENT – INGESTION (HTO) (μSv/Bq)	EFFECTIVE DOSE COEFFICIENT – INGESTION (OBT) (μSv/Bq)
INFANT	8.0E-5	5.3E-5	1.3E-4
CHILD	3.8E-5	2.5E-5	6.3E-5
ADULT	3.0E-5	2.0E-5	4.6E-5

NOTE: The dose coefficients listed for inhalation are multiplied by 1.5 to take into account absorption.

The dose assessed for the Critical Group is a summation of:

- Tritium uptake from inhalation and absorption through skin at the place of residence and/or the place of work, ($P_{(i)19}$ and $P_{(e)19}$), and
- Tritium uptake due to consumption of well water (P_{29}), and
- Tritium uptake due to consumption of produce (P_{49}), and
- Tritium uptake due to consumption of dairy products (P_{59}).

Dose due to inhalation

The closest residence to SRBT is located by Passive Air Sampler NW250 approximately 240 meters from the point of release. The 2016 average concentration of tritium oxide in air at Passive Air Sampler NW250 has been determined to be **1.21 Bq/m^3**.

Three passive air samplers are located close to the SRBT facility and represent the tritium oxide in air ($P_{(i)19}$ and $P_{(e)19}$) concentrations for the critical group member (adult worker) at samplers 1, 2, and 13. The sampler indicating the highest tritium oxide in air concentration is used to calculate the P19 dose values while at work. The highest average result for 2016 for PAS # 1, PAS # 2, and PAS # 13 is **3.30 Bq/m^3** at PAS # 1.

Using the following inhalation rates coefficients found in CSA Guideline N288.1-14[60] and assuming 2,080 hours (23.744%) of work per year with 6,680 hours (76.256%) at home for a total of 8,760 hours per week:

TABLE 23: CSA GUIDELINE N288.1-14 INHALATION RATES

AGE GROUP	INHALATION RATE (m^3/a)
INFANT	2,740
CHILD	7,850
ADULT	8,400

$P_{(i)19}$: Adult worker dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler taken as representing the place of residence for the defined critical group equals 1.21 Bq/m^3.

$$P_{(i)19r} = [\text{H-3}_{air}]\ (\text{Bq/m}^3) \times \text{Resp. Rate}\ (\text{m}^3/\text{a}) \times \text{Occup. Factor} \times DCF_{H3}\ (\mu\text{Sv/Bq})$$
$$= 1.21\ \text{Bq/m}^3 \times 8{,}400\ \text{m}^3/\text{a} \times 0.76256 \times 3.0\text{E-}05\ \mu\text{Sv/Bq}$$
$$= 0.233\ \mu\text{Sv/a}$$

$P_{(i)19}$: Adult worker dose due to HTO inhaled at work

Taking the highest concentration between Passive Air Samplers #1, #2, and #13 is Passive Air Samplers #13 at 3.30 Bq/m^3.

$$P_{(i)19w} = [\text{H-3}_{air}]\ (\text{Bq/m}^3) \times \text{Resp. Rate}\ (\text{m}^3/\text{a}) \times \text{Occup. Factor} \times DCF_{H3}\ (\mu\text{Sv/Bq})$$
$$= 3.30\ \text{Bq/m}^3 \times 8{,}400\ \text{m}^3/\text{a} \times 0.23744 \times 3.0\text{E-}05\ \mu\text{Sv/Bq}$$
$$= 0.197\ \mu\text{Sv/a}.$$

$P_{(i)19}$: Adult resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined critical group equals 1.21 Bq/m^3:

$$\mathbf{P_{(i)19}} = [H\text{-}3_{air}]\ (Bq/m^3) \times \text{Resp. Rate}\ (m^3/a) \times DCF_{H3}\ (\mu Sv/Bq)$$
$$= 1.21\ Bq/m^3 \times 8{,}400\ m^3/a \times 3.0E\text{-}05\ \mu Sv/Bq$$
$$= 0.305\ \mu Sv/a$$

$P_{(i)19}$: Infant resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined critical group equals 1.21 Bq/m^3:

$$P_{(i)19} = [H\text{-}3_{air}]\ (Bq/m^3) \times \text{Resp. Rate}\ (m^3/a) \times DCF_{H3}\ (\mu Sv/Bq)$$
$$= 1.21\ Bq/m^3 \times 2{,}740\ m^3/a \times 8.0E\text{-}05\ \mu Sv/Bq$$
$$= 0.265\ \mu Sv/a$$

$P_{(i)19}$: Child resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined critical group equals 1.21 Bq/m^3:

$$P_{(i)19} = [H\text{-}3_{air}]\ (Bq/m^3) \times \text{Resp. Rate}\ (m^3/a) \times DCF_{H3}\ (\mu Sv/Bq)$$
$$= 1.21\ Bq/m^3 \times 7{,}850\ m^3/a \times 3.8E\text{-}05\ \mu Sv/Bq$$
$$= 0.361\ \mu Sv/a$$

Dose due to skin absorption

Beginning with the 2016 ACR, dose due to skin absorption is wholly accounted for by the application of modified inhalation dose conversion factors applied above.

Please see CSA N288.1-14, Table C.1 footnotes for details on the modification of dose conversion factors to account for skin absorption.

Dose due to consumption of well water

The tritium uptake due to consumption of well water is calculated by taking the average tritium concentration of the water sampled.

Using the following annual consumption rates (at the 95th percentile) found in CSA Guideline N288.1-14[61]:

TABLE 24: CSA GUIDELINE N288.1-14 WATER CONSUMPTION RATES

AGE GROUP	WELL WATER CONSUMPTION RATE (L/a)
INFANT	305.7
CHILD	482.1
ADULT	1,081.1

The highest concentration in a residential well used as the sole source of the drinking water is found in RW-8 at **175 Bq/L** and will therefore be used in the calculation of the public dose.

P_{29}: Adult dose due to consumption of well water

$$P_{29} = [H\text{-}3]_{well} \times M \times 2.0E\text{-}05\ \mu Sv/Bq;$$
$$= [175\ Bq/L] \times 1{,}081.1\ L/a \times 2.0E\text{-}05\ \mu Sv/Bq$$
$$= 3.784\ \mu Sv/a$$

P_{29}: Infant dose due to consumption of well water

$$P_{29} = [H\text{-}3]_{well} \times M \times 5.3E\text{-}05\ \mu Sv/Bq;$$
$$= [175\ Bq/L] \times 305.7\ L/a \times 5.3E\text{-}05\ \mu Sv/Bq$$
$$= 2.835\ \mu Sv/a$$

P_{29}: Child dose due to consumption of well water

$$P_{29} = [H\text{-}3]_{well} \times M \times 2.5E\text{-}05\ \mu Sv/Bq;$$
$$= [175\ Bq/L] \times 482.1\ L/a \times 2.5E\text{-}05\ \mu Sv/Bq$$
$$= 2.109\ \mu Sv/a$$

Dose due to consumption of produce

The tritium uptake due to consumption of produce, both locally purchased and home grown is calculated by taking the average tritium concentration of produce purchased from the local market and consuming 70% of the annual total and by taking the average tritium concentration from local gardens and consuming 30% of the annual total. These fractions are based upon the site-specific survey conducted in 2005, which determined that the home-grown fraction of plant products consumed by residents in the surrounding area was approximately 30% - a slightly higher value than those recommended in the generic guidance of N288.1-14 (20-25%).

Using the following annual consumption rates for produce found in CSA Guideline N288.1-14[62]:

TABLE 25: CSA GUIDELINE N288.1-14 PRODUCE CONSUMPTION RATES

AGE GROUP	FRUIT CONSUMPTION RATE (Kg/a)	ABOVE-GROUND VEGETABLES CONSUMPTION RATE (Kg/a)	ROOT VEGETABLES CONSUMPTION RATE (Kg/a)	TOTAL CONSUMPTION RATE (Kg/a)
INFANT	76.6	36.1	12.1	124.8
CHILD	124.4	97.6	43.2	265.2
ADULT	149.2	192.3	71.8	413.3

The average tritium concentration in produce purchased from the sampled market in 2016 was **7.7 Bq/kg**, while the average concentration in produce from a local garden in 2016 was **94 Bq/kg** at 413 Sweezy Court.

Historically the average concentration of all produce in all gardens was used but it was determined that using the garden with the highest average concentrations would be more conservative.

P_{49}: Adult dose due to consumption of produce (HTO)

$$\mathbf{P_{49HTO}} = [[\mathbf{H_{prod,market}}] + [\mathbf{H_{prod,res}}]] \times 2.0E\text{-}05\ \mu Sv/Bq$$
$$= [[H\text{-}3_{veg}]\ (Bq/kg) \times (kg) \times 0.7] + [H\text{-}3_{veg}]\ (Bq/kg) \times (kg) \times 0.3]] \times 2.0E\text{-}5\ \mu Sv/Bq$$
$$= [[7.7\ Bq/kg \times 413.3\ kg/a \times 0.7] + [94\ Bq/kg \times 413.3\ kg/a \times 0.3]] \times 2.0E\text{-}05\ \mu Sv/Bq$$
$$= [[2{,}228\ Bq/a] + [11{,}655\ Bq/a]] \times 2.0E\text{-}05\ \mu Sv/Bq$$
$$= 0.278\ \mu Sv/a$$

P_{49}: Infant dose due to consumption of produce (HTO)

$$
\begin{aligned}
\mathbf{P_{49HTO}} &= [[\mathbf{H_{prod,market}}] + [\mathbf{H_{prod,res}}]] \times 5.3\text{E-05 } \mu Sv/Bq \\
&= [[\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.7] + [\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.3]] \times 5.3\text{E-5 } \mu Sv/Bq \\
&= [[7.7 \text{ Bq/kg} \times 124.8 \text{ kg/a} \times 0.7] + [94 \text{ Bq/kg} \times 124.8 \text{ kg/a} \times 0.3]] \times 5.3\text{E-05 } \mu Sv/Bq \\
&= [[673 \text{ Bq/a}] + [3{,}519 \text{ Bq/a}]] \times 5.3\text{E-05 } \mu Sv/Bq \\
&= 0.222 \ \mu Sv/a
\end{aligned}
$$

P_{49}: Child dose due to consumption of produce (HTO)

$$
\begin{aligned}
\mathbf{P_{49HTO}} &= [[\mathbf{H_{prod,market}}] + [\mathbf{H_{prod,res}}]] \times 2.5\text{E-05 } \mu Sv/Bq \\
&= [[\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.7] + [\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.3]] \times 2.5\text{E-5 } \mu Sv/Bq \\
&= [[7.7 \text{ Bq/kg} \times 265.2 \text{ kg/a} \times 0.7] + [94 \text{ Bq/kg} \times 265.2 \text{ kg/a} \times 0.3]] \times 2.5\text{E-05 } \mu Sv/Bq \\
&= [[1{,}429 \text{ Bq/a}] + [7{,}479 \text{ Bq/a}]] \times 2.5\text{E-05 } \mu Sv/Bq \\
&= 0.223 \ \mu Sv/a
\end{aligned}
$$

SRBT directly monitored organically bound tritium (OBT) concentrations in various produce types – tomatoes and carrots in two separate residential gardens, and tomatoes from the commercial market garden. The average OBT concentration from the residential produce was measured as 8.5 Bq/kg, while for the commercial produce a value of 2 Bq/kg was measured.

P_{49}: Adult dose due to consumption of produce (OBT)

$$
\begin{aligned}
\mathbf{P_{49OBT}} &= [[\mathbf{H_{prod,market}}] + [\mathbf{H_{prod,res}}]] \times 4.6\text{E-05 } \mu Sv/Bq \\
&= [[\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.7] + [\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.3]] \times 4.6\text{E-5 } \mu Sv/Bq \\
&= [[2 \text{ Bq/kg} \times 413.3 \text{ kg/a} \times 0.7] + [8.5 \text{ Bq/kg} \times 413.3 \text{ kg/a} \times 0.3]] \times 4.6\text{E-05 } \mu Sv/Bq \\
&= [[579 \text{ Bq/a}] + [1{,}054 \text{ Bq/a}]] \times 4.6\text{E-05 } \mu Sv/Bq \\
&= 0.075 \ \mu Sv/a
\end{aligned}
$$

P_{49}: Infant dose due to consumption of produce (OBT)

$$
\begin{aligned}
\mathbf{P_{49OBT}} &= [[\mathbf{H_{prod,market}}] + [\mathbf{H_{prod,res}}]] \times 1.3\text{E-4 } \mu Sv/Bq \\
&= [[\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.7] + [\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.3]] \times 1.3\text{E-4 } \mu Sv/Bq \\
&= [[2 \text{ Bq/kg} \times 124.8 \text{ kg/a} \times 0.7] + [8.5 \text{ Bq/kg} \times 124.8 \text{ kg/a} \times 0.3]] \times 1.3\text{E-4 } \mu Sv/Bq \\
&= [[175 \text{ Bq/a}] + [318 \text{ Bq/a}]] \times 1.3\text{E-4 } \mu Sv/Bq \\
&= 0.064 \ \mu Sv/a
\end{aligned}
$$

P_{49}: Child dose due to consumption of produce (OBT)

$$
\begin{aligned}
\mathbf{P_{49OBT}} &= [[\mathbf{H_{prod,market}}] + [\mathbf{H_{prod,res}}]] \times 6.3\text{E-5 } \mu Sv/Bq \\
&= [[\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.7] + [\text{H-3}_{veg}] (Bq/kg) \times (kg) \times 0.3]] \times 6.3\text{E-5 } \mu Sv/Bq \\
&= [[2 \text{ Bq/kg} \times 265.2 \text{ kg/a} \times 0.7] + [8.5 \text{ Bq/kg} \times 265.2 \text{ kg/a} \times 0.3]] \times 6.3\text{E-5 } \mu Sv/Bq \\
&= [[371 \text{ Bq/a}] + [676 \text{ Bq/a}]] \times 6.3\text{E-5 } \mu Sv/Bq \\
&= 0.066 \ \mu Sv/a
\end{aligned}
$$

P_{49}: Adult dose due to consumption of produce (HTO + OBT)

$$
\begin{aligned}
\mathbf{P_{49}} &= \mathbf{P_{49HTO}} + \mathbf{P_{49OBT}} \\
&= 0.278\ \mu Sv/a + 0.075\ \mu Sv/a \\
&= 0.353\ \mu Sv/a
\end{aligned}
$$

P_{49}: Infant dose due to consumption of produce (HTO + OBT)

$$
\begin{aligned}
\mathbf{P_{49}} &= \mathbf{P_{49HTO}} + \mathbf{P_{49OBT}} \\
&= 0.222\ \mu Sv/a + 0.064\ \mu Sv/a \\
&= 0.286\ \mu Sv/a
\end{aligned}
$$

P_{49}: Child dose due to consumption of produce (HTO + OBT)

$$
\begin{aligned}
\mathbf{P_{49}} &= \mathbf{P_{49HTO}} + \mathbf{P_{49OBT}} \\
&= 0.223\ \mu Sv/a + 0.066\ \mu Sv/a \\
&= 0.289\ \mu Sv/a
\end{aligned}
$$

Dose due to consumption of local milk

The tritium uptake due to consumption of milk, from a local producer and distributor is calculated by taking the average tritium concentration of the milk sampled.

Using the following annual milk consumption rates found in CSA Guideline N288.1-14[62]:

TABLE 26: CSA GUIDELINE N288.1-14 MILK CONSUMPTION RATES

AGE GROUP	MILK CONSUMPTION RATE (kg/a)
INFANT	339.9
CHILD	319.6
ADULT	188.5

The average concentration in milk being 3.333 Bq/L but adjusting for the density of milk 3.333 Bq/L x 0.97 L/kg = **3.233 Bq/kg**.

P_{59}: Adult dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 2.0E-05 µSv/Bq;
= [3.233 Bq/kg] x 188.5 kg/a x 2.0E-05 µSv/Bq
= 0.012 µSv/a

P_{59}: Infant dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 5.3E-05 µSv/Bq;
= [3.233 Bq/kg] x 339.9 kg/a x 5.3E-05 µSv/Bq
= 0.058 µSv/a

P_{59}: Child dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 5.3E-05 µSv/Bq;
= [3.233 Bq/kg] x 319.6 kg/a x 2.5E-05 µSv/Bq
= 0.026 µSv/a

Critical group annual dose due to tritium uptake based on EMP

Based on the EMP results and the coefficients and parameters taken from N288.1-14[59,60,61,62], the annual dose (P_{total}) due to tritium uptake from inhalation and skin absorption, consumption of local produce, local milk and well water equates to a conservatively calculated maximum of **4.579 µSv** for an adult worker of the critical group in 2016 compared to 6.840 µSv in 2015, and 6.738 µSv in 2014 (note: 2014 and earlier calculations were performed using parameters and coefficients found in the 2008 version of N288.1).

TABLE 27: 2016 CRITICAL GROUP ANNUAL DOSE BASED ON EMP

DOSE CONTRIBUTOR		ADULT WORKER ANNUAL DOSE (µSv/A)	ADULT RESIDENT ANNUAL DOSE (µSv/A)	INFANT RESIDENT ANNUAL DOSE (µSv/A)	CHILD RESIDENT ANNUAL DOSE (µSv/A)
DOSE DUE TO INHALATION and ABSORPTION AT WORK	$P_{(I)19}$	0.197	N/A	N/A	N/A
DOSE DUE TO INHALATION and ABSORPTION AT RESIDENCE	$P_{(I)19}$	0.233	0.305	0.265	0.361
DOSE DUE TO CONSUMPTION OF WELL WATER	P_{29}	3.784	3.784	2.835	2.109
DOSE DUE TO CONSUMPTION OF PRODUCE	P_{49}	0.353	0.353	0.286	0.289
DOSE DUE TO CONSUMPTION OF MILK	P_{59}	0.012	0.012	0.058	0.026
2016 PUBLIC DOSE	P_{TOTAL}	**4.579**	4.454	3.444	2.785

Statement of Uncertainties in Calculation of Public Dose:

All parameters taken from N288.1-14 are at the 95th percentile where available. Actual ingestion and inhalation rates are likely to be lower for most of the population. Calculated doses are likely to be significantly higher than actual doses to critical group members as a result.

4.3.6 Program Effectiveness

SRBT environmental protection programs have continued to be effective in measuring tritium in the environment and at ensuring the prevention of unreasonable risk to the environment.

A total of 40 passive air samplers (PAS) are located throughout a two kilometer radius from the SRBT facility, in eight sectors, ranging in distance at 250, 500, 1,000, and 2,000 meters. Our passive air sampler system is effective and provides the full extent of tritium concentrations in air resulting from the emissions from the facility and in turn effective at providing real data to accurately estimate the dose to a member of the critical group resulting from the emissions from the facility.

The percentage decrease of HTO emissions (a reduction of approximately 46%) correlates very well with the observed decrease in cumulative average of all PAS data (-40%), suggesting excellent correlation between these two parameters.

Total air emissions in 2016 decreased by nearly 49% of what they were in 2015, while tritium processed in fact increased very slightly. This is indicative of continued success in reducing process-based emissions as part of SRBT’s Emissions Reduction Initiative.

Our groundwater monitoring system is effective at providing the full extent of tritium concentrations in groundwater resulting from the emissions from the facility and in turn effective at providing real data to accurately estimate the dose to a member of the critical group resulting from the emissions from the facility.

Our precipitation monitoring system is effective at monitoring soil moisture concentrations resulting from the emissions from the facility and in turn effective at providing real data to accurately estimate the future groundwater conditions resulting from the emissions from the facility.

Tritium concentrations in both milk and produce that are consumed by residents living near the facility are measured. This data is effective at providing the full extent of tritium concentrations in human food resulting from the emissions from the facility and in turn effective at providing real data to accurately estimate the dose to a member of the critical group resulting from the emissions from the facility.

4.3.7 Program Review and Audit Summary

In 2016, programs and processes relating to Environmental Protection were subjected to a comprehensive internal audit conducted in August, focused predominantly on SRBT’s EMP, effluent monitoring, and groundwater monitoring activities.

The audit resulted in one non-conformance being raised, and one opportunity for improvement being identified. The audit also identified that each of the identified issues in the 2015 audit had been addressed and closed.

The issues raised are described below, along with corrective actions taken to address each item:

TABLE 28: ENVIRONMENTAL PROTECTION NON-CONFORMANCE REPORTS

IDENTIFIER	FINDING	ACTION TAKEN
NCR-536	Documentation associated with the measurement of the physical level of groundwater in monitoring wells is not being properly controlled as obsolete forms are being used.	Personnel responsible for these activities were provided the correct forms to use.
OFI-207	Although the requirement is currently being met, there is an opportunity for improvement to include a review requirement and frequency directly in the ‘Licence Limits, Action Levels and Administrative Limits’ document to ensure that reviews are not overlooked.	The document was issued as revision E on November 14, 2014. It is next due for review and revision in 2019. Upon next revision in 2019 (or earlier if needed), the review requirement in the licence conditions handbook will be integrated into the text of the document.

4.3.8 CSA N288-series Gap Analysis

In 2015, SRBT undertook a gap analysis of the entire set of management system documentation associated with Environmental Protection against the available suite of CSA standards related to the subject. These standards included:

- CSA N288.4-10 – *Environmental monitoring at Class I nuclear facilities and uranium mines and mills*
- CSA N288.5-11 – *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.6-12 – *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*
- CSA N288.7-15 – *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*

The final gap analysis document was submitted to CNSC staff on January 15, 2016[45], with an associated action plan designed as a multi-year project of improvement and assessment of all aspects of environmental protection associated with our operations.

Comments from CNSC staff were received on March 31, 2016[46], which were subsequently dispositioned through a new revision of the gap analysis / action plan document. This was provided to CNSC staff on May 26, 2016[47], and the plan has continued to be executed since then. Major milestones were achieved in 2016, including:

- The revision and submission of a revised Environmental Monitoring Program (EMP) document which meets the requirements of N288.4-10.
- A new set of EMP procedures for all aspects of the program, including field sampling, laboratory analysis, data acceptance and quality control.
- The development and submission of a revised Derived Release Limits (DRL) document, developed as per the guidance of N288.1-14, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities.*
- The revision and submission of the overall Environmental Management System (EMS) document, in line with the guidance of regulatory document (REGDOC) 2.9.1, *Environmental Protection Policies, Programs and Procedures.*
- The development and submission of a new stand-alone Effluent Monitoring Program (EffMP) document which meets the requirements of N288.5-11, as well as the shifting of procedures into this program which used to be included in the Radiation Safety Operations procedure group.

4.3.9 Emission Reduction Initiatives

SRBT has committed to investing a significant percentage of annualized profits into researching, developing and implementing initiatives aimed at reducing the emission of tritium to the environment associated with our licenced activities.

In 2016, SRBT continued to allocate resources into several areas in order to adhere to this commitment and further reduce emissions. A description of these initiatives is provided here.

4.3.9.1 Remote Display and Alarm Units

In 2015-16, SRBT collaborated with a third party manufacturer of tritium monitoring equipment to design, develop and manufacture two dedicated remote display units (RDU) to be integrated into the gaseous effluent monitoring system (GEMS). The RDUs were installed in the processing areas of Zone 3, in order to display real-time tritium concentration data in both active ventilation systems.

Previous to the installation of this equipment, technician were required to look through a window and visually assess the data being displayed on the chart recorder outside of Zone 3 in order to determine the concentration of tritium in the active ventilation systems.

By providing the RDUs, technicians now can directly monitor the concentration as the processing is occurring, and respond immediately if an upset condition develops.

The RDUs are equipped with both audible and visual alarms, and a two-stage alarm function (low and high-level), and are tested quarterly with the rest of the system to ensure accurate function.

The equipment has performed very well, and has resulted in lower emissions by enabling a more effective and immediate response to abnormal tritium releases.

The RDUs were put into full service on June 2, 2016, and have performed very well ever since.

4.3.9.2 PUTT Valve Improvements

As part of the action plan associated with the exceedance of an action level in May 2015, SRBT conducted a review of the type of valves used on tritium traps, in consultation with the manufacturer of the current valve type, in order to determine if there were other valve types that could be used that would effectively reduce or eliminate leakage through the valve stem over time. The review determined that emissions could be effectively reduced by two measures.

In consultation with the manufacturer of these types of valves, a custom designed bellows-sealed model was produced. Beginning in January 2016, two valves were put into use and tested in order to ensure design and performance criteria were met. The new model of valve was accepted for full use by the Mitigation Committee on March 16, 2016 after a trial period of approximately two months where the valves exhibited excellent performance.

The change has resulted in significant reductions in gaseous emissions during processing, in worker dose, and has eliminated the possibility of packing failure during valve operation.

4.3.9.3 International Tritium Conference

Between April 17-22, 2016, the Manager of Health Physics and Regulatory Affairs attended the 11th International Conference on Tritium Science and Technology in Charleston, South Carolina. During the conference, several presentations and poster sessions focused on tritium management and control in various types of facilities were observed, as well as sessions on tritium behaviour in the environment.

The conference provided an excellent opportunity to network with other organizations that handle and process tritium for other purposes, such as fusion experimentation. Attending events such as the conference will ensure that SRBT continues to explore all reasonably possible avenues for optimizing our unique operations into the future, and for minimizing our impact on people and the environment.

4.4 SCA – Emergency Management and Fire Protection

As most potential hazards associated with the facility would result from fire, Emergency Management and Response for the facility are addressed by an extensive Fire Protection Program supported by an Emergency Plan.

4.4.1 Fire Protection

Various measures were taken at the facility in 2016 to improve fire safety. These activities included but were not limited to the following:

- A third party completed an addendum for the Fire Hazard Analysis for the extension at the facility;
- Fire Protection Program (FPP) was revised and re-formatted making the Fire Safety Plan a subset document of the FPP;
- Third party contractor completed a Site Condition Inspection at the facility (a detailed report was completed);
- The Pembroke Fire Department completed an inspection of the SRBT facility;
- Provided employee fire safety training session;
- Enhanced training for two Fire Protection committee members;
- Emergency responders received training at the SRBT facility; and
- Upgrades made to enhance fire protection and life safety in the facility.

4.4.1.1 Fire Protection Committee

In 2016, nine formal Fire Protection Committee meetings were held which resulted in the implementation of several improvements for fire protection and life safety at the facility. All Fire Protection Committee meeting minutes are kept on file.

One new member was added to the Fire Protection Committee in 2016. This new member is on the Workplace Health and Safety Committee at SRBT which requires working closely with the Fire Protection Committee.

Two Fire Protection Committee members are enrolled in a Fire Protection Program course provided at Algonquin College, Ottawa campus. The course content covers chemistry and physics of fires, building design for life safety, as well as other aspects of fire protection and up to date information on applicable building and fire codes.

4.4.1.2 Fire Protection Program and Procedures

The SRBT Fire Protection Program document was revised and re-formatted in 2016 making the Fire Safety Plan a subset document of the Fire Protection Program.

The following is a listing of the operating licence, and specific codes and standards that have been incorporated into the Fire Protection Program:

- Nuclear Substance Processing Facility Operating Licence (NSPFOL-13.00/2022),
- The Licence Conditions Handbook (LCH) associated with NSPFOL-13.00/2022,
- National Building Code of Canada, 2010,
- National Fire Code of Canada, 2010, and
- CSA Standard N393-13, *Fire Protection for Facilities That Process, Handle and Store Nuclear Substances*.

Five new Fire Protection Procedures were created and numerous upgrades and minor revisions were made to internal existing procedures to enhance fire protection and life safety at the facility, in line with our policy of continuous improvement.

4.4.1.3 Fire Hazards Analysis

On June 24, 2016 a qualified third party created an addendum for the SRBT Fire Hazard Analysis regarding a new extension at the SRBT facility. The addendum of the Fire Hazard Analysis was submitted to, and accepted by CNSC staff.

4.4.1.4 Maintenance of the Sprinkler System

In 2016 quarterly and annual maintenances were performed on the sprinkler system by a third party. In addition, a weekly check of various valves and line pressures were performed by trained SRBT staff. All records are kept on file.

4.4.1.5 Fire Protection Equipment Inspections

In 2016 in-house routine inspection, testing and maintenance was performed on all fire protection and life safety equipment at the SRBT facility on a daily, weekly, monthly and annual basis by trained staff.

Qualified third party contractors also performed routine inspection, testing and maintenance of fire protection and life safety equipment at the SRBT facility. Annual inspection, testing and maintenance include fire extinguishers, emergency lighting, the fire panel and sprinkler system.

4.4.1.6 Fire Extinguisher Training

Annual fire extinguisher training was provided to SRBT staff by the Pembroke Fire Department on September 23, 2016. Training records are maintained on file.

The training was conducted using an electronic simulator. The simulation is equivalent to extinguishing a Class A fire.

4.4.1.7 Fire Protection Committee Member Training

The Fire Protection Committee now includes two members that are volunteer firefighters for local fire departments.

They are provided with ongoing fire protection training from their departments and are also enrolled in a fire protection course at Algonquin College, Ottawa campus.

4.4.1.8 Fire Responder Training

Following an expansion to the SRBT facility and the addition of new volunteer fire responders to the Pembroke Fire Department, it was decided fire responder training would be required in 2016.

Two separate training sessions were held, one on October 4 the other on October 11, 2016. A total of twenty volunteer and full time fire responders participated in the training. SRBT provided the Pembroke Fire Department with radiation protection training and information about the possible risks associated with a fire emergency at the SRBT facility. Each fire responder was provided with an “Emergency Responder Radiation Safety Training” handout to keep.

4.4.1.9 Fire Alarm Drills

A total of eight in-house Fire Alarm Drills were conducted in 2016.

Following each fire drill, supervisory staff and other personnel complete a Fire Alarm Drill Report. Each report is reviewed by the Fire Protection Committee and actions are taken as required to enhance fire and life safety at the facility.

4.4.1.10 Fire Protection Consultant Inspection

In 2016 a qualified third party (PLC Fire Safety Solutions) was contracted to complete a Site Condition Inspection, in order to meet the operating licence requirements, including the requirements of CSA standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances*.

The scope of the inspection was to evaluate the SRBT facility for compliance with the applicable inspection, testing and maintenance requirements of our operating licence.

The following codes and standards were reviewed for applicability to the specific systems at SRBT:

- NFCC-2010, *National Fire Code of Canada*
- NBCC-2010, *National Building Code of Canada*
- CSA standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances*.

Following the inspection, PLC prepared a “Site Condition Inspection Report”, from which one minor finding was observed. The finding was rectified immediately following the handover of the report.

4.4.1.11 Pembroke Fire Department Inspection

The Pembroke Fire Department conducted a facility inspection to confirm compliance with the Ontario Fire Code on June 15, 2016. No items of non-compliance were noted in the report following the inspection.

4.4.2 Emergency Preparedness

Various measures were taken at the facility in 2016 to further improve emergency preparedness and emergency response measures.

4.4.2.1 Emergency Plan

The Emergency Plan was not revised in 2016; however, a revised version of the plan was drafted in 2016, and submitted to CNSC staff for acceptance on January 26, 2017.

The changes made were mostly administrative in nature, with no significant technical alterations to the planned response to an emergency situation, other than changes to address the last of the recommendations resulting from the emergency exercise conducted in February 2015.

4.4.2.2 Emergency Exercises

In 2016 SRBT did not conduct an emergency exercise. The last full scale emergency exercise was conducted in 2015. As per the Emergency Plan, SRBT conducts such exercises at least once every five years.

4.5 SCA – Waste Management

SRBT implements a Waste Management Program (WMP) that is aligned with the applicable requirements and guidelines in the following CSA Standards:

- CSA N292.0-14, *General principles for the management of radioactive waste and irradiated fuel*
- CSA N292.3-14, *Management of low- and intermediate-level radioactive waste*
- CSA N292.5-11, *Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances*

4.5.1 Radioactive Consignments – Waste

Seven shipments of "Low Level Waste" (LLW) were made in 2016.

Of the seven shipments, six included expired gaseous tritium light sources (January 26, March 29, May 10, July 5, September 13 and November 29). A total of 329 Type A packages of expired gaseous tritium light sources were generated in 2016.

Two of the seven shipments included waste materials generated by other processes, including used protective clothing, used equipment components, crushed glass, filters, broken lights and cleaning material.

The following table is provided as a summary of the low-level waste material that was generated and routed to a licenced waste management facility in 2016.

TABLE 29: RADIOACTIVE WASTE CONSIGNMENTS (2016)

DATE	CONSIGNOR	WASTE DESCRIPTION	QTY AND PACKAGE DESCRIPTION	TOTAL WEIGHT (Kg)	TOTAL ACTIVITY (TBq)
Jan. 26, 2016	CNL	LLW	60 x Type A Pkgs	240	1,416.60
		LLW	1 x 200 L Drums	70	0.46
		LLW	10 x UN2910 Boxes	210	0.10
Mar. 29, 2016	CNL	LLW	52 x Type A Pkgs	208	1,023.48
May 10, 2016	CNL	LLW	50 x Type A Pkgs	200	1,132.30
July 5, 2016	CNL	LLW	50 x Type A Pkgs	200	839.87
Aug. 10, 2016	CNL	LLW	2 x 200 L Drums	140	0.50
		LLW	14 x UN2910 Boxes	294	0.06
Sept. 13, 2016	CNL	LLW	64 x Type A Pkgs	256	1,112.05
Nov. 29, 2016	CNL	LLW	53 x Type A Pkgs	237	1,132.33

4.5.2 Storage of Radioactive Waste

Radioactive waste was stored on-site and inventory records of the waste were maintained. All packaged wastes were inspected monthly for potential off-gassing and container integrity.

4.5.2.1 Low-level Waste Interim Storage

Low-level waste (LLW) is any waste assessed as possessing activity levels that exceeds conditional clearance limits (for tritium), or in excess of the exemption quantities established in the Nuclear Substances and Radiation Devices Regulations (for all other radionuclides). Typical examples of such wastes are tritium-contaminated equipment or components, crushed glass, filters, broken lights, clean-up material, pumps, pump oil, etc.

LLW was collected in various sealed receptacles, assessed, and ultimately placed into approved containers in the Waste Storage Room within Zone 3. Once sufficient material was collected, it was prepared for transfer to a licensed waste handling facility, using approved processes.

TABLE 30: INTERIM STORAGE OF LOW-LEVEL WASTE

AMOUNT IN STORAGE AT YEAR END 2015	AMOUNT GENERATED THROUGHOUT 2016	TRANSFERRED OFF SITE 2016	AMOUNT IN STORAGE AT YEAR END 2016
1 x 200 L drums	+ 5 x 200 L drums	- 3 x 200 L drums	3 x 200 L drums
0.46 TBq	+ 0.53 TBq	- 0.96 TBq	0.03 TBq

4.5.2.2 Clearance-level Waste Interim Storage

Waste that is only minimally contaminated and is likely to meet accepted clearance criteria is classified as “Very Low-Level Waste” (VLLW). This classification is temporary, as ultimately VLLW is assessed and routed through one of two accepted disposal pathways – either as LLW or as clearance-level waste (CLW).

Examples of such materials are typically paper towels, gloves, disposable lab coats, shoe covers, etc. and was collected in various receptacles in the active areas of the facility, assessed, and ultimately placed into storage awaiting transfer or disposal.

Throughout 2016, the WMP clearance criteria applied to VLLW was 0.25 MBq/g, up to a maximum of 3 tonnes of cleared material per pathway.

Any VLLW that was assessed as being less than this criteria was routed through accepted CLW pathways, such as landfill or recycling.

The amount of CLW generated and stored in 2016 is tabulated below.

TABLE 31: INTERIM STORAGE OF CLEARANCE-LEVEL WASTE (LANDFILL)

AMOUNT IN STORAGE AT YEAR END 2015	AMOUNT GENERATED THROUGHOUT 2016	TRANSFERRED OFF SITE 2016	AMOUNT IN STORAGE AT YEAR END 2016
0 Kg	+1,293.80 Kg	-1,293.80 Kg	0 Kg
0 GBq	+33.53 GBq	-33.53 GBq	0 GBq

TABLE 32: INTERIM STORAGE OF CLEARANCE-LEVEL WASTE (PLASTIC RECYCLE)

AMOUNT IN STORAGE AT YEAR END 2015	AMOUNT GENERATED THROUGHOUT 2016	TRANSFERRED OFF SITE 2016	AMOUNT IN STORAGE AT YEAR END 2016
618.50 kg	+2,152.50 kg	-2,391.40 kg	379.60 kg
53.51 GBq	+80.74 GBq	-127.31 GBq	6.94 GBq

4.5.2.3 Hazardous Waste

SRBT conducted an internal audit of the Coating Room in 2016, where it was identified that the disposal methods of small amounts of waste zinc sulfide powder (typically called ‘phosphor’ powder) may be improved. Certain types of this material were noted to present a mild ecological hazard under certain conditions, if disposed of through conventional means.

After consulting with an independent third party, it was determined that the waste powder could be handled as a subject waste material in order to optimize handling and reduce risk to the environment. As a result, SRBT instituted a new process to govern how this waste is handled and disposed of.

Procedure WMP-004, *Process for Managing Waste Phosphor Powder* was implemented in September, at which time SRBT began routing the waste through a licenced hazardous waste management contractor. This waste is picked up quarterly, and disposed of in accordance with the requirements of the Ontario Ministry of Environment and Climate Change.

4.5.2.4 Soil from Groundwater Monitoring

Twelve drums of compacted soil collected from the drilling of groundwater monitoring wells in 2006-07 were assessed in 2016 as meeting unconditional clearance requirements with respect to tritium (i.e. less than 100 Bq/g). In addition, the material was also determined to meet the definition of non-hazardous solid waste through leachate analysis conducted by an independent, accredited laboratory specializing in soil analysis.

The drums were collected by a third party contractor for ultimate disposal as non-hazardous, unconditionally cleared material on February 18, 2016.

4.5.2.5 Waste Minimization

SRBT continues to minimize the generation of radioactive waste materials as part of our overall approach to waste management.

The Waste Management committee met three times through the year to review and discuss initiatives that could ultimately minimize the amount of radioactive waste routed to licenced waste management facilities.

Continued segregation of material prior to bringing items into active zones remains effective at reducing waste materials that require management. The implementation of Conditional Clearance Levels for waste materials has also been successful in reducing the amount of waste material that is needlessly disposed of as radioactive waste.

4.5.2.6 Expired Product Management

SRBT continues to offer return and disposal services to customers who possess expired tritium-illuminated devices, such as ‘EXIT’ signs.

In 2016, a total of 31,667 expired (or otherwise removed from service) self-luminous safety ‘EXIT’ type signs were accepted by SRBT from Canadian and American sources, representing a total activity of 5,853.75 TBq of tritium.

As well, an additional 702 TBq of tritium was accepted from international origins (i.e. other than Canada and the United States) in the form of expired tritium illuminated devices, such as aircraft signs, dials, gauges and other smaller equipment.

Expired signs are disassembled safely and the light sources removed, in order to ensure that the volume of low-level radioactive waste that is generated is minimized. The expired lights are then packaged and shipped to a licenced radioactive waste management service provider.

A small number of these signs were evaluated as being fit for service in other applications, or having light sources that could be reused in other self-luminous devices. This practice is the only re-use of the lights and the tritium associated with these lights, and would represent a very small fraction of the total light sources managed. SRBT no longer ‘reclaims’ tritium gas from expired or non-conforming light sources, and has not done so since 2007.

4.6 SCA – Security

SRB Technologies (Canada) Inc. implements an accepted Facility Security Program for the facility, in accordance with CNSC regulatory requirements and expectations.

SRBT did not experience any security-related events in 2016.

New staff members are required to qualify for a Facility Access Security Clearance (FASC), even if they are not expected to handle nuclear substances as part of their responsibilities. Individuals and contractors that visit the facility are required to also have an FASC or be escorted at all times by a staff member with a valid FASC.

Maintenance of the physical facility security system is performed by an independent third party at least every 6 months.

In 2016, SRBT implemented a system of identification badges as an improvement measure for facility security. Each employee, contractor and visitor is now issued a badge to be worn on their person at all times while within the facility. The badges include a radiofrequency identification tag to permit location monitoring within the facility, as well as a call button to send an alert to appropriate SRBT personnel in case of emergency.

4.7 SCA – Safeguards and Non-Proliferation

SRBT possesses, uses, stores and manages an extremely small quantity of depleted uranium, which is a controlled nuclear substance. Our inventory of depleted uranium inventory did not increase in 2016.

This material is used as storage media for tritium gas on our processing equipment, a well-understood and widely-used strategy for manipulating and storing tritium in its gaseous, elemental state. By using depleted uranium in this fashion, we can ensure that the quantity of gaseous tritium being used during any given processing operation is restricted. This helps to ensure that the consequences of any unplanned event are minimized with respect to radiation and environmental protection, by ensuring that any release of tritium is limited.

During 2016, the IAEA did not conduct verification activities of our inventory of this material, nor requested any information on this matter. As a licensee, and pursuant to the General Nuclear Safety and Control Regulations, SRBT is fully committed to ensure that we meet all applicable regulatory requirements relating to Canada’s obligations relating to nuclear non-proliferation and safeguards.

Should a safeguards verification activity be requested or conducted, or a request for information made by the IAEA, SRBT will provide all accommodation to the agency and CNSC Staff in order to satisfy our responsibilities in this safety and control area.

At the end of 2015, CNSC staff had completed a compliance inspection at SRBT focused on the import and export of shipments of tritium; a report was issued on January 20, 2016, and included four compliance directives and two recommendations. SRBT took action to address these non-compliances, resulting in closure of all but one directive on April 11, 2016. The final directive was addressed after incorporating CNSC staff comments on a submitted procedure revision, resulting in the closure of the inspection on May 5, 2016.

In September 2016, CNSC staff conducted a follow up inspection focused on SRBT processes that control and manage the import and export of tritium from the facility. The final inspection report was issued on October 3, 2016[16], and found that the actions taken by SRBT as a result of the December 2015 inspection had been implemented in satisfactorily. The report included one compliance directive, with SRBT taking immediate action to address this non-compliance, resulting in closure of the issue and the inspection report on October 25, 2016.

4.8 SCA – Packaging and Transport of Nuclear Substances

SRBT prepared, packaged and shipped all manufactured products containing nuclear substances in accordance with the *Packaging and Transport of Nuclear Substances Regulations.*

For the purpose of packaging and offering for transport, shipments of product designated as dangerous goods, SRBT must comply with the requirements of:

- CNSC
- IAEA
- International Air Transport Association (IATA)
- Transport Canada

The procedures used at SRBT are based on regulations and practices found in the following publications:

- Packaging and Transport of Nuclear Substances Regulations (PTNSR)
- IAEA Safety Standards Series - No. SSR-6
- Dangerous Goods Regulations (IATA)
- The TDG Compliance Manual: Clear Language Edition (Carswell)

Staff members involved with the packaging, offering for transport and receipt of dangerous goods are given Transportation of Dangerous Goods (TDG) training in accordance with the applicable regulations and are issued certificates by the employer.

In 2016, one “dangerous occurrence” (as per Section 35 of the PTNSR) occurred associated with packaging and transport of SRBT products to or from the facility. A trailer containing four skids of expired exit signs destined for our facility was stolen in southern Ontario, only to be recovered several weeks later with all items accounted for and undamaged. This event was reported to CNSC staff as required in the PTNSR; additional details can be found in section 4.8.3.

4.8.1 Outgoing Shipments

In total, 1,001 consignments were safely shipped to various customers located in 18 countries around the world, including Canada.

A table is provided comparing the amount of outgoing shipments of our products over the past five years.

TABLE 33: OUTGOING SHIPMENTS OF PRODUCT (2012-2016)

Year	2012	2013	2014	2015	2016
Number of Shipments*	367	744	1,122	1,150	1,001
Number of Countries	17	13	19	16	18

*Note – SRBT often ships single palletized shipments of safety signs to the US which subsequently get broken down into multiple sub-consignments. These types of shipments are counted as a single consignment for the purposes of this table.

All outgoing shipments were conducted in compliance with all regulatory requirements pertaining to the transport of dangerous goods and / or nuclear substances. All packages were assessed for surface contamination prior to being offered for transport as required by SRBT procedures.

Information pertaining to the number of monthly outgoing shipments containing radioactive material for 2016 can be found in **Appendix T** of this report.

4.8.2 Incoming Shipments

In total, 562 consignments of radioactive shipments were received from various customers located in 9 countries around the world, including Canada. These returns held a total activity of 6,737 TBq of tritium.

The vast majority of the returned, expired devices were in the form of expired 'EXIT' signs that were destined to have the expired light sources removed and sent for storage at a licenced waste management facility.

A table is provided comparing the amount of incoming shipments of radioactive products have been made over the past five years.

TABLE 34: INCOMING SHIPMENTS OF RADIOACTIVE PRODUCT (2012-2016)

Year	2012	2013	2014	2015	2016
Number of Shipments	25	204	467	598	562
Number of Countries	6	6	10	9	9

All incoming shipments were received safely and in acceptable condition. Incoming packages containing nuclear substances are assessed for tritium leakage upon receipt.

Information pertaining to the number of monthly received shipments containing radioactive material for 2016 can be found in **Appendix U** of this report.

4.8.3 Dangerous Occurrence

A shipment of expired tritium safety signs was in transit between the original consignor (SRB Technologies USA in Winston-Salem, North Carolina) and the consignee (SRB Technologies Canada in Pembroke, Ontario). The shipment, consisting of four pallets of expired signs (3,298 signs, averaging about 145 GBq of tritium each), left Winston-Salem on Tuesday, November 22, 2016, by road transport, and cleared customs on Thursday, November 24, 2016 under CNSC Import Licence IL-A1-5194.0/2020.

At approximately 0945h on Monday, November 28, the carrier of these goods informed SRBT by telephone that the trailer in which the shipment was being transported was stolen from the parking lot of a logistics company in Mississauga, Ontario sometime between 1600h on Saturday, November 26, 2016 and 0200 on Sunday, November 27, while awaiting further transport.

The carrier noted that the police had been notified of the theft of the trailer. The consignor was informed of the event within 30 minutes of SRBT being informed of the occurrence.

As defined in the Packaging and Transport of Nuclear Substances Regulations, this event meets the definition of a ‘Dangerous Occurrence’ in Section 35, (c), which states:

“…a dangerous occurrence is any of the following situations: radioactive material is lost, stolen or no longer in the control of a person who is required to have control of it under the Act.”

SRBT completed a preliminary report to CNSC staff through the Duty Officer the morning of November 28, and kept contact with the investigating officer through the following weeks as attempts were made to locate the trailer.

On December 15, 2016, SRBT was informed that the missing trailer had been located in Toronto, Ontario. The trailer was opened and inspected by the carrier and the police, in close consultation with SRBT. It was determined that all items containing nuclear substances destined for SRBT were present and accounted for, that it appeared that the shipment had not been tampered with, and remained in good condition for transport.

Once released to the carrier, the trailer was brought to Pembroke, Ontario with all goods on board. The shipment was assessed by members of the SRBT Health Physics Team on Monday, December 19, 2016, prior to taking receipt of the items. There was no evidence of any radiological hazard associated with the packages.

A full report was submitted to CNSC staff that same day with all pertinent details on the occurrence, and the report was posted on our website in accordance with our Public Information Program. CNSC accepted the report and notified SRBT that the file was closed on February 7, 2017.

5. Other Matters of Regulatory Interest

5.1 Public Information and Disclosure

This section of the report will provide public information initiatives taken in 2016.

5.1.1 Direct Interaction with the Public

Historically almost all public inquiries occur during re-licensing. In 2016, there were no public inquiries made, which is consistent with other non-relicensing years.

In 2016 we have sampled water from a number of wells belonging to the public every four months for tritium concentration. On a yearly basis we also sample produce from gardens belonging to members of the public for tritium concentration. We promptly provide each member of the public with a report of the sample results along with the anticipated radioactive exposure due to tritium from consuming either the water or produce. We provide members of the public a comparison of this exposure against the CNSC limit and against radioactive exposure from other known sources, such as cosmic radiation, x-rays, etc.

Plant tours have proven to be a useful tool for SRBT to reach the public. In 2016 we have provided plant tours to 27 members of the general public (compared with 51 in 2015) who had expressed interest in our facility. This number is very comparable to 2014 (28 tours) which was also a non-relicensing year.

In 2016 we provided plant tours to local representatives of:

- the Renfrew County Community Futures Development Corporation,
- the Business Development Bank of Canada,
- The City of Pembroke,
- the Pembroke Fire Department,
- the Ontario Provincial Police,
- Canadian Imperial Bank of Commerce (CIBC),
- Ontario Power Generation, and
- the Muskrat Watershed Council.

In 2016 as part of conducting our business in Pembroke we have also provided plant tours to local employee representatives of our existing and prospective suppliers of goods and/or services, including:

- Canadian Nuclear Laboratories,
- Canadawide Scientific, and
- University of Ottawa.

In 2016 we also provided plant tours to existing and prospective customers including:

- Isolite,
- FedDev, and
- Javelin.

TABLE 35: PLANT TOURS (2016)

	2016
GENERAL PUBLIC	27
LOCAL INSTITUTIONS	9
LOCAL SUPPLIERS	5
CUSTOMERS	3
TOTAL	**44**

Considering that SRBT did not receive any inquiries or concerns from the public during the calendar year, nor during the presentation of the annual regulatory oversight report at a public meeting held by the CNSC in Port Hope, Ontario on November 10, 2016, the Public Information Committee discussed and agreed to not have a presentation to Pembroke City Council in 2016, nor to initiate a public opinion survey in 2016 (though the survey is available on our website). These considerations will be revisited in 2017.

During 2016, the President of SRBT made several presentations to members of the public:

- On May 18, a presentation was made to the Rotary Club, including a question and answer session,
- On May 26 at the second annual Spring Business Leadership Conference in Pembroke, SRBT accepted the Business Innovation Award from Algonquin College, and the President gave a speech to attendees,

- On November 10, the President appeared on “Be My Guest”, a locally-produced television show, to discuss several topics.
- On November 30, a presentation was made during a Business Bistro meeting in Pembroke, including a question and answer session,
- The President of SRBT is also a member of the Pembroke Economic Development Advisory Committee, attending monthly meetings where SRBT was discussed on occasions.

5.1.2 Program Revision

Revision 9 of the Public Information Program (PIP) continues to demonstrate SRBT’s commitment to openness and transparency. In 2017, a review is planned to determine if changes or improvements to the PIP can be made; for example, the inclusion of non-local stakeholders may be considered considering the interest from this sector during the 2015 licence renewal process.

5.1.3 Program Audit

An internal audit of the PIP was conducted on September 20, 2016, with no non-conformances or opportunities for improvement being identified.

5.1.4 Public Information Committee

The Public Information Committee held five formal meetings in 2016, mostly consisting of our groundwater brochure, the general information brochure and pamphlet all updated on March 31, 2016 which all reflect the data in the 2015 Annual Compliance Report and subsequently posted on our website.

The committee also discussed press releases, letters sent to residences and businesses, funding the Muskrat Watershed Council, the CNSC public meeting, improvements made to the website, Emergency Response Personnel Training, Public Notifications and public perception. One or two new members were thought to be added to the committee throughout 2016 but due to lack of interest from the public this has not yet been pursued.

5.1.5 Website and Social Media

SRBT continues to operate a website at www.srbt.com, which continues to provide current environmental monitoring data, information about tritium, content on emergency preparedness, the safe transport of tritium to the facility and products from the facility, how to safely dispose of products, and the Licence and Licence Condition Handbook.

The main page provides a number of possible information sources for the public on tritium and radiation exposure. Several “Public Notifications” were posted on the website in 2016, including details on the fire extinguisher training and two reportable events, as well as the annual regulatory oversight report for our facility as presented by CNSC on November 10 in Port Hope. Three senior members of SRBT management attended the meeting in person, and were available to answer all questions directly.

SRBT has implemented a Facebook page, beginning in early 2015, which continues to post information of public interest on a frequent basis. SRBT also intends to initiate the use of Instagram and Twitter in the near future as part of an expanded social media presence.

5.1.6 Community Support

SRBT has supported the local community by providing support to various organizations and causes.

SRBT provided to funding commitments to the Muskrat Watershed Council (MWC) in support of the water quality monitoring data report, and ongoing work towards improving the health of the watershed. SRBT is one of the first gold-level corporate club members of the MWC.

SRBT is a member of the Algonquin College Radiation Safety Program Advisory Committee and for the second consecutive summer employed a student who graduated the Radiation Safety Program at Algonquin College.

In 2016, SRBT became title sponsor for Health Sciences division of the Renfrew County Regional Science and Technology Fair, where the first place project in the division went on to capture a gold medal in the Canada-wide Science fair.

SRBT supports the Main Street Community Services who provides research based programs for children with special needs.

SRBT supports causes such as Canadian Breast Cancer Foundation, Community Living Upper Ottawa Valley and Bernadette McCann House for Women.

SRBT also supported Festival Hall, the local community theater, a memorial golf tournament, and the ‘Ladders Up’ auction in support of the Canadian Fallen Firefighters Association. We also sponsor several sports teams and groups, including a local hockey team, fishing team, and a youth basketball skills development program.

SRBT supported the 11th annual Black and White Gala, which helps improvements to the Pembroke Regional Hospital. SRBT also supported the Zombie Thrill run in support of the Carefor Mental Health Wing.

5.2 Preliminary Decommissioning Plan and Financial Guarantee

The SRBT Preliminary Decommissioning Plan (PDP) and Financial Guarantee last underwent a significant revision in 2014-15 prior to licence renewal, and was accepted by the Commission on June 29, 2015 with the renewal of the SRBT operating licence for a period of seven years. The next revision of the PDP is scheduled for 2019.

The SRBT Financial Guarantee is a cash fund held in escrow, and does not rely on any letters of credit, bonds, insurance or other expressed commitments.

In 2015, third party consultants directly involved with the decommissioning of similar facilities determined that the projected decommissioning cost for the SRBT facility was $652,488. In order to ensure the financial guarantee was fully funded, a series of six equal installments were scheduled to be made over a three year period, beginning in October 2015, as part of the renewal of our operating licence.

In 2016, SRBT deposited both of the required installments[63,64]; $616,153 is currently held in escrow and building interest, with three installments remaining until the financial guarantee is fully funded in April 2018.

Historical annual inflationary indexes are typically below the annual accrued interest rate of the Escrow Account; as such, SRBT proposed that all accrued interest in the existing Escrow Account remain in that account and be used to address inflationary indexing.

6. Improvement Plans and Forecast

6.1 First Full Year of Implementation of New Management System

Since 2014, SRBT worked toward completing a comprehensive action plan[13] for transitioning to a management system that meets the requirements of CSA Standard N286-12, *Management system requirements for nuclear facilities.*

Throughout 2016, progress continued to be steady and to meet expectations and target dates. Frequent project meetings were held in order to drive forward with the project deliverables, and to address any issues or problems in achieving the ultimate goal of the plan.

In March[12], July[13] and December[14], SRBT furnished comprehensive updates to CNSC staff on the status of the project. No significant comments or concerns were received regarding either of the submissions.

As of December 31, 2016, SRBT has formally implemented the new management system in its entirety. The year 2017 represents the first full year of operation under this new system, and is expected to provide a significant opportunity to identify what works well, and what could be further optimized to ensure that we operate and manage the facility in a safe and compliant manner, commensurate with the level of risk and the needs of the business.

CNSC staff have notified SRBT of a planned inspection of the new Management System, to be conducted in March of 2017. As well, in the fall of 2017, SRBT expects BSI to conduct a certification audit for our transition to the 2015 version of the ISO 9001 standard. The management system put in place by SRBT is in alignment with the provisions of this standard as well. Based upon the feedback received during these activities, SRBT will ensure that the system is improved.

6.2 Emission Reduction Initiatives

SRBT continues to explore multiple avenues toward reducing tritium emissions from the facility, as per our stated commitment to ensuring investment in this area[65]. SRBT has made the commitment to invest no less than 5% of the company annualized net profit back into emission reduction initiatives (based upon fiscal year profit figures, October 1 through September 30 each year).

On September 30, 2016, the first full fiscal year elapsed under the renewed operating licence, permitting the evaluation of net profits, and by extension a comparison of the financial resources invested into emissions reduction. We are pleased to report that the 5% goal was exceeded, with a significant amount of resources being allocated in this first fiscal period.

Going forth into 2017, several of the initiatives which began in the past fiscal year will continue forward, such as increased maintenance frequency on wearable parts associated with tritium processing equipment, and research into the feasibility of using band heaters with tritium traps. As well, additional analysis on the effectiveness of initiatives already implemented will occur.

6.3 Safety Performance Objectives for 2017

For the coming year, SRBT Senior Management has established a set of performance objectives which will be tracked and reported on as part of the 2017 ACR.

The following table documents the safety performance objectives for SRBT in 2017:

TABLE 36: SRBT SAFETY AND PERFORMANCE OBJECTIVES FOR 2017

PARAMETER	OBJECTIVE
Maximum Worker Dose	≤ 0.75 mSv
Average Worker Dose	≤ 0.060 mSv
Calculated Dose to Member of the Public	≤ 0.0063 mSv
Total Tritium Emissions to Atmosphere (per week average)	≤ 747 GBq / week
Ratio – Tritium Emissions vs. Processed	≤ 0.16
Total Tritium Emissions – Liquid Effluent Pathway	≤ 6 GBq
Action Level Exceedances – Environmental	≤ 1
Action Level Exceedances – Radiation Protection	≤ 1
Contamination Control – Facility-wide Pass / Fail Rate	≥ 95%
Lost Time Injuries	0
EDHRC Reportable Injuries	≤ 20

6.4 Planned Modifications and Foreseen Changes

In 2017, several improvements are expected to be realized with respect to our operations and licenced activities.

The following key management system programs or documents are scheduled to be created or revised, submitted in 2017, and subsequently reviewed and accepted by CNSC staff:

- SRBT Safety Analysis Report (Revision 4)
- Radiation Safety Program
- Waste Management Program
- Emergency Plan
- Dosimetry Program (new, for Dosimetry Services Licence renewal)
- Groundwater Monitoring Program – new for N288.7 compliance
- Groundwater Protection Program – new for N288.7 compliance
- Hazard Prevention Program

SRBT is planning on exploring the feasibility of extending the tritium trap cycle usage limit from the current 13 cycles, as part of a Research and Development Plan. It is theorized that with the improvements to the design of the tritium trap valves, the trap bases will likely have a longer effective life. Extending the life of these valves would reduce the rate of generation of this type of radioactive waste, and optimize the usage of depleted uranium.

In 2017, in conjunction with the site landlord, SRBT is planning on upgrading the electrical power system supply to 600 ampere service. This upgrade is in support of plans to acquire new production equipment focused on plastics molding and 3-dimensional printing, also to be completed in 2017. These initiatives were the driving force behind the facility expansion completed in 2016.

The new equipment is not associated with our tritium processing operations; however, the introduction of this equipment and the electrical upgrade will be fully controlled as per MSP-007, *Change Control.*

SRBT plans to explore training opportunities for staff members, for various specialty services that are currently performed by third party contractors. This will help enhance our internal capabilities, and reduce reliance on third parties for key activities.

As well, SRBT will continue to pursue and explore opportunities to reduce emissions in all forms, as part of our 2015 commitment to allocate 5% of our annualized net profit towards this end.

7. Concluding Remarks

Throughout 2016, the management and staff of SRBT complied with all regulatory and licensing requirements of our operating licence.

The completion of the transition to a management system that meets the requirements of CSA N286-12 is a significant step in our evolution, and we look forward to gathering experience in operating under the new system in order to continually improve our operations.

Our facility remains within its designed safety basis, and continues to be fit for service; key systems have continued to be maintained diligently and effectively throughout 2016. Our maintenance program continues to ensure that all key components and systems remain reliable and in service.

Exposures to ionizing radiation to both workers and members of the public continue to remain low, and are far less than the regulatory limits prescribed. The local environment has remained protected, and continues to recover from historical practices, as we continue to implement best practices each and every day. Licence limits for our nuclear substance effluent streams continue to be respected with significant margin.

There were no instances of any conventional injury that resulted in lost time to our workers in 2016. Security of the facility and all nuclear substances was maintained at all times. One instance of a safety-related event with respect to the packaging and transport of our packages occurred that was beyond our direct control; however, SRBT has taken this event as a learning opportunity should future events of this nature occur.

We continue to be well protected from fire hazards, and have maintained an accepted plan should an emergency condition arise. Our public information program fully satisfies the requirements of the CNSC, and we continue to look for new ways to reach out into our local community in a positive and constructive fashion.

We continue to effectively manage all forms of waste generated by our operations, and continue to look to minimize the amount of waste that must be managed and controlled.

Our decommissioning responsibilities are fully documented and resourced, with additional funds being deposited as required. Although we plan on operating the facility for at least the next two decades if not longer, having a complete, self-funded financial guarantee is an additional testament to our commitment of being a good community partner.

Safety and excellence in operations shall always remain as the number one overall priority in everything we do, and 2016 was a direct reflection of the success at achieving these goals.

8. References

[1] Nuclear Substance Processing Facility Operating Licence NSPFOL-13.00/2022, valid from July 1, 2015 to June 30, 2022.

[2] Licence Condition Handbook – SRB Technologies (Canada) Inc. Nuclear Substance Processing Facility Operating Licence NSPFOL-13.00/2022 (e-Doc 4624621 (Rev. 0), 4899130 (Rev.1), 5127037 (Rev. 2)).

[3] Annual Compliance Monitoring and Operational Performance Reporting Requirements for Class 1B Nuclear Facilities (CNSC e-Doc 3471152); provided via email to J. MacDonald (SRBT) by J. Campbell (CNSC), February 17, 2016.

[4] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Preliminary Report: Activation of Smoke Alarm at SRBT, Implementation of Contingency Plan,* June 1, 2016.

[5] Letter w/attached report from S. Levesque (SRBT) to R. Buhr (CNSC), *Full Report – Activation of Contingency Plan (June 1, 2016)*, June 8, 2016.

[6] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRBT Full Report – Activation of Contingency Plan (June 1, 2016),* June 15, 2016 (e-Doc 5023088).

[7] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Report Made to Duty Officer – Dangerous Occurrence under Section 35 (c) of PTNSR,* November 28, 2016.

[8] Letter w/attached report from S. Levesque (SRBT) to R. Buhr (CNSC), *Full Report – Event Defined as a Dangerous Occurrence, as per Section 35 (c) of the PTNSR*, December 19, 2016.

[9] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRBT Full Report – Event Defined as a Dangerous Occurrence, as per Section 35 (c) of the PTNSR,* February 7, 2017 (e-Doc 5184810).

[10] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *Independent Third Party Review of SRBT's Facility Extension,* April 12, 2016 (e-Doc 4977184).

[11] SRBT Implementation Plan – Alignment of SRBT Management System with N286-12, dated September 8, 2014.

[12] Letter from S. Levesque (SRBT) to J. Campbell (CNSC), *Third Status Update on N286-12 Implementation Plan,* March 31, 2016.

[13] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Fourth Status Update on N286-12 Implementation Plan,* July 27, 2016.

[14] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Final Status Update on N286-12 Implementation Plan,* December 1, 2016.

[15] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Acceptance of SRBT's Compliance Verification Criteria Programs,* December 20, 2016 (e-Doc 5148398).

[16] *CNSC Regulatory Compliance Inspection Report: Import and Export of Tritium,* Report Number NPECD-SRB-2016-09, September 2016 (e-Doc 5078830).

…References cont'd

[17] Letter from S. Levesque (SRBT) to L. Chamney (CNSC), SRBT Response – Inspection Report NPECD-SRB-2016-09, October 14, 2016.

[18] Letter from L. Chamney (CNSC) to S. Levesque (SRBT), CNSC Staff's Review of SRBT Response – Inspection Report NPECD-SRB-2016-09, October 25, 2016 (e-Doc 5110535).

[19] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), SRB Technologies (Canada) Inc. Inspection Report No. SRBT-2016-01 October 4, 2016 – October 5, 2016, December 20, 2016 (e-Doc 5138759); with attached CNSC Compliance Inspection Report SRBT-2016-01, December 16, 2016 (e-Doc 5138669).

[20] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), SRBT Response – Inspection Report SRBT-2016-01, January 26, 2017.

[21] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), CNSC response to SRB Technologies (Canada) Inc. Corrective Actions related to Inspection Report SRBT-2016-01, February 7, 2017 (e-Doc 5184531).

[22] Report from D. Phillips, (BSI), *Assessment Report Periodic Visit – December 2016, SRB Technologies (Canada) Inc*., visit date: December 14, 2016.

[23] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), CNSC Staff Comments on the Safety Report for SRB Technologies (Canada) Inc., Revision 3, June 30, 2016 (e-Doc 5029116).

[24] Letter from D. Newland (CNSC) to S. Levesque (SRBT), Request pursuant to subsection 12(2) of the General Nuclear Safety and Control Regulations – reporting processes, February 25, 2016 (e-Doc 4944604).

[25] Letter from S. Levesque (SRBT) to D. Newland (CNSC), SRBT Report Pursuant to GNSCR 12(2) Request, March 1, 2016.

[26] Letter from S. Levesque (SRBT) to D. Newland (CNSC), SRBT Review of Reporting Processes - GNSCR 12(2) Request, March 23, 2016.

[27] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), Submission of SRBT Training Program Manual Rev. B, May 20, 2016.

[28] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), CNSC response to SRB Technologies (Canada) Inc. Corrective Actions related to Inspection Report NPFD-SRB-2015-10-06, May 30, 2016 (e-Doc 5009013).

[29] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), Submission of Addendum to SRBT Fire Hazards Analysis, June 30, 2016.

[30] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), CNSC Staff review of Addendum to SRBT Fire Hazards Analysis, January 26, 2017 (e-Doc 5175049).

[31] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revised Derived Release Limits for SRBT,* June 30, 2016.

…References cont'd

[32] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Comments on SRBT's Derived Release Limits,* September 12, 2016 (e-Doc 5077678).

[33] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Final 2016 Derived Release Limits for SRBT,* October 31, 2016.

[34] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Comments on Final 2016 Derived Release Limits for SRBT,* January 13, 2017 (e-Doc 5165192).

[35] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revised Final 2016 Derived Release Limits,* January 26, 2017.

[36] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revised SRBT Environmental Monitoring Program,* June 30, 2016.

[37] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Comments on the SRBT's Environmental Monitoring Program,* August 2, 2016 (e-Doc 5051525).

[38] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Disposition of Comments on SRBT Revised EMP,* August 15, 2016.

[39] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Acceptance of SRBT's Environmental Monitoring Program,* September 12, 2016 (e-Doc 5078041).

[40] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revised Fire Protection Program* August 31, 2016.

[41] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Acceptance of SRBT's Compliance Verification Criteria Programs,* December 20, 2016 (e-Doc 5148398).

[42] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Submission of Revised Appendix C Listed Document,* with attached SRBT Health and Safety Policy Rev. A, December 9, 2016.

[43] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Acceptance of SRBT's Compliance Verification Criteria Programs,* December 20, 2016 (e-Doc 5148398).

[44] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revised Environmental Management System and Effluent Monitoring Program,* December 30, 2016.

[45] SRBT Gap Analysis: *Regulatory Requirements and Standards for Environmental Management and Protection*, January 2016. Submitted under cover of letter from S. Levesque (SRBT) to J. Campbell (CNSC), *Environmental Protection Gap Analysis and Action Plan,* January 15, 2016.

[46] Letter from J. Campbell (CNSC) to S. Levesque (SRBT), *SRB Technologies (Canada) Inc.'s Gap Analysis – Regulatory Requirements and Standards for Environmental Management and Protection,* March 31, 2016 (e-Doc 4967340).

[47] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Disposition of Comments – SRBT Environmental Protection Gap Analysis and Action Plan,* May 26, 2016.

…References cont'd

[48] Letter from M. Rinker (CNSC) to S. Levesque (SRBT), *Implementation of CSA N286-12: Management System Requirements for Nuclear Facilities,* June 13, 2014 (e-Doc 4452663).

[49] Email from R. Buhr (SRBT) to S. Levesque (SRBT) *Quality Manual and CSA N286 gap Analysis,* November 6, 2014.

[50] SRBT Safety Analysis Report, Revision 3 (January 2016)

[51] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revision 3 of the SRBT Safety Analysis Report,* January 15, 2016.

[52] Dosimetry Service Licence 11341-3-18.1, valid from January 20, 2015 to May 31, 2018. Previously Dosimetry Service Licence 11341-3-18.0, valid from June 1, 2013 to May 31, 2018.

[53] Email from A. DiNardo (Radiation Protection Bureau – Health Canada) to J. MacDonald (SRBT), *2016 Tritium Report and Letter code,* June 22, 2016.

[54] Email from J. MacDonald (SRBT) to T. Barr (CNSC), *2015 Annual Compliance Report for SRBT DSL 11341-3-18.1*, March 10, 2016.

[55] SRBT *Licence Limits, Action Levels and Administrative Limits*, Revision E, November 14, 2014.

[56] SRBT *Environmental Monitoring Program*, Revision B, August 12, 2016.

[57] Ontario Ministry of the Environment, *Certificate of Approval Air,* number 5310-4NJQE2, August 31, 2000.

[58] Ecometrix Inc. *Comprehensive Report – Groundwater Studies at the SRB Technologies Facility, Pembroke, ON,* January 2008 (including Addendum 1 dated February 7, 2008 and Addendum 2 dated February 13, 2008).

[59] CSA standard N288.1-14 , *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities,* Tables C.1, C.2.

[60] CSA standard N288.1-14 , *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities,* Table 19.

[61] CSA standard N288.1-14 , *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities,* Table 21.

[62] CSA standard N288.1-14 , *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities,* Table G.9c.

[63] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Decommissioning Escrow Account Deposit – April 2016,* April 15, 2016, with attached investment directions dated April 15, 2016.

[64] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *RE: Decommissioning Escrow Account Deposit – April 2016,* October 26, 2016, with attached investment directions dated October 17, 2016.

[65] SRB Technologies (Canada) Inc. *Written Submission for Hearing in Support of Application to Renew Nuclear Substance Processing Facility Operating Licence for a Period of Ten Years,* dated March 13, 2015.

9. Appendices

DESCRIPTION **LETTER**

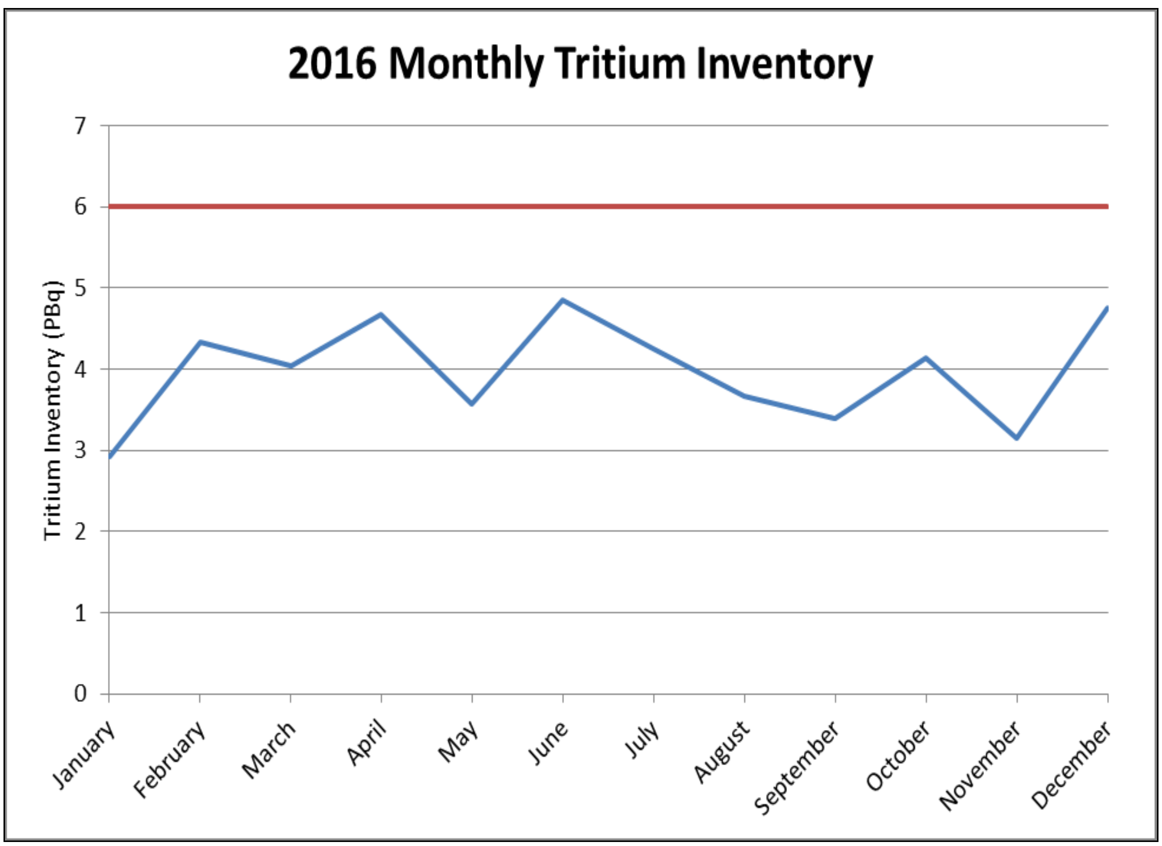
APPENDIX A

Tritium Activity on Site During 2016

TRITIUM ACTIVITY ON SITE DURING 2016

Month	Month-end H-3 Activity On-Site (PBq)	Percent of Licence Limit (%)
January	2.93	48.8
February	4.34	72.3
March	4.14	67.3
April	4.68	78.0
May	3.57	59.5
June	4.86	81.0
July	4.25	70.8
August	3.67	61.2
September	3.39	56.5
October	4.14	69.0
November	3.15	52.5
December	4.75	79.2
2016 Monthly Average	***3.98***	***66.3***

Note: Tritium possession limit = 6.00 PBq



APPENDIX B

Equipment Maintenance Information for 2016

2016 Scheduled Maintenance Activities Performed

Semi-Annual maintenance on HVAC equipment: **Contract** J.W HVAC Services Ltd	April 29, 2016 Sept 21, 2016
Quarterly maintenance on Rig & Bulk stack units: **Contract:** J.W HVAC Services Ltd	March 24, 2016 June 1, 2016 Sept 22, 2016 Dec 15, 2016
Annual stack verification by a third party on Rig & Bulk stack units: **Contract:** Tab Inspection	Oct 7, 2016
Sprinkler System quarterly maintenance by a third party: **Contract:** Drapeau Automatic Sprinkler Corp	March 24, 2016 June 23, 2016 Sept 16, 2016 Dec 15, 2016
Emergency Lighting & Fire Extinguisher annual inspection by a third party: **Contract:** Layman Fire and Safety	March 16, 2016
Sprinkler System inspection by SRBT:	Weekly
Fire Alarm Components inspection by SRBT:	Weekly
Fire Separation doors inspection by SRBT:	Weekly
Fire Extinguisher inspection by SRBT:	Monthly
Emergency Lights inspection by SRBT:	Monthly
Quarterly maintenance carried out on the compressor: **Contract:** Valley Compressor	Jan 6, 2016 April 19, 2016 July 14, 2016 Oct 18, 2016
Fumehood Inspections by SRBT:	Monthly
Tritium-in-Air Sample Collector Bubblers maintenance:	Bi-monthly
Tritium-in-Air Sample Collector Bubblers third party annual verification: **Contract:** Canadian Nuclear Laboratories	Feb 23, 2016
Liquid Scintillation Counters third party annual maintenance: **Contract:** PerkinElmer	Nov 8, 2016
Real-time Stack Monitoring system verification by SRBT:	March 7, 2016 June 2, 2016 Sept 6, 2016 Dec 7, 2016
Monitoring well inspection by SRBT:	Feb 1, 2016 May 31, 2016 Oct 3, 2016
Report of any weakening or possible major failure of any components:	None

All ventilation systems were maintained at a high fitness for service. Corrective maintenance was performed as required and one non-conformance was raised on the bulk unit to capture corrective maintenance details. SRBT's non-conformance process was followed and the item was corrected within 30 days. Ventilation equipment maintenance was performed under contract with a fully licensed maintenance and TSSA certified local HVAC contract provider.

All process equipment is serviced and maintained by qualified staff and through contract with companies that specialize in process control systems. All process equipment has been maintained in fully operational condition. Corrective maintenance was performed on equipment as required as a result of as found conditions during inspections and is recorded.

APPENDIX C

Ventilation Equipment Maintained in 2016

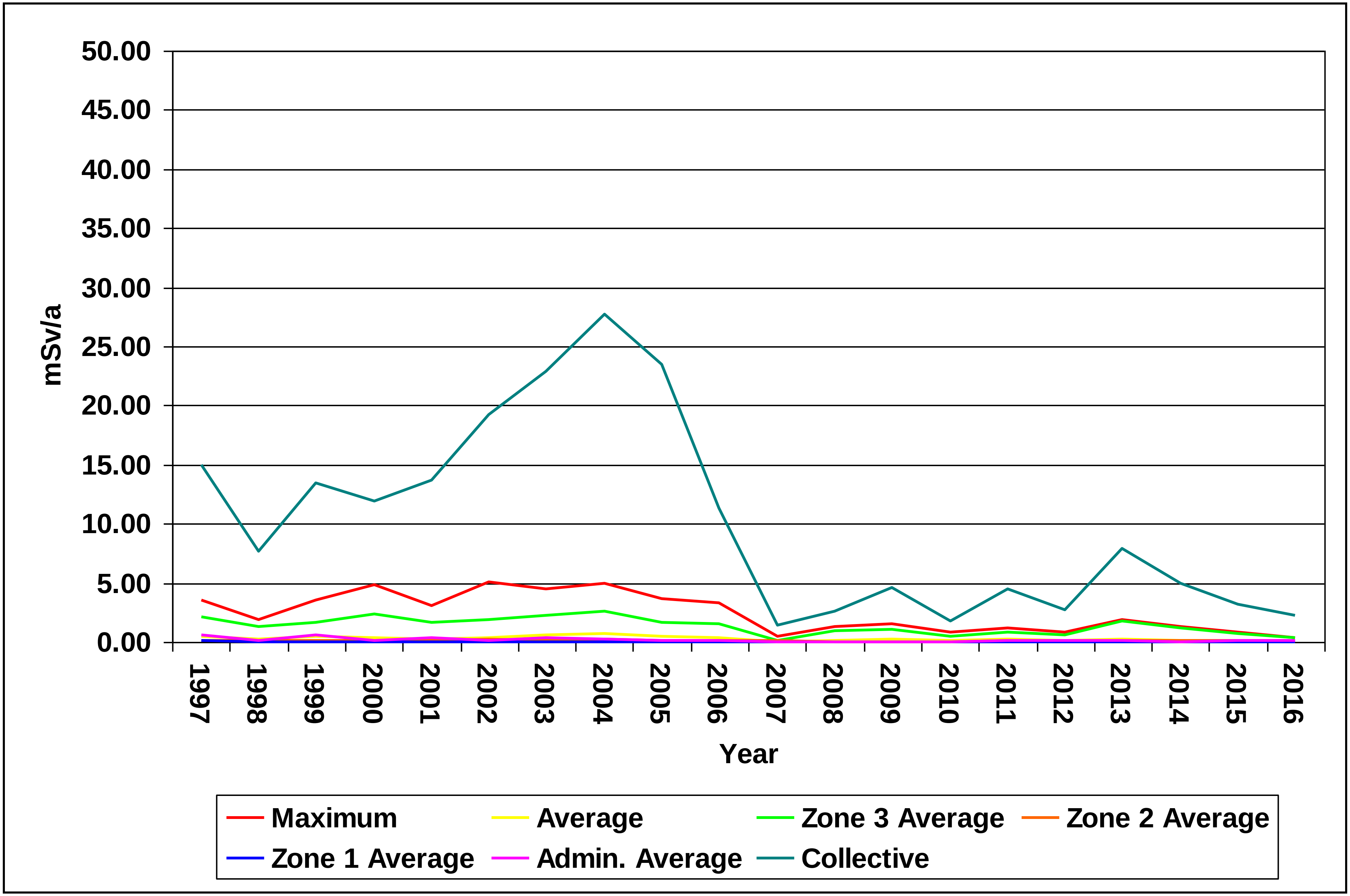
VENTILATION EQUIPMENT MAINTAINED IN 2016

	TYPE	ZONE SERVICED	LOCATION OF UNIT
1	Gas Furnace	1	Front office / server hallway
1	Mid efficient gas furnace	1	Receiving area
1	Mid efficient gas furnace & central air	1	Stores
1	Mid efficient gas furnace	1	Back bay
1	Heat Recovery unit	1	Receiving area
1	HRV with reheat	2	Coating
2	Makeup air units	1 & 2	Coating room
3	Unit heaters	1 & 3	Rig room, Glass shop, Receiving area
3	A/C wall units	1	Coating room, Glass shop
3	A/C wall units	1	Coating room, Glass shop
4	Exhaust fans	1 & 2	Coating, Assembly, Glass room, Paint Booth
1	Electric furnace with central air	1	Front office
1	Bulk stack air handling unit	3	Compound
1	Rig stack air handling unit	3	Compound
2	Rig and Bulk stack air handling units pitot tubes	3	Compound

APPENDIX D

Radiological Occupational Annual Dose Data for 2016

SRBT Radiological Annual Dose Data (1997 – 2016)



(Note: Zone and Admin Averages are Quarterly Collective Dose)

SRB RADIOLOGICAL ANNUAL DOSE DATA (1997 – 2016)

ANNUAL DOSE (mSv/year)		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*	2007*	2008*	2009	2010	2011	2012	2013	2014	2015	2016	AVERAGE
Maximum Dose		3.55	1.91	3.48	4.89	3.11	5.08	4.54	4.90	3.61	3.35	0.48	1.34	1.50	0.88	1.15	0.80	1.93	1.29	0.87	0.34	2.45
Average Dose		0.52	0.24	0.46	0.38	0.29	0.40	0.55	0.67	0.50	0.30	0.04	0.16	0.25	0.11	0.25	0.11	0.21	0.10	0.07	0.05	0.28
Average Quarterly Collective Dose	**Zone 3**	2.12	1.26	1.62	2.30	1.70	1.94	2.22	2.58	1.61	1.57	0.17	1.00	1.06	0.42	0.87	0.58	1.82	1.14	0.65	0.38	1.35
	Zone 2	0.07	0.12	0.11	0.15	0.08	0.18	0.16	0.18	0.12	0.07	0.07	0.02	0.01	0.01	0.11	0.03	0.08	0.07	0.08	0.07	0.09
	Zone 1	0.08	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.02	<0.01	<0.01	0.00	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.03	0.05	0.02
	Admin	0.61	0.17	0.60	0.12	0.31	0.11	0.39	0.24	0.12	0.09	<0.01	0.05	0.05	0.02	0.13	0.06	0.08	0.03	0.06	0.06	0.17
Collective Dose		15.01	7.72	13.47	11.91	13.65	19.21	22.91	27.75	23.50	11.34	1.40	2.62	4.57	1.82	4.47	2.75	7.94	4.98	3.22	2.21	10.12

DOSIMETRY RANGE (mSv/year)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	AVERAGE
0.00 – 0.99	23	29	28	33	43	43	39	30	39	34	32	15	15	17	16	24	34	47	47	45	31.65
1.00 – 1.99	4	3	4	1	4	2	0	5	3	3	0	1	3	0	2	0	4	1	0	0	2.00
2.00 – 2.99	1	0	0	1	1	2	3	2	3	0	0	0	0	0	0	0	0	0	0	0	0.65
3.00 – 3.99	1	0	2	1	1	0	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0.60
4.00 – 4.99	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0.20
> 5.00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05
> 50.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Staff Members	29	32	34	37	49	48	45	41	47	38	32	16	18	17	18	24	38	48	47	45	35.15

(*Notes: 2006 operations over 48 weeks; 2007 operations over 5 weeks; 2008 operations over 26 weeks)

APPENDIX E

Swipe Monitoring Results for 2016

2016 Routine Contamination Assessment Summary - Zone 3

Zone 3 Swipe Area	No. of Assessments	Amount > Admin. Level	Pass Rate
Floor at Rig 1	246	13	94.7
Floor at Rig 5	246	57	76.8
Floor at Rig 6	246	57	76.8
Floor at Rig 7	246	56	77.2
Floor at Rig 8	246	35	85.8
Rig 1	246	9	96.3
Rig 5	246	3	98.8
Rig 6	246	7	97.2
Rig 7	246	3	98.8
Rig 8	246	11	95.5
Floor at Barrier	246	25	89.8
Muffle Fume Hood	246	20	91.9
EIP Area	246	3	98.8
Laser Room Fume Hood	246	31	87.4
Laser Room Floor	246	25	89.8
Tritium Laboratory Floor	246	30	87.8
Bulk Splitter Fume Hood	246	20	91.9
Disassembly Fume Hood	197	9	95.4
Shoe Covers	181	52	71.3
Tritium Laboratory Table	135	9	93.3
Reclaim Fume Hood	123	1	99.2
Shoe Cover Bins	111	6	94.6
Reclaim Sash	110	3	97.3
Waste Room Floor	108	1	99.1
Lower Rig 5	74	2	97.3
Tritium Laboratory Storage Room	73	7	90.4
Table at Barrier	70	6	91.4
Waste Room Walls	70	0	100.0
Computer Keyboard/Mouse	62	1	98.4
Waste Room Door	62	0	100.0
Port-hole	59	0	100.0
Propane Cylinder	59	1	98.3
Safety Glasses	59	0	100.0
Laser Stick Cabinet	49	0	100.0
Pen Drawers	49	0	100.0
Tritium Laboratory Cabinet	49	2	95.9
Storage Room Shelves	23	11	52.2
Bulk Splitter Sash	6	1	83.3
Paperwork Rack	6	0	100.0
Scint Table	6	0	100.0
Waste Room Shelving	6	0	100.0
TOTAL ZONE 3	**5,929**	**517**	**91.3**

2016 Routine Contamination Assessment Summary - Zone 2

Zone 2 Swipe Area	No. of Assessments	Amount > Admin. Level	Pass Rate
Counter at Barrier	148	16	89.2
Floor at Barrier	148	13	91.2
WIP Cabinets	148	7	95.3
Work Counters	148	5	96.6
Paint Booth Floor	148	10	93.2
Work Area Floors	148	9	93.9
Storage Room Floor	119	3	97.5
Bubbler Fume Hood	108	8	92.6
Insp. Prep. Counter	106	9	91.5
Fridge	82	3	96.3
Silk Screening Floor	78	3	96.2
Shoe Covers	66	4	93.9
Computer Keyboard/Mouse	42	1	97.6
Storage Room Walls	42	0	100.0
Photometer Room Floor	41	0	100.0
Stock Sign Cabinets	40	1	97.5
Chairs	37	0	100.0
QA Shelving	37	1	97.3
Reflector Bin Handles	29	1	96.6
Sign Light Stock Cabinet	29	1	96.6
Welding Area Counter	29	0	100.0
Inspection Prep Cabinet	4	0	100.0
Sonic Welding Area	4	0	100.0
QA Cabinets	3	0	100.0
TOTAL ZONE 2	**1,784**	**95**	**94.7**

2016 Routine Contamination Assessment Summary - Zone 1

Zone 1 Swipe Area	No. of Assessments	Amount > Admin. Level	Pass Rate
Assy Barrier	51	3	94.1
LSC Room	51	1	98.0
Lunch Room	51	0	100.0
RR Ante Rm	51	2	96.1
RR Barrier	51	0	100.0
Shipping Area	36	0	100.0
Zone 2 Door	36	1	97.2
Hallway Outside Lunchroom	27	0	100.0
Back Offices	13	0	100.0
Glass Shop	13	0	100.0
Hallway outside Assembly	14	0	100.0
Machining Area	13	0	100.0
Shipping Work Counters	13	0	100.0
Mezzanine	10	0	100.0
Rear Facility Door	10	0	100.0
Zone 3 Door	10	0	100.0
TOTAL ZONE 1	**450**	**7**	**98.4**

Overall Facility Summary

Facility Zone	No. of Assessments	Amount > Admin. Level	Pass Rate
ZONE 3	5929	517	91.3
ZONE 2	1784	95	94.7
ZONE 1	450	7	98.4
TOTAL ZONE 1	**8,163**	**619**	**92.4**

APPENDIX F

Passive Air Sampler Results for 2016

2016 Environment Monitoring Program

Passive Air Sampling System

Sampler No.	Sampler ID	Location	Dist. to SRBT	Jan (Jan6-Feb2)	Feb (Feb 2-Mar1)	Mar (Mar 1-Apr 6)	Apr (Apr 6 - May 4)	May (May 4 - Jun 1)	Jun (Jun 1 - Jul 5)	Jul (Jul 5 - Aug 3)	Aug (Aug 3 - Sep 1)	Sep (Sep 1 - Oct 3)	Oct (Oct 3 - Nov 1)	Nov (Nov1-Dec1)	Dec (Dec 1 - Jan 4)	Average (Bq/m3)
				(Bq/m3)												
1	N250	N 45º 48.486' W 077º 07.092' Elev. 137m	322m	0.74	0.33	0.41	0.54	0.65	0.44	0.88	1.02	1.00	1.20	0.51	1.00	0.73
2	N500	N 45º 48.572' W 077º 07.008' Elev. 134m	493m	0.32	0.32	0.26	0.35	0.34	0.32	0.35	0.55	0.53	0.34	0.31	0.59	0.38
3	N1000	N 45º 48.869' W 077º 06.997' Elev. 135m	1040m	0.33	0.35	0.25	0.32	0.34	0.26	0.33	0.95	0.30	0.34	0.31	0.28	0.36
4 (PAS #4)	NW250	N 45º 48.412' W 077º 07.189' Elev. 137m	222m	1.20	0.45	1.10	2.10	1.20	0.62	1.10	0.99	1.70	2.20	0.87	1.00	1.21
5	NW500	N 45º 48.577' W 077º 07.382' Elev. 134m	615m	0.52	0.92	0.58	0.58	0.34	0.27	0.38	0.34	0.93	0.83	0.44	0.46	0.55
6 (PAS # 8)	NW1000	N 45º 48.754' W 077º 07.599' Elev. 130m	1050m	0.32	0.33	0.24	0.31	0.32	0.26	0.32	0.33	0.44	0.37	0.31	0.27	0.32
7	NW2000	N 45º 49.141' W 077º 08.090' Elev. 139m	2000m	0.33	0.33	0.25	0.66	0.43	1.10	0.90	1.20	0.80	0.48	0.32	0.28	0.59
8	W250	N 45º 48.300' W 077º 07.323' Elev. 138m	297m	0.93	0.69	1.20	1.50	0.90	0.27	0.31	1.20	1.20	0.94	0.75	0.46	0.86
9	W500	N 45º 48.288' W 077º 07.393' Elev. 137m	389m	0.60	0.43	0.69	1.20	0.50	0.27	0.34	0.75	0.93	0.45	0.33	0.41	0.58
10	W1000	N 45º 48.306' W 077º 07.630' Elev. 134m	691m	0.58	0.33	0.46	0.58	0.32	0.24	0.32	0.34	0.29	0.33	0.37	0.36	0.38
11	SW250	N 45º 48.247' W 077º 07.206' Elev. 140m	183m	0.33	0.33	0.49	2.00	0.70	0.35	0.34	0.79	0.82	0.34	0.31	0.27	0.59
12	SW500	N 45º 47.896' W 077º 07.307' Elev. 148m	839m	0.33	0.33	0.25	0.37	0.33	0.26	0.32	0.34	0.29	0.34	0.31	0.27	0.31
13	SW1000	N 45º 47.599' W 077º 07.543' Elev. 149m	1470m	0.32	0.32	0.25	0.32	0.33	0.26	0.32	0.33	0.29	0.34	0.31	0.27	0.31
14	SW2000	N 45º 47.408' W 077º 07.866' Elev. 155m	2110m	0.32	0.33	0.26	0.33	0.33	0.26	0.32	0.34	0.30	0.34	0.31	0.27	0.31
15	S250	N 45º 48.129' W 077º 07.014' Elev. 131m	356m	0.45	1.10	1.00	1.20	1.20	0.76	1.20	0.49	0.77	0.63	0.90	0.27	0.83
16	S500	N 45º 48.029' W 077º 07.110' Elev. 143m	532m	0.33	0.32	0.28	0.64	0.41	0.30	0.32	0.33	0.46	0.34	0.31	0.27	0.36
17 (PAS # 12)	S1000	N 45º 46.466' W 077º 07.441' Elev. 158m	1450m	0.33	0.33	0.25	0.32	0.32	0.26	0.32	0.33	0.29	0.34	0.31	0.27	0.31
18	SE250	N 45º 48.189' W 077º 06.874' Elev. 132m	365m	2.50	1.80	2.20	1.90	3.10	2.60	1.00	1.40	0.80	1.40	1.41	1.40	1.79
19	SE500	N 45º 48.108' W 077º 06.783' Elev. 123m	554m	1.20	0.88	1.20	1.10	1.60	1.50	0.40	0.57	0.29	0.63	0.79	0.46	0.89
20	SE1000	N 45º 47.894' W 077º 06.501' Elev. 120m	1090m	0.33	0.39	0.25	0.83	0.59	0.39	0.32	0.34	0.29	0.34	0.31	0.27	0.39
21	SE2000	N 45º 47.505' W 077º 05.978' Elev. 137m	2080m	0.33	0.32	0.25	0.31	0.32	0.25	0.32	0.33	0.29	0.34	0.31	0.27	0.30
22	E250	N 45º 48.234' W 077º 06.807' Elev. 131m	401m	3.60	0.84	0.64	0.92	1.90	1.90	1.10	1.80	0.80	1.40	1.68	1.10	1.47
23	E500	N 45º 48.333' W 077º 06.693' Elev. 132m	520m	0.40	0.53	0.33	0.31	0.55	0.59	0.50	0.37	0.69	0.34	0.31	0.34	0.44
24	E1000	N 45º 48.303' W 077º 06.260' Elev. 143m	1080m	0.33	0.32	0.25	0.31	0.35	0.26	0.32	0.33	0.41	0.33	0.32	0.27	0.32
25	NE250	N 45º 48.371' W 077º 06.964' Elev. 124m	198m	1.40	0.71	0.85	0.54	2.70	3.50	6.00	4.60	4.10	0.43	1.16	1.60	2.30
26	NE500	N 45º 48.421' W 077º 06.732' Elev. 131m	508m	0.32	0.32	0.47	0.31	0.66	0.78	0.87	0.50	0.90	0.34	0.31	0.54	0.53
27	NE1000	N 45º 48.683' W 077º 06.441' Elev. 148m	1100m	0.33	0.32	0.25	0.31	0.33	0.32	0.32	0.34	0.29	0.34	0.31	0.28	0.31
28	NE2000	N 45º 49.116' W 077º 05.843' Elev. 156m	2200m	0.32	0.33	0.24	0.31	0.32	0.25	0.32	0.33	0.29	0.34	0.31	0.27	0.30
Pre-Sample Points																
(PAS #1)		N 45º 48.287' W 077º 07.123' Elev. 129m	94.1m	1.20	0.37	2.80	7.20	7.20	3.90	4.30	2.00	5.70	2.90	1.70	0.27	3.30
(PAS #2)		N 45º 48.325' W 077º 07.132' Elev. 132m	52.8m	1.50	1.80	1.70	5.70	4.80	2.20	2.30	4.10	5.40	2.70	1.99	0.69	2.91
(PAS #13)		N 45º 48.262' W 077º 07.093' Elev. 132m	61.5m	0.32	0.46	1.30	5.60	3.50	2.50	1.10	3.60	4.10	1.10	0.89	0.27	2.06
Replicates																
4-2	NW250	N 45º 48.412' W 077º 07.189' Elev. 137m	222m	0.91	0.41	0.97	2.00	1.20	0.47	1.10	0.96	1.70	2.10	0.76	0.81	1.12
11-2	SW250	N 45º 48.247' W 077º 07.206' Elev. 140m	183m	0.32	0.33	0.44	1.60	0.60	0.26	0.32	0.67	0.81	0.34	0.31	0.27	0.52
18-2	SE250	N 45º 48.189' W 077º 06.874' Elev. 132m	365m	2.10	1.70	2.20	1.80	2.90	2.60	0.90	1.20	0.80	1.30	1.23	1.20	1.66
25-2	NE250	N 45º 48.371' W 077º 06.964' Elev. 124m	198m	1.10	0.57	0.78	0.53	2.70	3.50	5.30	3.70	3.80	0.37	1.07	1.50	2.08
Background Samples																
Maika (PAS # 10)	SW	N 45º 46.367' W 077º 11.447' Elev. 149m	6690m	0.33	0.33	0.25	0.31	0.32	0.26	0.35	0.36	0.31	0.34	0.31	0.27	0.31
Maika	Duplicate	Same as above	6690m	0.32	0.32	0.25	0.31	0.32	0.26	0.32	0.33	0.30	0.33	0.31	0.27	0.30
Fitzpatrick	SE	N 45º 44.818' W 076º 59.822' Elev. 159m	11400m	0.32	0.33	0.25	0.31	0.33	0.26	2.60	1.10	0.60	0.30	0.31	0.27	0.58
Petawawa	NW	N 45º 51.497' W 077º 12.828' Elev. 149m	9480m	0.32	0.33	0.25	0.31	0.32	0.25	0.31	0.33	0.29	0.34	0.31	0.27	0.30
Farm	NE	N 45º 53.071' W 076º 56.768' Elev. 142m	16000m	0.32	0.33	0.24	0.31	0.32	0.26	0.32	0.33	0.29	0.34	0.31	0.27	0.30
			Sum	28.40	21.58	26.58	46.45	45.89	35.56	39.06	40.21	44.59	28.84	24.00	20.16	33.44

APPENDIX G

Wind Direction Graphs for 2016

Passive Air Sampling Data (Results in Bq/m3)

1st Quarter

Direction	January 250 M	January 500 M	January 1000 M	January 2000 M	February 250 M	February 500 M	February 1000 M	February 2000 M	March 250 M	March 500 M	March 1000 M	March 2000 M
North	0.74	0.32	0.33		0.33	0.32	0.35		0.41	0.26	0.25	
North West	1.20	0.52	0.32	0.33	0.45	0.92	0.33	0.33	1.10	0.58	0.24	0.25
West	0.93	0.60	0.58		0.69	0.43	0.33		1.20	0.69	0.46	
Southwest	0.33	0.33	0.32	0.32	0.33	0.33	0.32	0.33	0.49	0.25	0.25	0.26
South	0.45	0.33	0.33		1.10	0.32	0.33		1.00	0.28	0.25	
South East	2.50	1.20	0.33	0.33	1.80	0.88	0.39	0.32	2.20	1.20	0.25	0.25
East	3.60	0.40	0.33		0.84	0.53	0.32		0.64	0.33	0.25	
North East	1.40	0.32	0.32	0.32	0.71	0.32	0.32	0.33	0.85	0.47	0.25	0.24

2nd Quarter

Direction	April 250 M	April 500 M	April 1000 M	April 2000 M	May 250 M	May 500 M	May 1000 M	May 2000 M	June 250 M	June 500 M	June 1000 M	June 2000 M
North	0.54	0.35	0.32		0.65	0.34	0.34		0.44	0.32	0.26	
North West	2.10	0.58	0.31	0.66	1.20	0.34	0.32	0.43	0.62	0.27	0.26	1.10
West	1.50	1.20	0.58		0.90	0.50	0.32		0.27	0.27	0.24	
Southwest	2.00	0.37	0.32	0.33	0.70	0.33	0.33	0.33	0.35	0.26	0.26	0.26
South	1.20	0.64	0.32		1.20	1.20	0.32		0.76	0.30	0.26	
South East	1.90	1.10	0.83	0.31	3.10	1.60	0.59	0.32	2.60	1.50	0.39	0.25
East	0.92	0.31	0.31		1.90	0.55	0.35		1.90	0.59	0.26	
North East	0.54	0.31	0.31	0.31	2.70	0.66	0.33	0.32	3.50	0.78	0.32	0.25

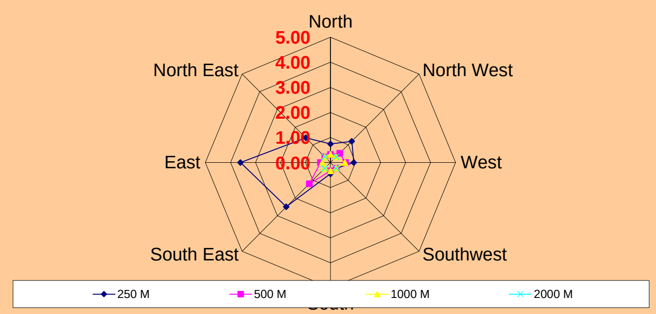
3rd Quarter

Direction	July 250 M	July 500 M	July 1000 M	July 2000 M	August 250 M	August 500 M	August 1000 M	August 2000 M	September 250 M	September 500 M	September 1000 M	September 2000 M
North	0.88	0.35	0.33		1.02	0.55	0.95		1.00	0.53	0.30	
North West	1.10	0.38	0.32	0.90	0.99	0.34	0.33	1.20	1.70	0.93	0.44	0.80
West	0.31	0.34	0.32		1.20	0.75	0.34		1.20	0.93	0.29	
Southwest	0.34	0.32	0.32	0.32	0.79	0.34	0.33	0.34	0.82	0.29	0.29	0.30
South	1.20	0.32	0.32		0.49	0.33	0.33		0.77	0.46	0.29	
South East	1.00	0.40	0.32	0.32	1.40	0.57	0.34	0.33	0.80	0.29	0.29	0.29
East	1.10	0.50	0.32		1.80	0.37	0.33		0.80	0.69	0.41	
North East	6.00	0.87	0.32	0.32	4.60	0.50	0.34	0.33	4.10	0.90	0.29	0.29

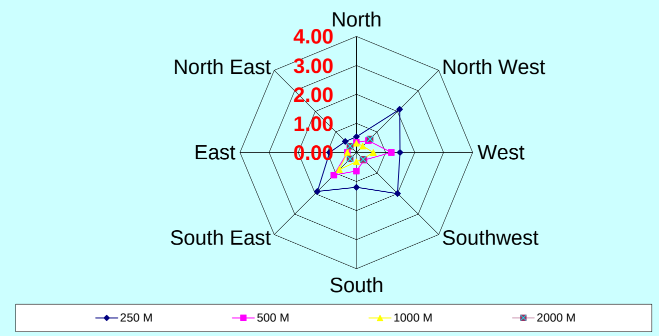
4th Quarter

Direction	October 250 M	October 500 M	October 1000 M	October 2000 M	November 250 M	November 500 M	November 1000 M	November 2000 M	December 250 M	December 500 M	December 1000 M	December 2000 M
North	1.20	0.34	0.34		0.51	0.31	0.31		1.00	0.59	0.28	
North West	2.20	0.83	0.37	0.48	0.87	0.44	0.31	0.32	1.00	0.46	0.27	0.28
West	0.94	0.45	0.33		0.75	0.33	0.37		0.46	0.41	0.36	
Southwest	0.34	0.34	0.34	0.34	0.31	0.31	0.31	0.31	0.27	0.27	0.27	0.27
South	0.63	0.34	0.34		0.90	0.31	0.31		0.27	0.27	0.27	
South East	1.40	0.63	0.34	0.34	1.41	0.79	0.31	0.31	1.40	0.46	0.27	0.27
East	1.40	0.34	0.33		1.68	0.31	0.32		1.10	0.34	0.27	
North East	0.43	0.34	0.34	0.34	1.16	0.31	0.31	0.31	1.60	0.54	0.28	0.27

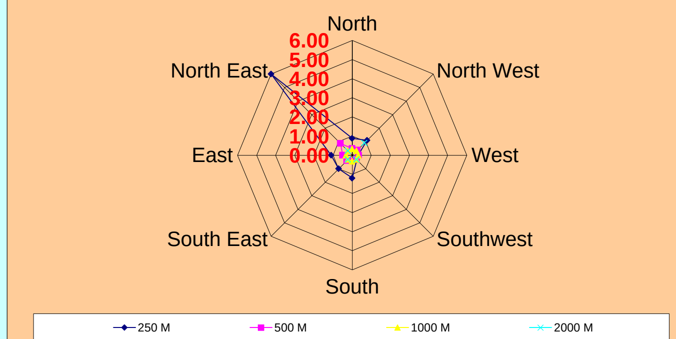
January
(Jan 6-Feb 2)



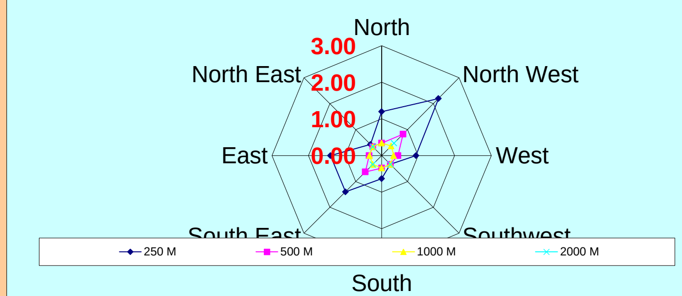
April
(Apr 6 - May 4)



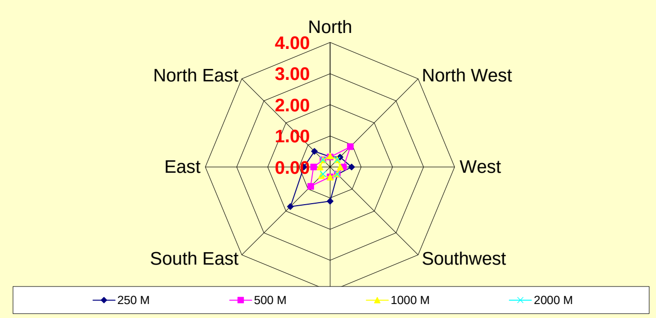
July
(July 5-Aug 3)



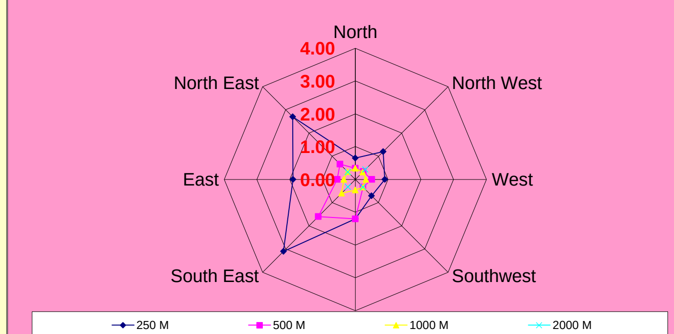
October
(Oct 3 - Nov 1)



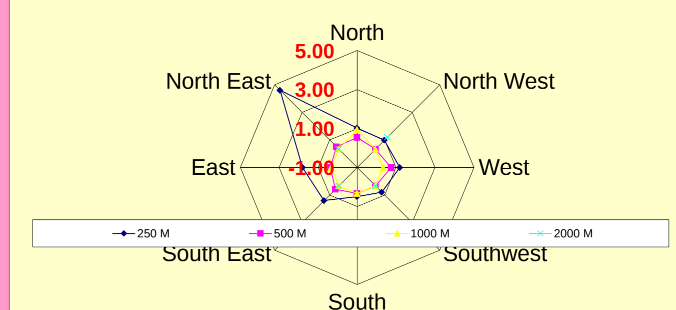
February
(Feb 2-Mar 1)



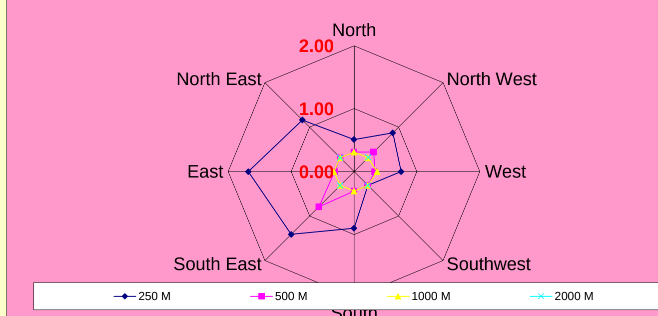
May
(May4-June1)



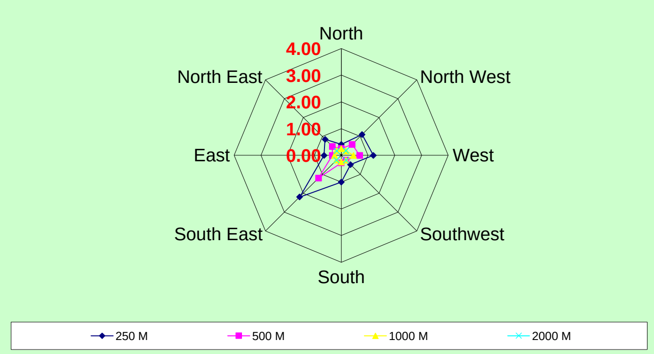
August
(Aug 3-Sept 1)



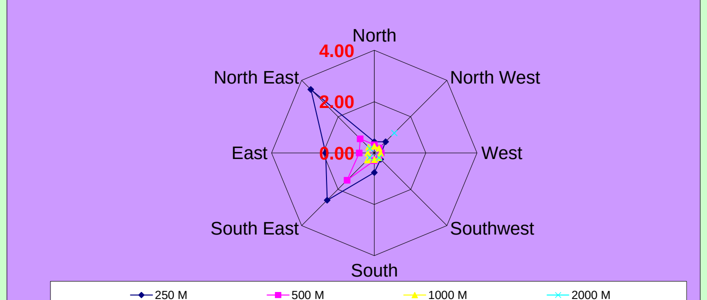
November
(Nov 1 - Dec 1)



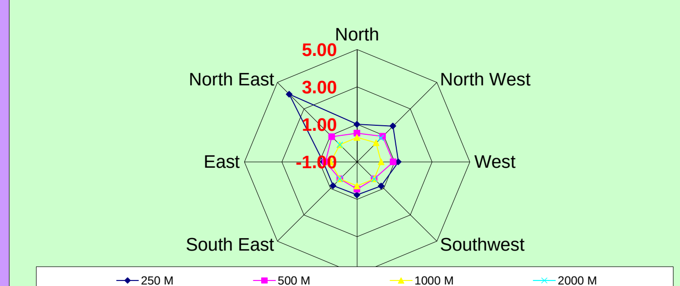
March
(Mar 1-Apr 6)



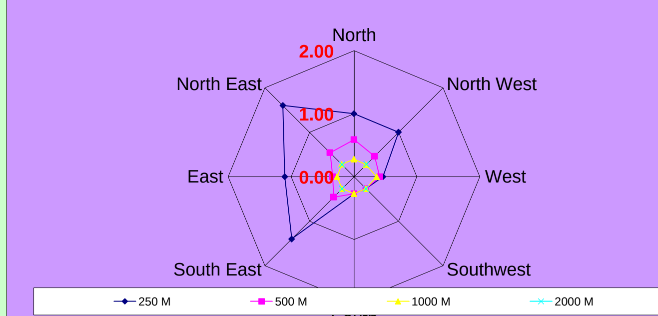
June
(June 1-July 5)



September
(Sept 1-Oct 3)



December
(Dec 1 - Jan 4)

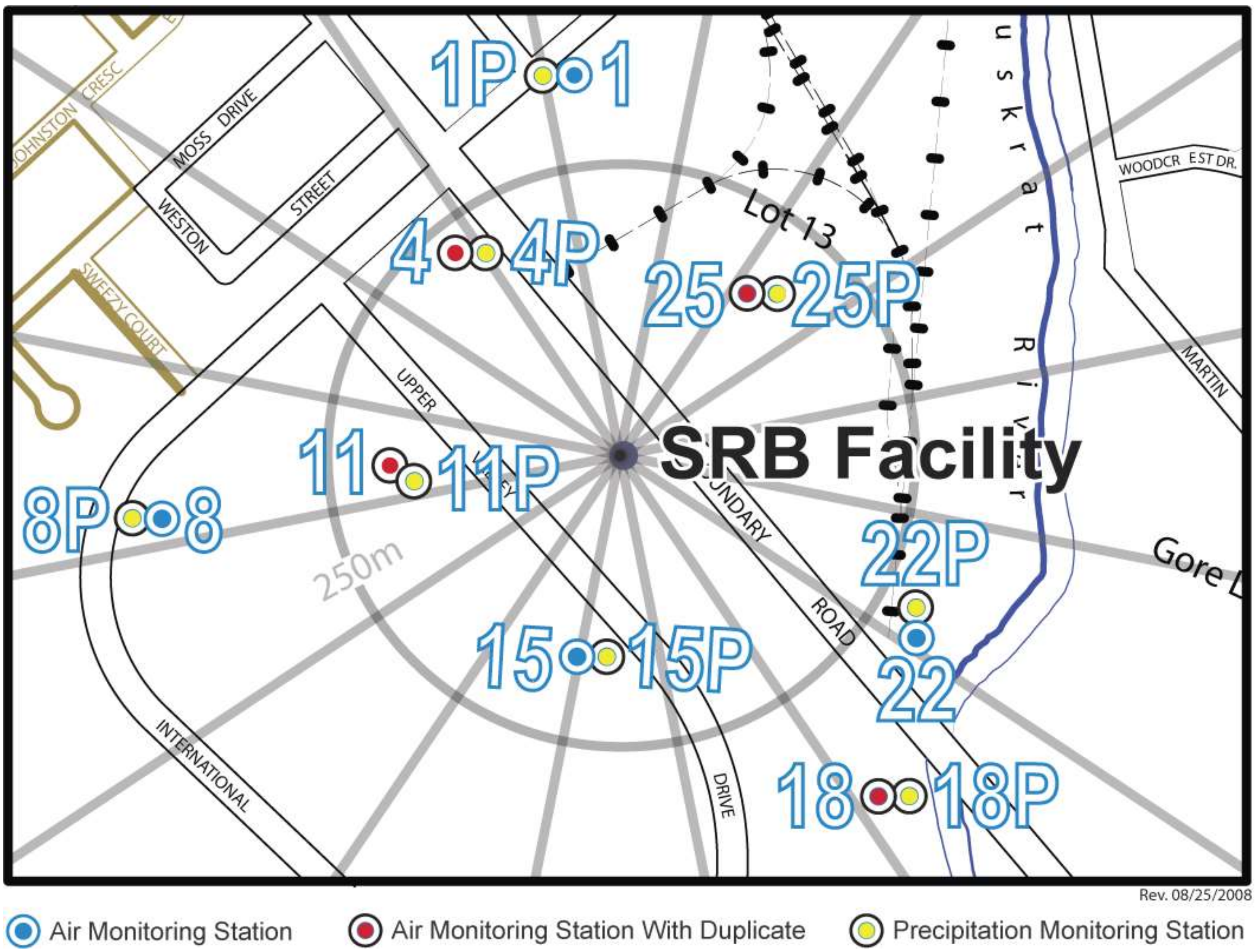


APPENDIX H

Precipitation Monitoring Results for 2016

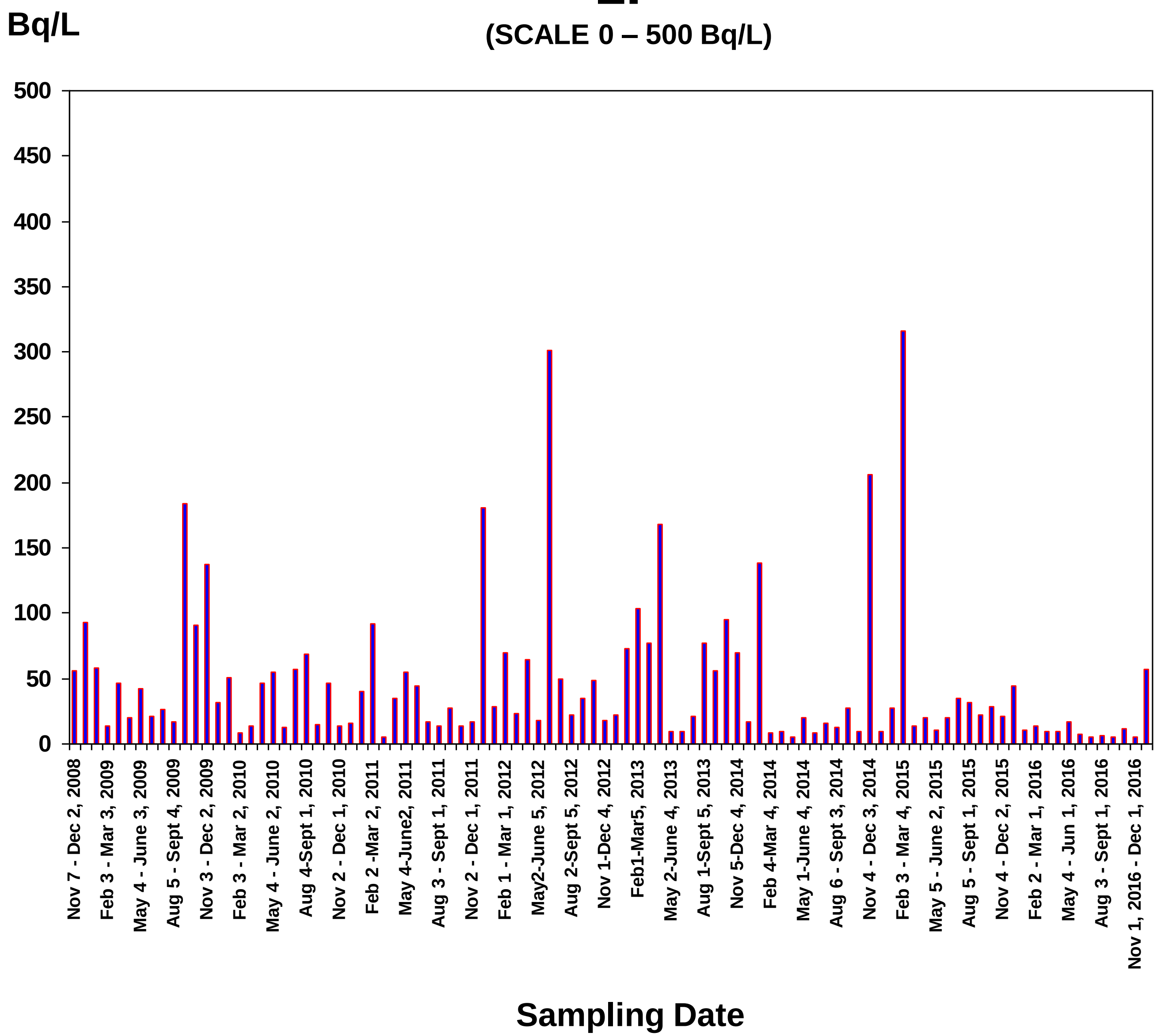
PRECIPITATION SAMPLERS									
	1P	4P	8P	11P	15P	18P	22P	25P	AVG
	Bq/L								
Jan. 6, 2016 to Feb. 2, 2016	11	90	58	7	11	152	252	20	75
Feb. 2, 2016 to Mar. 1, 2016	14	14	23	28	12	80	43	36	31
Mar. 1, 2016 to Apr. 6, 2016	9	25	22	10	11	15	8	5	13
Apr. 6, 2016 to May 4, 2016	10	21	24	21	7	38	9	13	18
May 4, 2016 to Jun. 1, 2016	17	27	32	7	13	21	16	18	19
Jun. 1, 2016 to Jul. 5, 2016	7	15	5	6	9	16	15	19	12
Jul. 5, 2016 to Aug. 3, 2016	5	20	7	10	7	7	5	28	11
Aug. 3, 2016 to Sept. 1, 2016	6	8	22	47	5	5	7	8	14
Sept. 1, 2016 to Oct. 3, 2016	5	30	69	10	7	5	5	19	19
Oct. 3, 2016 to Nov. 1, 2016	12	22	11	5	10	36	22	29	18
Nov. 1, 2016 to Dec. 1, 2016	5	51	6	5	5	54	41	15	23
Dec. 1, 2016 to Jan 4, 2017	57	31	59	14	11	87	41	82	48
AVERAGE	13	30	28	14	9	43	39	24	25

MAP OF AIR AND PRECIPITATION MONITORING STATIONS



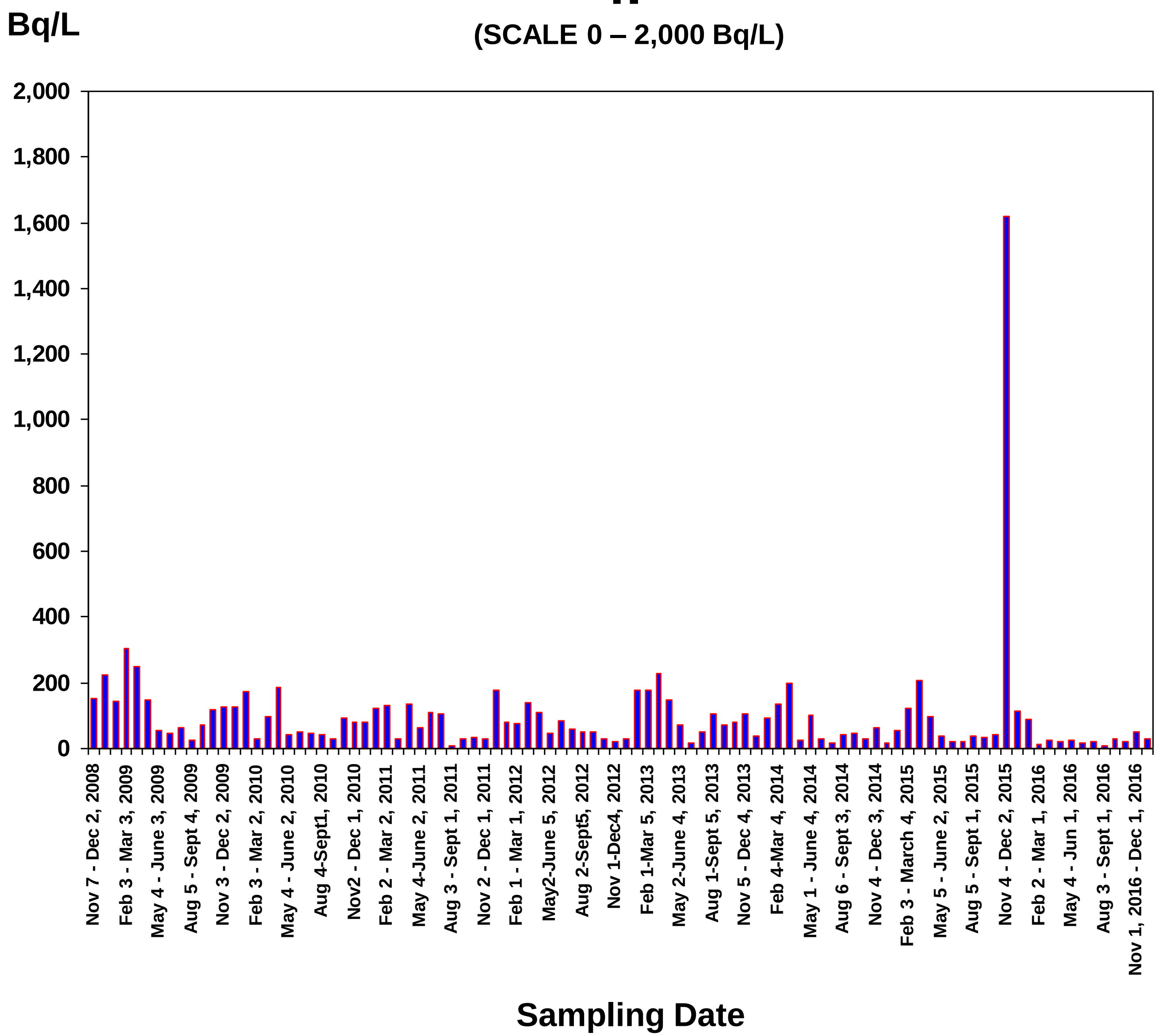
PRECIPITATION RESULTS
1P

(SCALE 0 – 500 Bq/L)

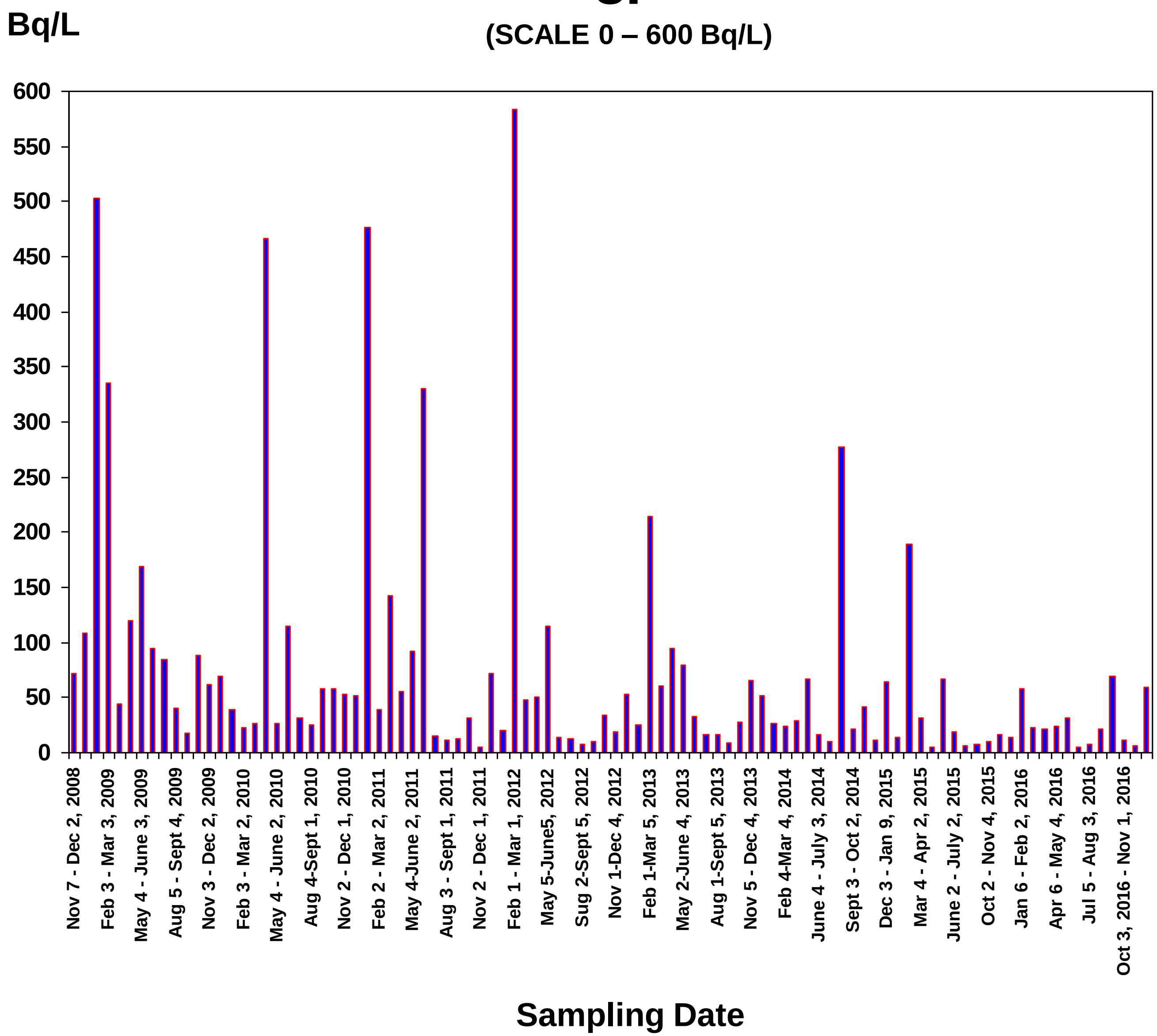


PRECIPITATION RESULTS
4P

(SCALE 0 – 2,000 Bq/L)



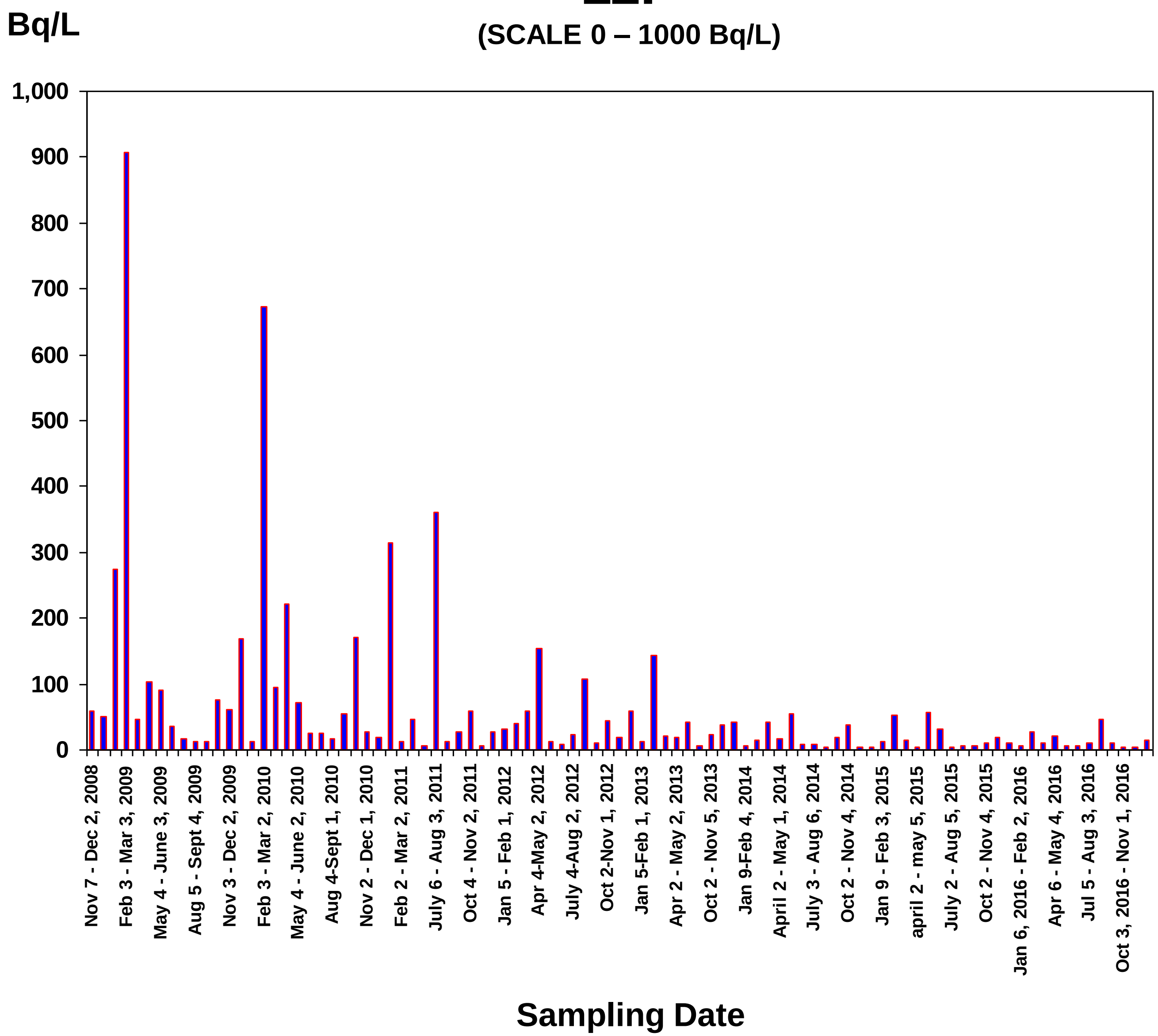
PRECIPITATION RESULTS
8P
(SCALE 0 – 600 Bq/L)



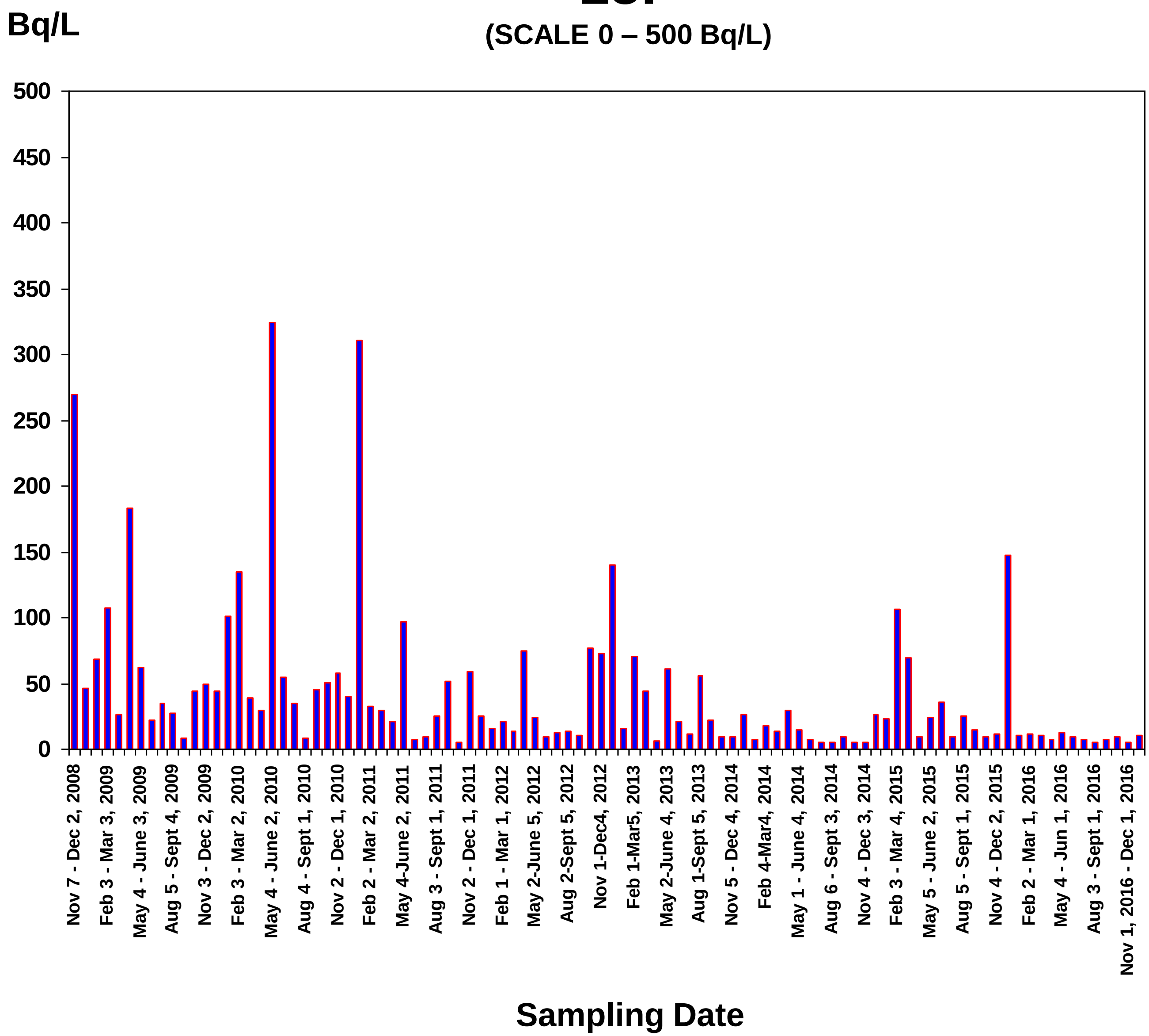
APPENDIX H

PRECIPITATION RESULTS
11P

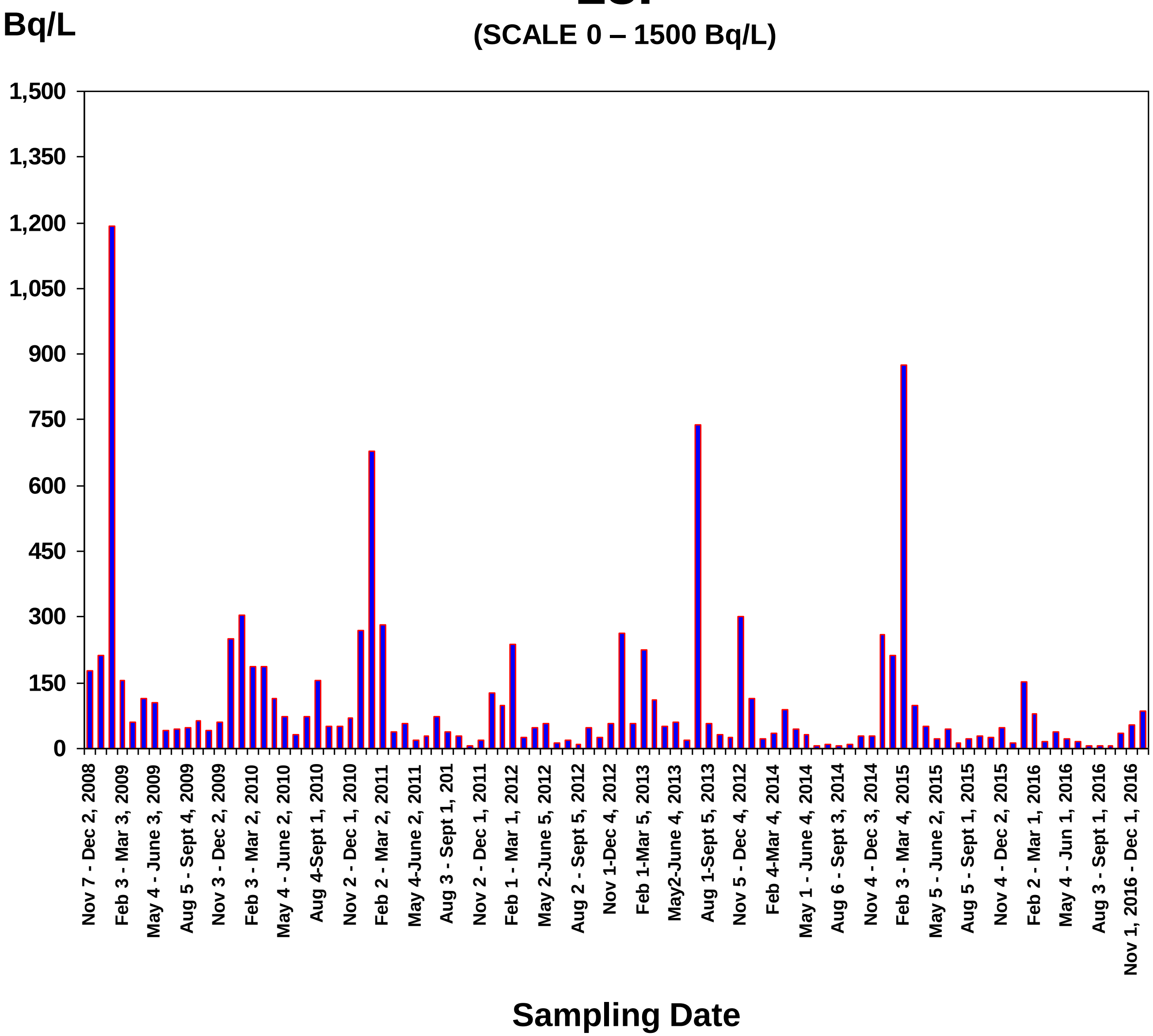
(SCALE 0 – 1000 Bq/L)



PRECIPITATION RESULTS
15P
(SCALE 0 – 500 Bq/L)

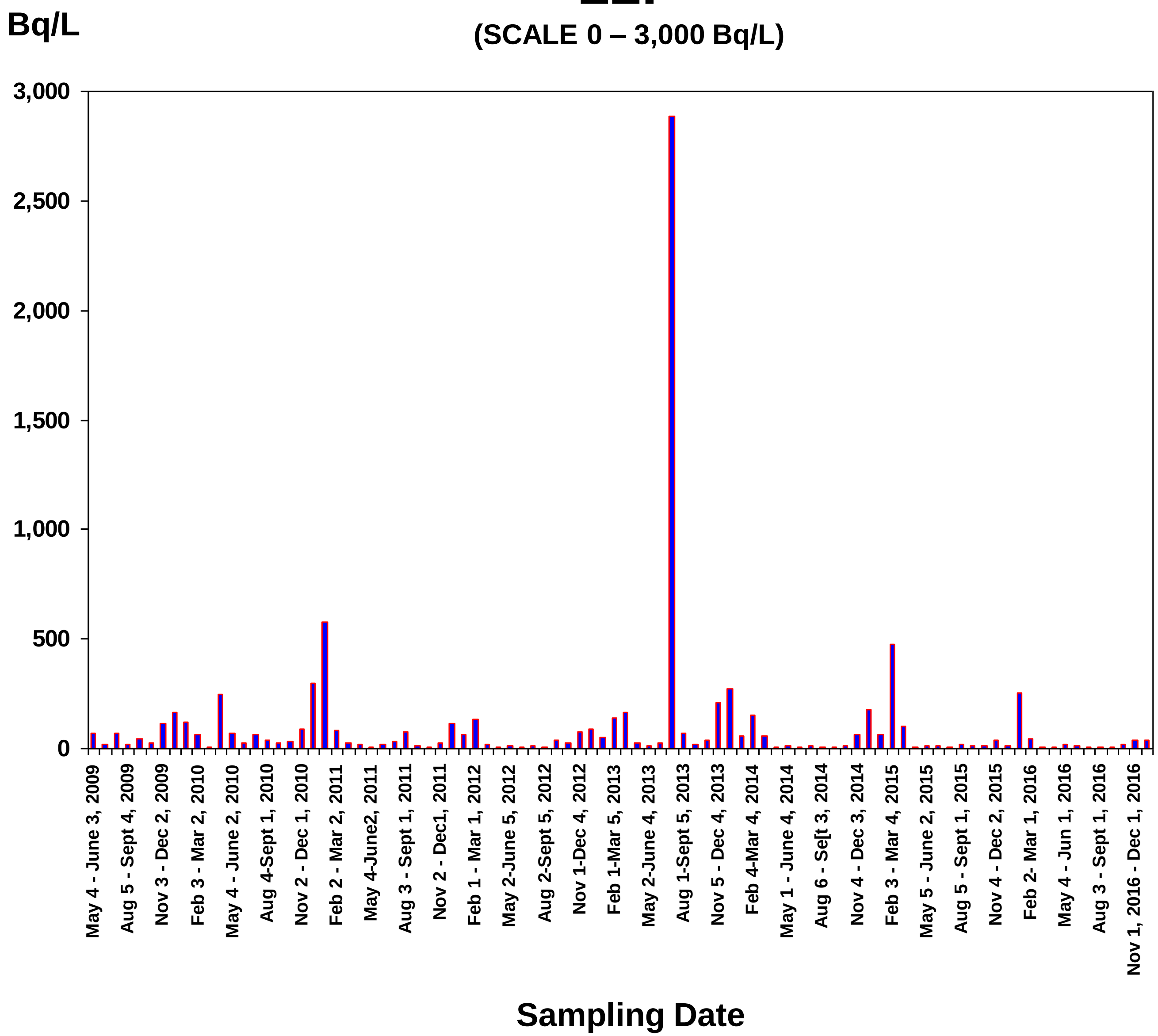


PRECIPITATION RESULTS
18P
(SCALE 0 – 1500 Bq/L)



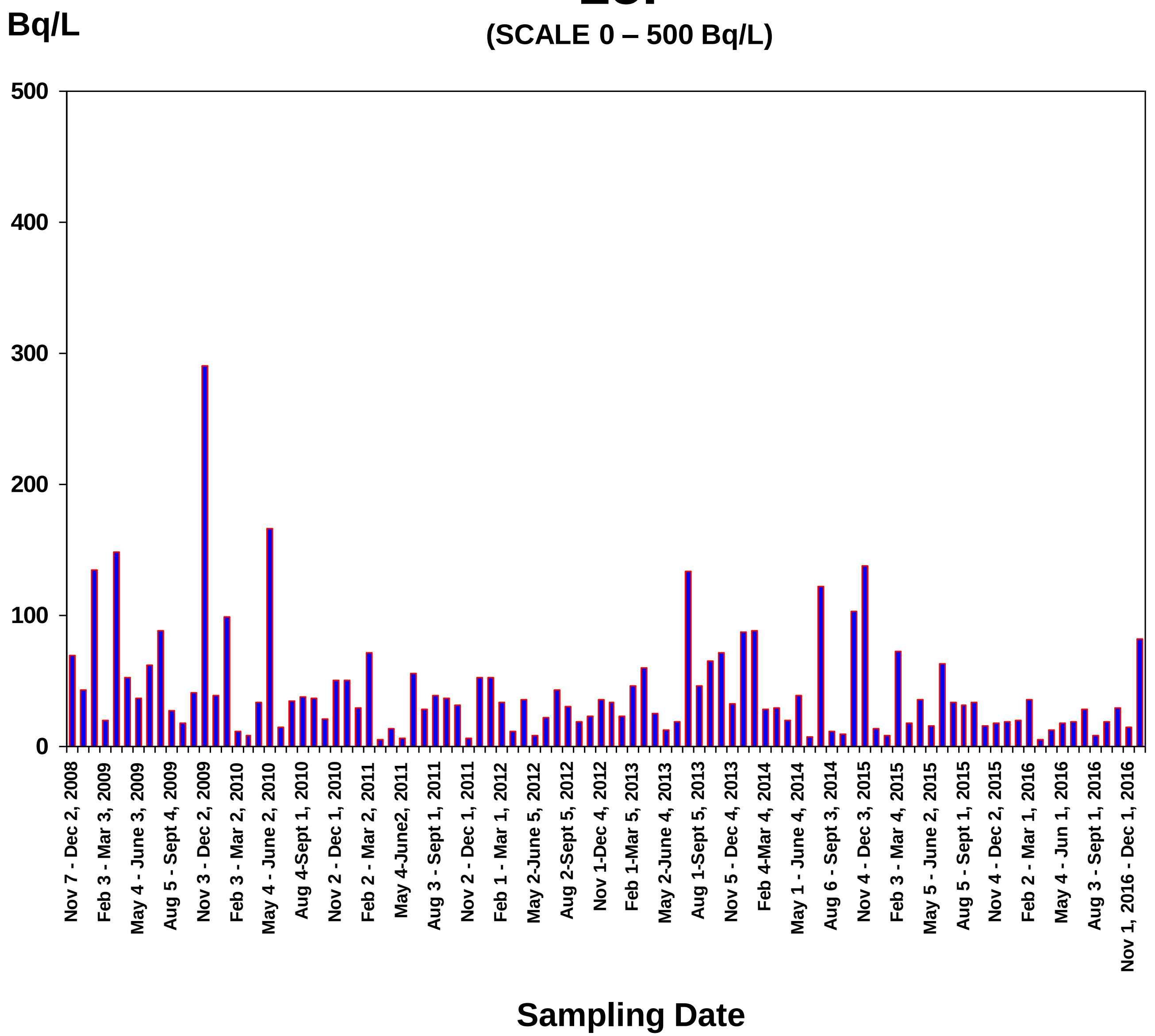
APPENDIX H

PRECIPITATION RESULTS
22P
(SCALE 0 – 3,000 Bq/L)



APPENDIX H

PRECIPITATION RESULTS
25P
(SCALE 0 – 500 Bq/L)



APPENDIX H

APPENDIX I

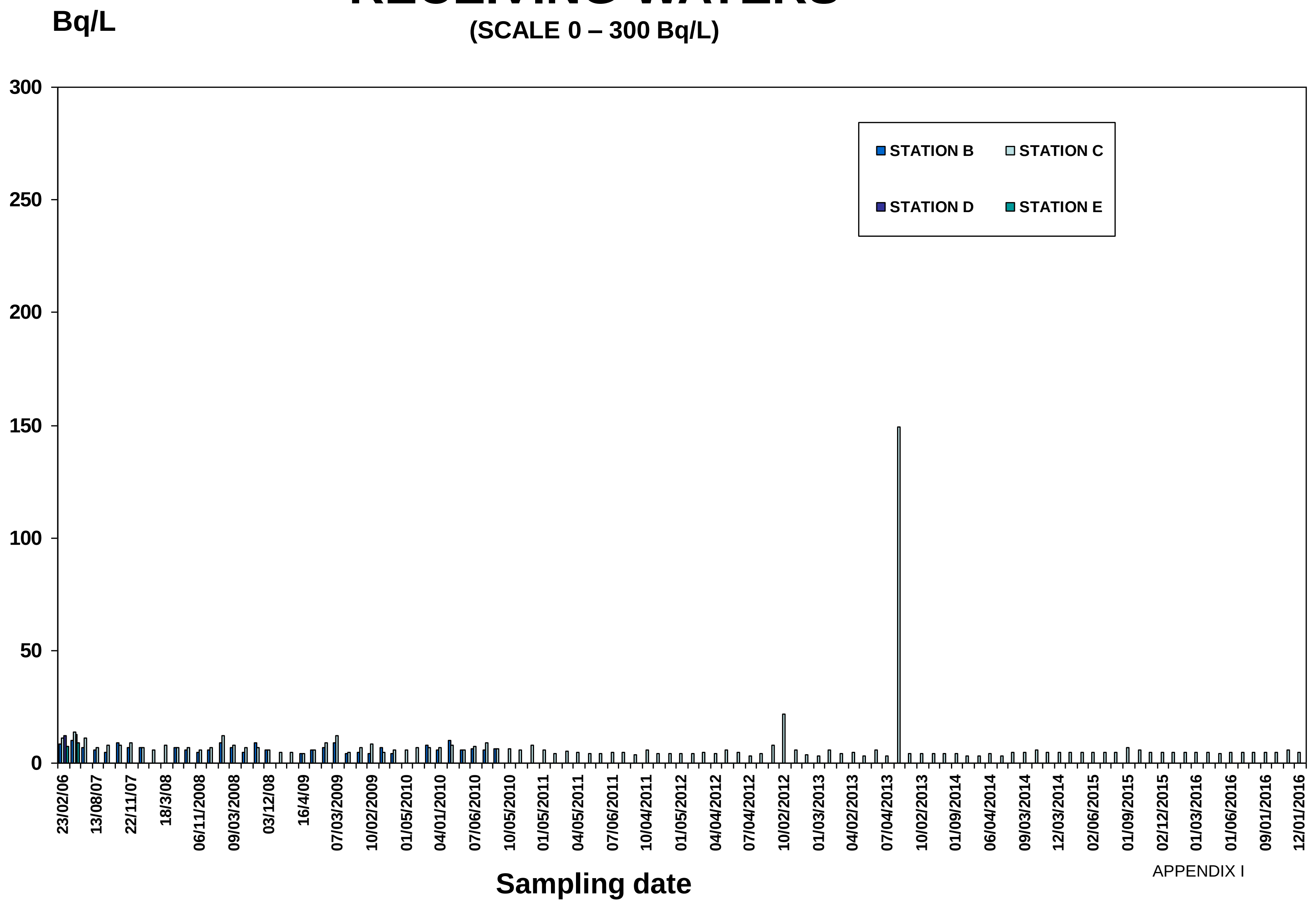
Receiving Waters Monitoring Results for 2016

RECEIVING WATERS MONITORING LOCATIONS

Basemap Source: City of Pembroke (www.pembrokeontario.com)

MONITORING RESULTS
RECEIVING WATERS

(SCALE 0 – 300 Bq/L)



APPENDIX I

APPENDIX J

Runoff Monitoring Results for 2016

Runoff Monitoring Results for 2016

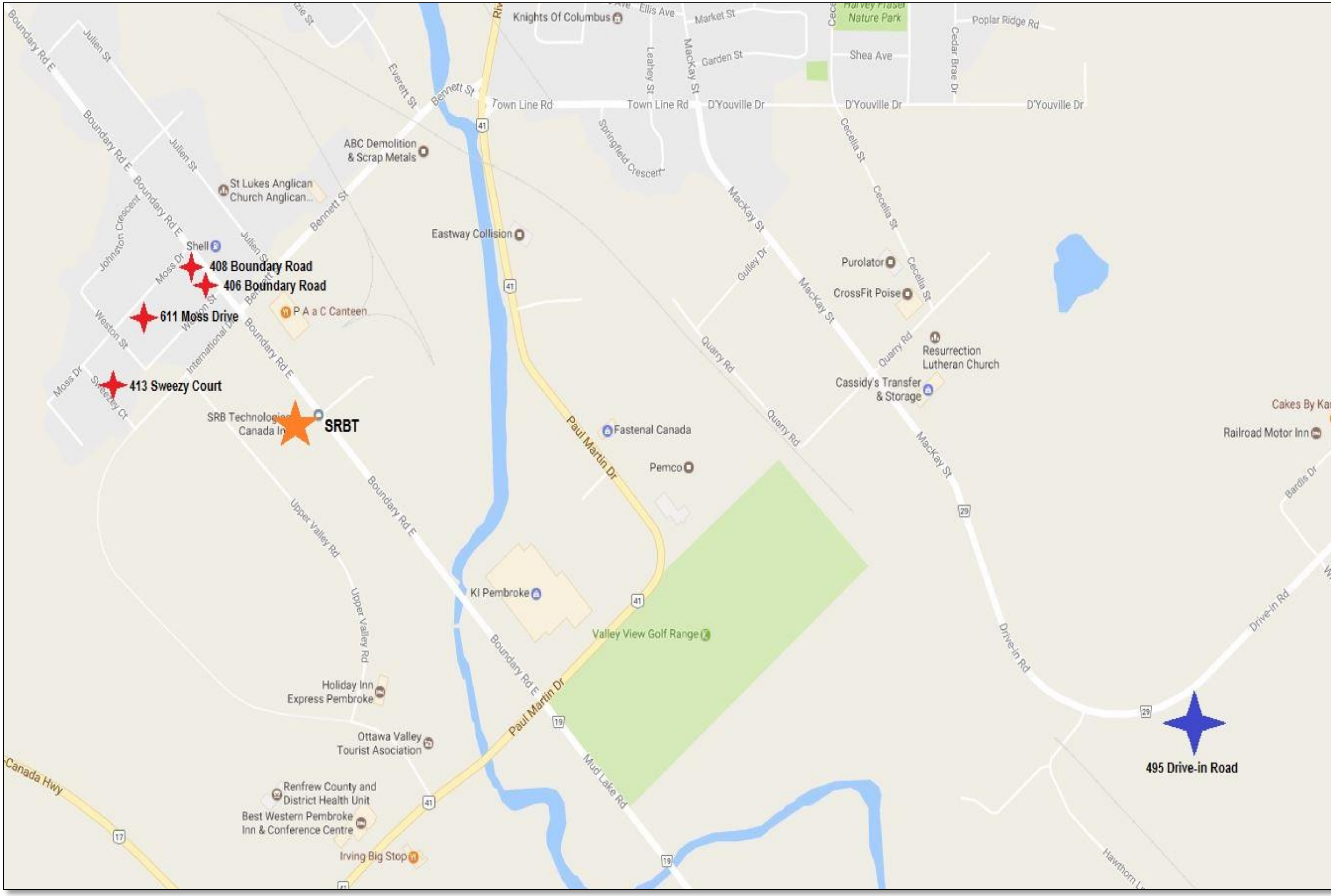
DOWNSPOUTS (Bq/L)							
Date	**Time**	**DS-1**	**DS-2**	**DS-3**	**DS-4**	**DS-5**	**DS-6**
31-Mar-16	10:00 AM	No sample	100	100	100	100	100
15-Jul-16	2:00 PM	No sample	100	100	200	100	300
30-Nov-16	1:15PM	No sample	100	100	100	100	100
Average (Bq/L)		**-**	**100**	**100**	**133**	**100**	**167**
Average all results		**120 Bq/L**					

Lower Limit of Detection – 100 Bq / L

APPENDIX K

Produce Monitoring Results for 2016

Map – 2016 Produce Sampling



Residential Garden Commercial Garden SRBT Facility **Approx. Scale: 1 cm = 110 m**

APPENDIX K

2016 Residential Produce Sampling – Free-water Tritium Concentration

Sample	Units	Result
Apples – 406 Boundary	Bq/kg Fresh weight	65
Tomatoes – 408 Boundary	Bq/kg Fresh weight	45
Apples – 416 Boundary	Bq/kg Fresh weight	71
Apples – 413 Sweezy	Bq/kg Fresh weight	106
Cucumbers – 413 Sweezy	Bq/kg Fresh weight	118
Beets – 413 Sweezy	Bq/kg Fresh weight	75
Carrots – 413 Sweezy	Bq/kg Fresh weight	75
Tomatoes – 611 Moss	Bq/kg Fresh weight	59
Carrots – 611 Moss	Bq/kg Fresh weight	36
AVERAGE (Bq/kg FW)		**72**

2016 Residential Produce Sampling – Organically-bound Tritium (OBT) Concentration

Sample	Units	Result
Tomatoes – 408 Boundary	Bq/kg Fresh weight	4
Carrot –413 Sweezy	Bq/kg Fresh weight	13

2016 Commercial Produce Sampling – Free-water Tritium Concentration

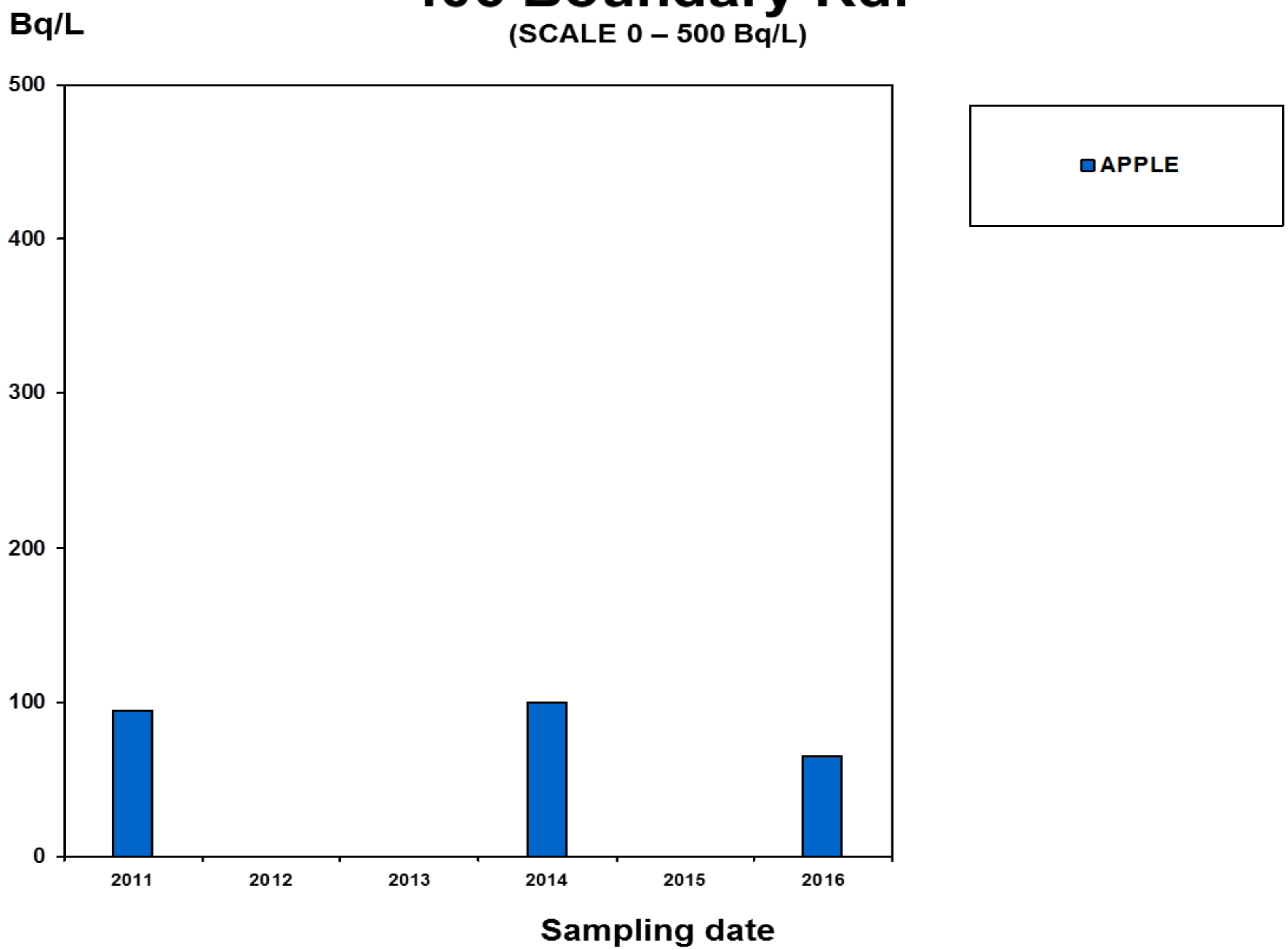
Sample	Units	Result
Cucumbers – 495 Drive-In	Bq/kg Fresh weight	8
Zucchini – 495 Drive-In	Bq/kg Fresh weight	7
Tomatoes – 495 Drive-In	Bq/kg Fresh weight	8
AVERAGE (Bq/kg FW)		**7.7**

2016 Commercial Produce Sampling – Organically-bound Tritium (OBT) Concentration

Sample	Units	Result
Tomatoes – 495 Drive-In	Bq/kg Fresh weight	2

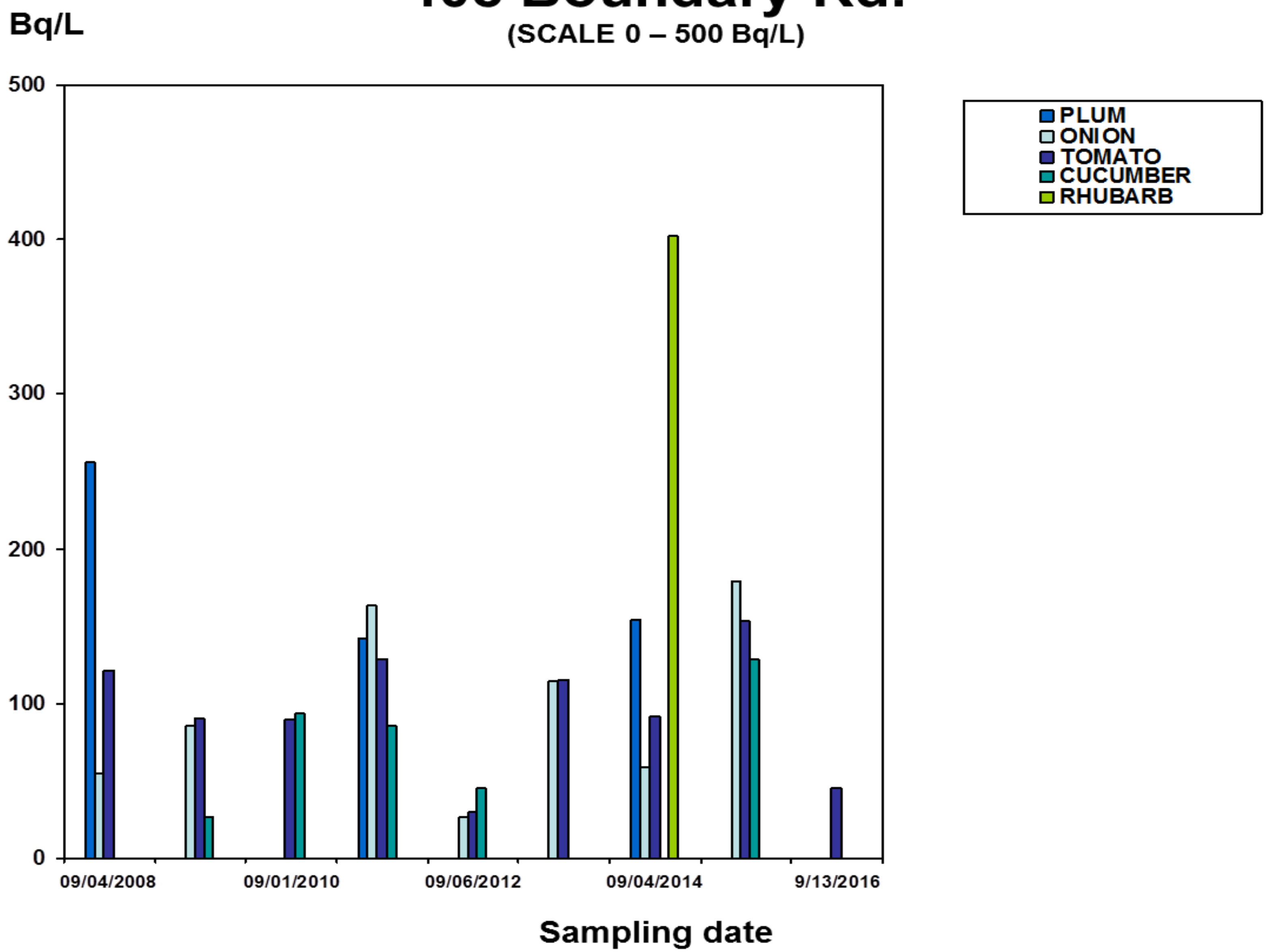
PRODUCE MONITORING RESULTS
406 Boundary Rd.

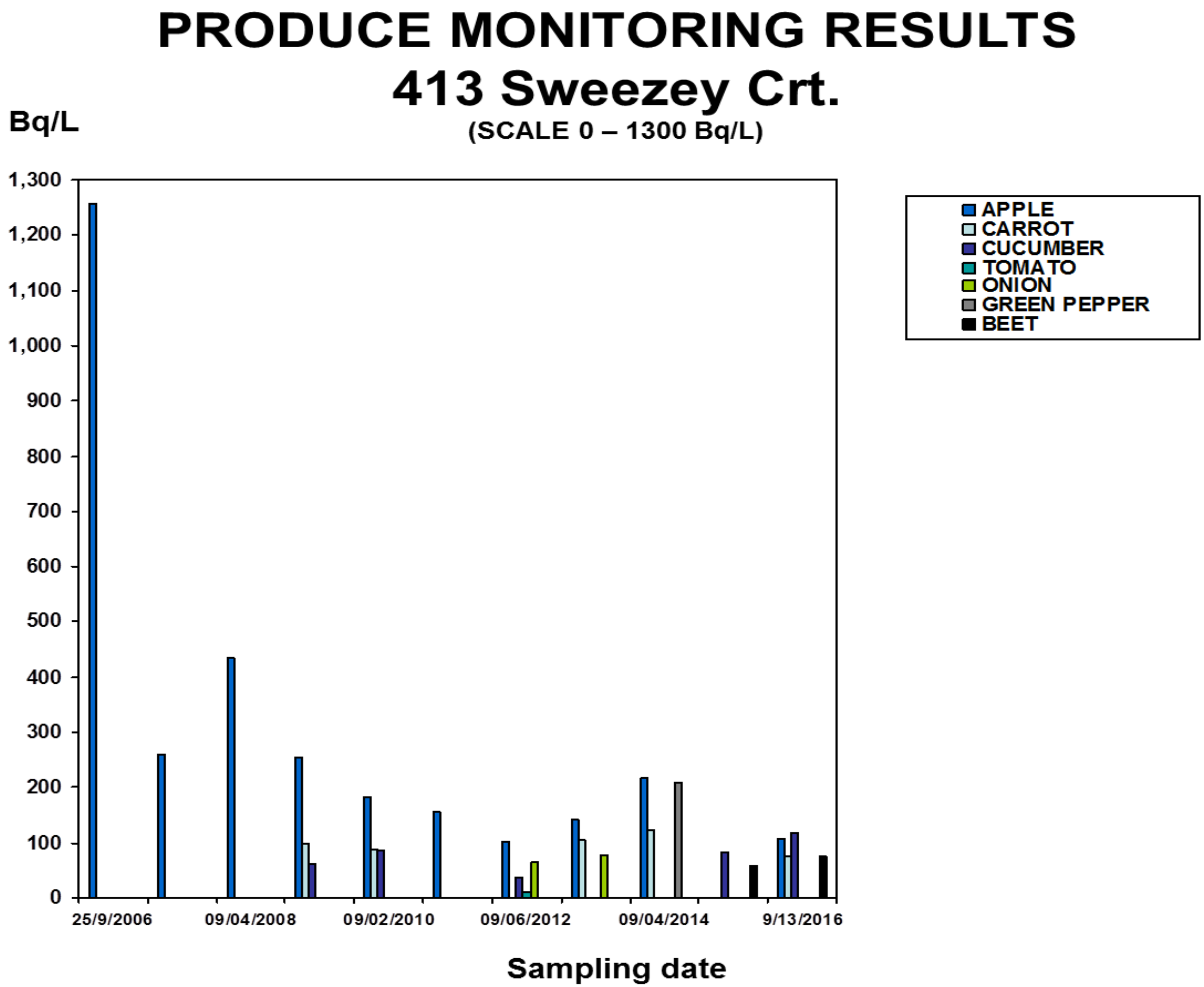
(SCALE 0 – 500 Bq/L)



PRODUCE MONITORING RESULTS
408 Boundary Rd.

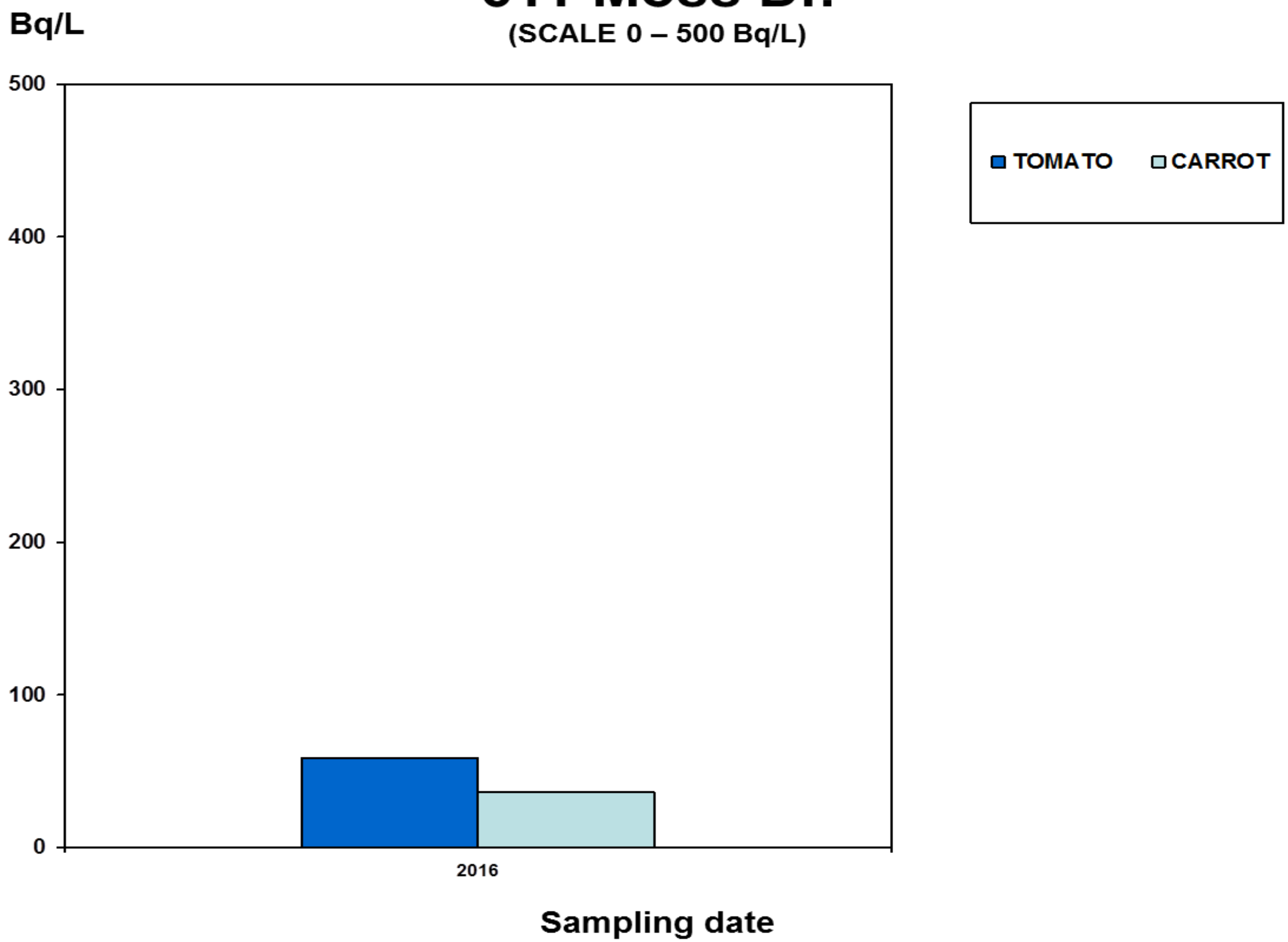
(SCALE 0 – 500 Bq/L)

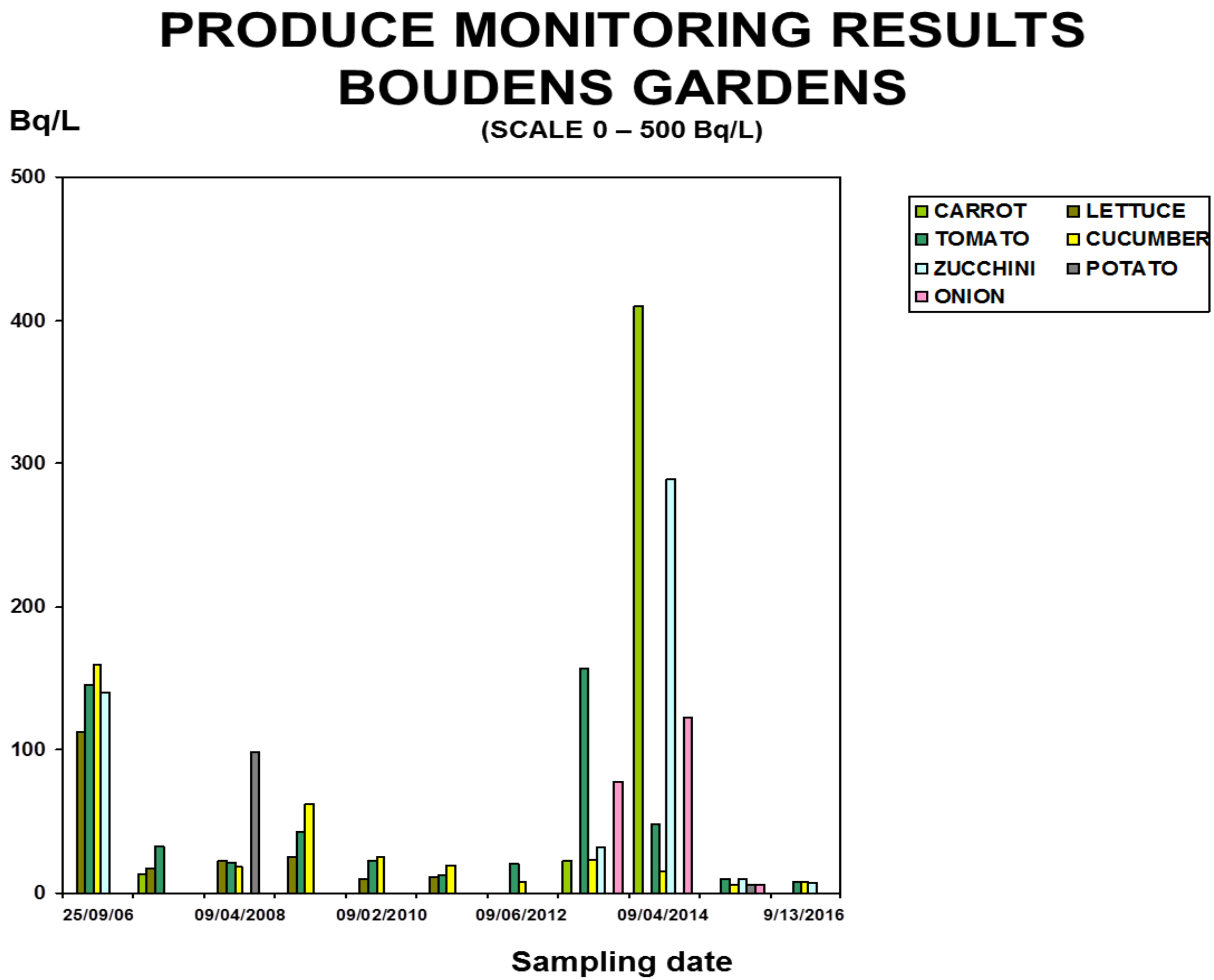



PRODUCE MONITORING RESULTS
413 Sweezey Crt.
(SCALE 0 – 1300 Bq/L)
Bq/L
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
25/9/2006
09/04/2008
09/02/2010
09/06/2012
09/04/2014
9/13/2016
Sampling date
APPLE
CARROT
CUCUMBER
TOMATO
ONION
GREEN PEPPER
BEET

APPENDIX K

PRODUCE MONITORING RESULTS
611 Moss Dr.




PRODUCE MONITORING RESULTS
BOUDENS GARDENS
(SCALE 0 – 500 Bq/L)
Bq/L
500
400
300
200
100
0
25/09/06
09/04/2008
09/02/2010
09/06/2012
09/04/2014
9/13/2016
Sampling date
CARROT
LETTUCE
TOMATO
CUCUMBER
ZUCCHINI
POTATO
ONION

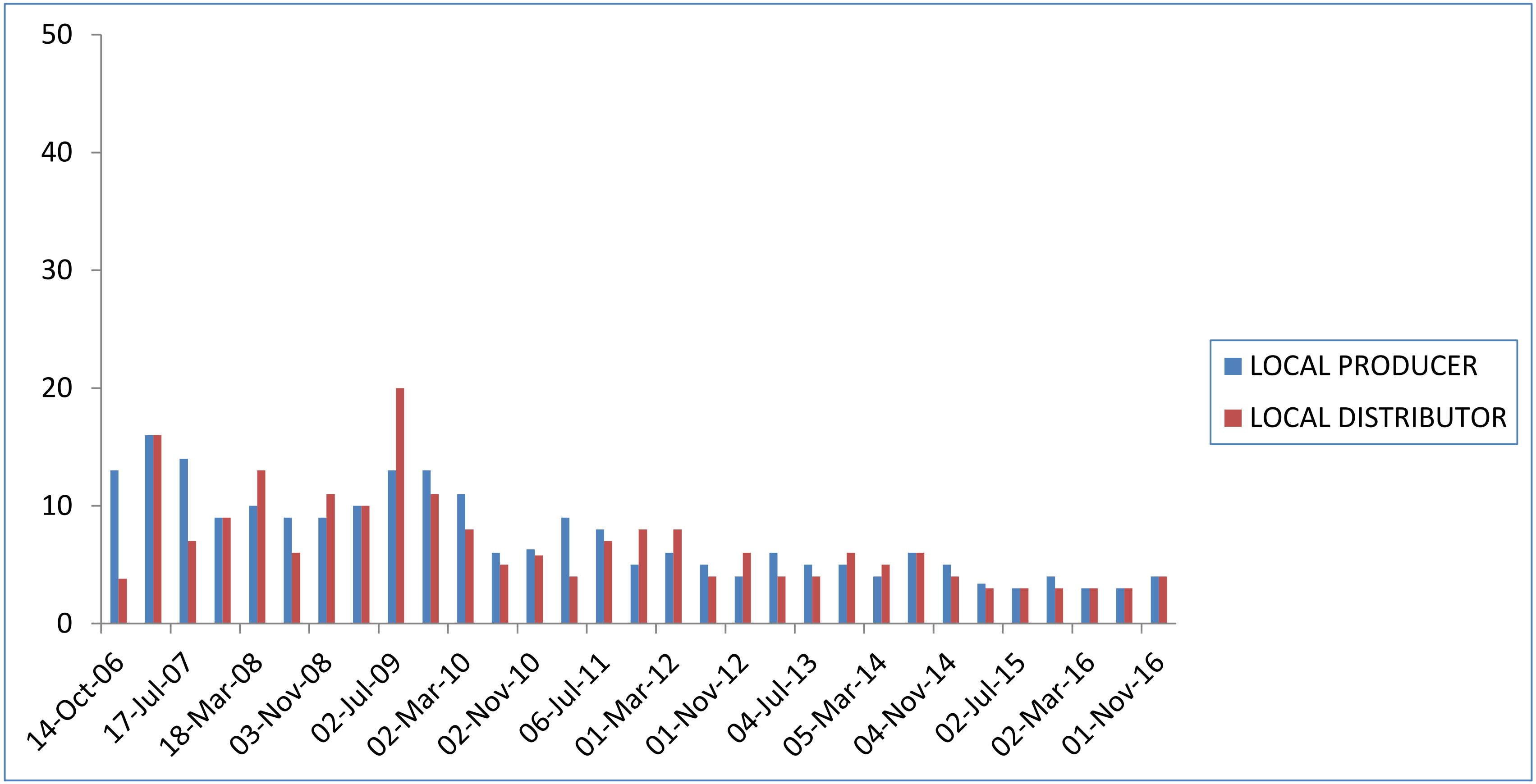
APPENDIX L

Milk Monitoring Results for 2016

MILK

	LOCAL MILK PRODUCER	LOCAL MILK DISTRIBUTOR
	Bq/L	**Bq/L**
14-Oct-06	13	3.8
21-Mar-07	16	16
17-Jul-07	14	7
23-Nov-07	9	9
18-Mar-08	10	13
10-Jul-08	9	6
03-Nov-08	9	11
03-Mar-09	10	10
02-Jul-09	13	20
03-Nov-09	13	11
02-Mar-10	11	8
06-Jul-10	6	5
02-Nov-10	6.3	5.8
02-Mar-11	9	4
06-Jul-11	8	7
02-Nov-11	5	8
01-Mar-12	6	8
04-Jul-12	5	4
01-Nov-12	4	6
05-Mar-13	6	4
04-Jul-13	5	4
05-Nov-13	5	6
05-Mar-14	4	5
03-Jul-14	6	6
04-Nov-14	5	4
04-Mar-15	3.4	3
02-Jul-15	3	3
03-Nov-15	4	3
02-Mar-16	3	3
03-Aug-16	3	3
01-Nov-16	4	4

MONITORING RESULTS
MILK
(SCALE 0 – 50Bq/L)

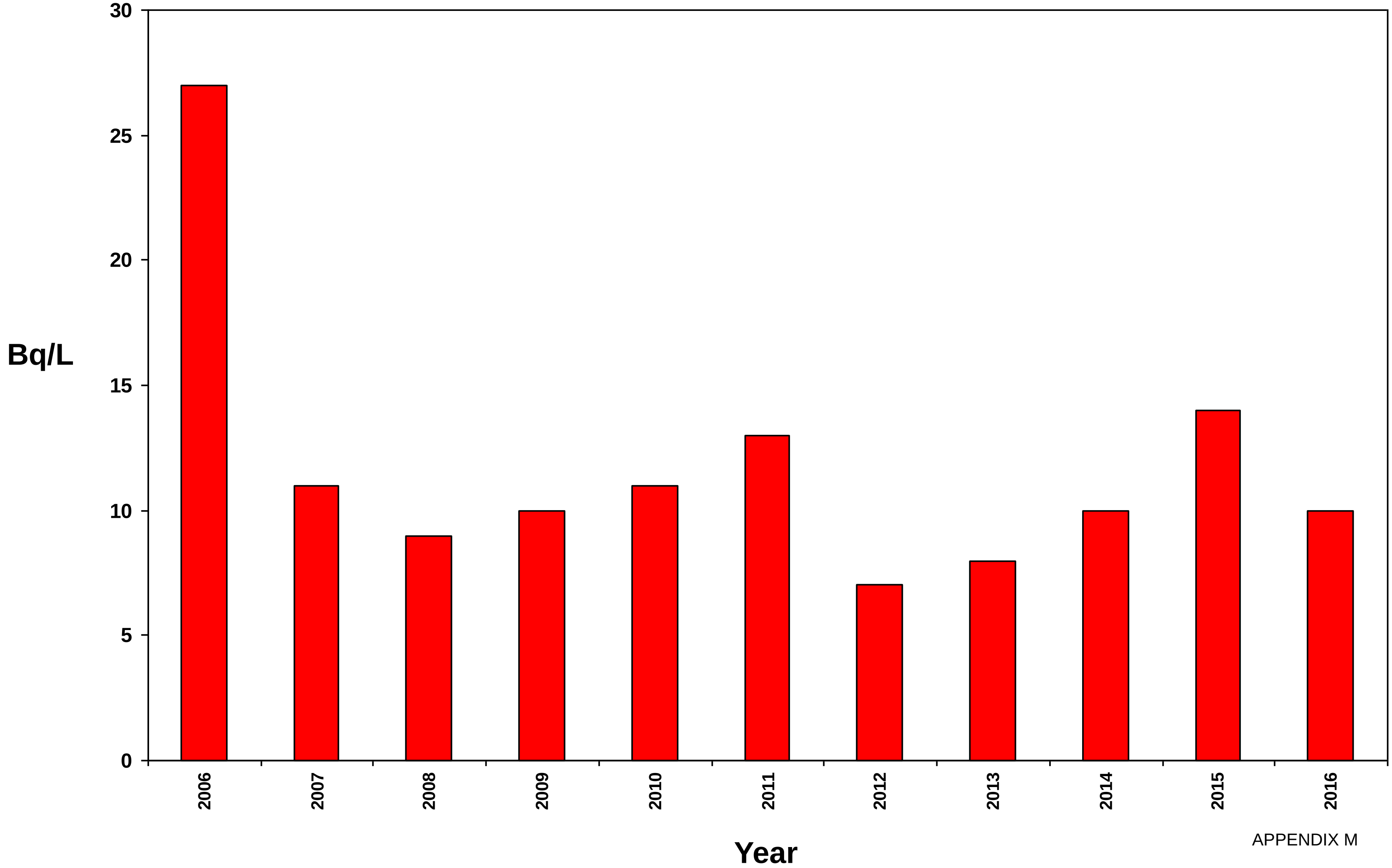


SAMPLING DATE

APPENDIX M

Wine Monitoring Results for 2016

MONITORING RESULTS
WINE
(SCALE 0 – 30 Bq/L)



APPENDIX M

APPENDIX N

Weather Data for 2016

WEATHER DATA SUMMARY

Month	Counts, # (TOTAL)	Wind Speed, m/s (AVG)	Gust Speed, m/s (AVG)	Wind Direction, ø (AVG)	Temp, °C (AVG)	RH, % (AVG)	DewPt, °C (AVG)	Wind sector (nesw)	Total rain (mm)
Jun-09	434	2.1	3.14	193.5	17.839	72.3	12.1	SSW	86.8
Jul-09	429	2.44	3.64	187.9	18.375	77.6	14.1	SSW	85.8
Aug-09	351	2.25	3.37	216.5	18.725	76.81	14.2	SW	70.2
Sep-09	274	2.38	3.56	204.3	13.225	79.5	9.4	SSW	54.8
Oct-09	311	2.68	3.94	184.37	5.94	80.39	2.6	SSW	62.2
Nov-09	223	2.38	3.37	181.22	3.09	84.08	0.48	SSW	44.6
Dec-09	205	3.06	4.28	212.67	-7.98	84.17	-10.20	SW	41
Jan-10	130	2.92	4.14	207.47	-8.00	82.83	-10.45	SSW	26
Feb-10	98	3.80	5.35	263.34	-4.77	78.74	-8.05	WSW	19.6
Mar-10	66	2.62	3.78	207.51	3.20	55.32	-5.74	SSW	13.20
Apr-10	241	3.32	4.87	225.19	9.76	59.56	1.11	SW	48.20
May-10	143	2.76	4.09	209.71	15.21	62.06	6.99	SSW	28.6
Jun-10	541	2.47	3.75	223.24	18.09	71.9	12.35	SW	108.2
Jul-10	456	2.22	3.37	205.34	21.58	74.64	16.40	SSW	91.20
Aug-10	212	2.3	3.52	182.9	19.79	74.62	14.6	SSW	42.4
Sep-10	582	2.71	4.01	215.29	12.94	83	9.88	SW	116.4
Oct-10	336	3.09	4.55	229.58	6.46	76.58	2.25	SW	67.2
Nov-10	488	2.8	4.04	181.89	1.41	80.28	-1.82	SSW	97.6
Dec-10	42	2.84	4.3	236.18	-6.11	83.63	-8.48	SW	8.4
Jan-11	36	2.32	3.35	218.96	-13.55	80.55	-16.23	SW	7.2
Feb-11	64	2.95	4.39	210.46	-7.9	72.02	-12.31	SSW	12.8
Mar-11	243	2.91	4.31	221.81	-2.22	68.57	-7.78	SW	48.6
Apr-11	625	3.07	4.71	198.53	5.98	66.85	-0.59	SSW	125
May-11	313	2.75	4.3	172.74	14.48	70.04	8.29	SSE	62.6
Jun-11	499	2.2	3.47	209.21	19.15	71.63	13.24	SSW	99.8
Jul-11	508	2.17	3.32	213.95	21.25	73.51	15.81	SW	101.6
Aug-11	297	2.18	3.34	205.71	19.43	75.64	14.65	SSW	59.4
Sep-11	345	2.29	3.51	207.55	14.94	79.58	11.12	SSW	69
Oct-11	263	2.52	3.80	195.43	8.90	76.23	4.57	SSW	52.6
Nov-11	334	2.74	4.01	191.12	3.78	76.18	-0.31	SSW	66.8
Dec-11	135	2.86	4.11	194.41	-3.94	84.07	-6.29	SSW	27
Jan-12	79	3.12	4.43	174.91	-8.8	82.65	-11.27	SSE	15.8
Feb-12	42	2.63	3.78	236.99	-5.22	76.11	-8.93	SW	8.4
Mar-12	143	2.98	4.47	184.54	2.98	73.12	-1.91	SSW	28.6
Apr-12	253	3.81	5.69	231.16	6.1	64.08	-1.11	SW	50.6
May-12	283	2.76	4.13	193.14	15.36	65.55	7.99	SSW	56.6
Jun-12	151	2.74	4.21	202.49	20.54	67.96	13.74	SSW	30.2
Jul-12	83	2.15	3.41	203.08	21.97	60.98	13.2	SSW	16.6
Aug-12	376	2.3	3.56	184.35	19.77	75.06	14.75	SSW	75.2
Sep-12	288	2.58	3.83	171.98	13.05	77.68	8.85	SSE	57.6
Oct-12	698	3.01	4.46	154.9	8.17	82.73	5.2	SSE	139.6
Nov-12	107	2.62	3.79	149.02	-0.27	79.5	-3.54	SE	21.4
Dec-12	227	2.64	3.79	175.86	-7.37	86.66	-9.26	SSE	45.4
Jan-13	238	2.88	4.07	158.51	-9.37	81.02	-12.09	SSE	47.6
Feb-13	120	3.11	4.44	172.1	-7.85	80.56	-10.7	SSE	24
Mar-13	56	3.11	4.42	184.89	-0.78	68.28	-6.26	SSW	11.2
Apr-13	393	3.4	4.96	180.57	5.45	67.35	-0.66	S	78.6
May-13	444	2.86	439	157.65	13.73	65.62	6.31	SSE	88.8
Jun-13	575	2	3.13	143.94	17.04	76.44	12.37	SE	115
Jul-13	616	1.96	3.17	204.94	20.78	75	15.76	SSW	123.2
Aug-13	189	1.99	3.23	194.8	18.57	75.66	13.78	SSW	37.8
Sep-13	329	2.17	3.43	179.28	13.51	79.07	9.55	SSE	65.8
Oct-13	485	2.48	3.78	185.72	7.62	78.89	3.94	SSW	97
Nov-13	181	3.53	5.19	165.64	-1.68	80.95	-4.64	SSE	36.2
Dec-13	54	2.61	3.78	157.56	-12.58	80.82	-15.27	SSE	10.8
Jan-14	126	3.06	4.38	179.86	-10.23	77.48	-13.51	SSE	25.2
Feb-14	36	3.03	4.39	163.35	-10.63	70.07	-15.21	SSE	7.2
Mar-14	63	3.3	4.8	146.1	-5.36	66.6	-10.93	SE	12.6
Apr-14	469	3.34	4.94	145.93	4.86	68.9	-1.08	SE	93.8
May-14	327	2.63	4.01	193.05	14.28	67.14	7.45	SSW	65.4
Jun-14	675	2.31	3.58	209.92	19.1	71.34	13.14	SSW	135
Jul-14	609	2.09	3.33	251.26	18.84	75.42	14.01	WSW	121.8
Aug-14	417	2.26	3.43	232.01	18.25	81.17	14.64	SW	83.4
Sep-14	371	2.21	3.42	185.84	13.75	82.62	10.63	SSW	74.2
Oct-14	477	2.79	4.28	164.52	8.38	82.8	5.47	SSE	95.4
Nov-14	123	2.95	4.69	212.65	-1.17	79.57	-4.33	SW	24.6
Dec-14	178	2.74	4.17	209.51	-7.37	82	-10	SSW	35.6
Jan-15	19	2.58	3.82	228.14	-14.19	75.42	-17.69	SW	3.8
Feb-15	20	2.79	4.12	220.51	-15.24	70.86	-19.58	SW	4.0
Mar-15	88	2.71	4.21	204.21	-3.66	64.74	-9.92	SSW	17.6
Apr-15	179	3.23	4.98	227.05	7.29	61.43	-0.69	SW	35.8
May-15	453	2.81	4.35	199.42	15.05	66.37	7.92	SSW	90.6
Jun-15	549	2.4	3.68	212.55	17.35	73.68	12.08	SW	109.8
Jul-15	313	2.1	3.33	163.86	20.55	74.6	15.44	SSE	62.6
Aug-15	357	1.88	2.95	145.95	19.3	80.6	15.59	SE	71.4
Sep-15	163	2.06	3.32	203.53	16.82	77.45	12.52	SSW	32.6
Oct-15	372	2.81	4.26	188.52	6.96	78.15	3.19	SSW	74.4
Nov-15	197	2.59	3.87	160.57	2.97	82.73	0.16	SSE	39.4
Dec-15	240	2.83	4.22	177.37	-0.78	84.3	-3.19	SSE	48
Jan-16	151	3.08	4.36	166.07	-7.51	83.6	-9.85	SSE	30.2
Feb-16	122	2.74	4.09	171.75	-9.74	77.68	-13.02	SSE	24.4
Jul-16	401	1.92	3.18	254.84	21.26	72.5	15.65	WSW	80.2
Aug-16	576	2.11	3.43	268.28	21.16	74.94	16.05	WSW	115.2
Sep-16	331	1.75	2.87	229.96	15.83	79.67	12	SW	66.2
Oct-16	140	2.86	4.41	214.86	7.89	80.07	4.44	SW	28
Nov-16	330	2.66	4.08	192.22	2.95	84.51	0.43	SSW	66
Dec-16	165	2.87	4.21	184.22	-5.76	83.12	-8.23	SSW	33

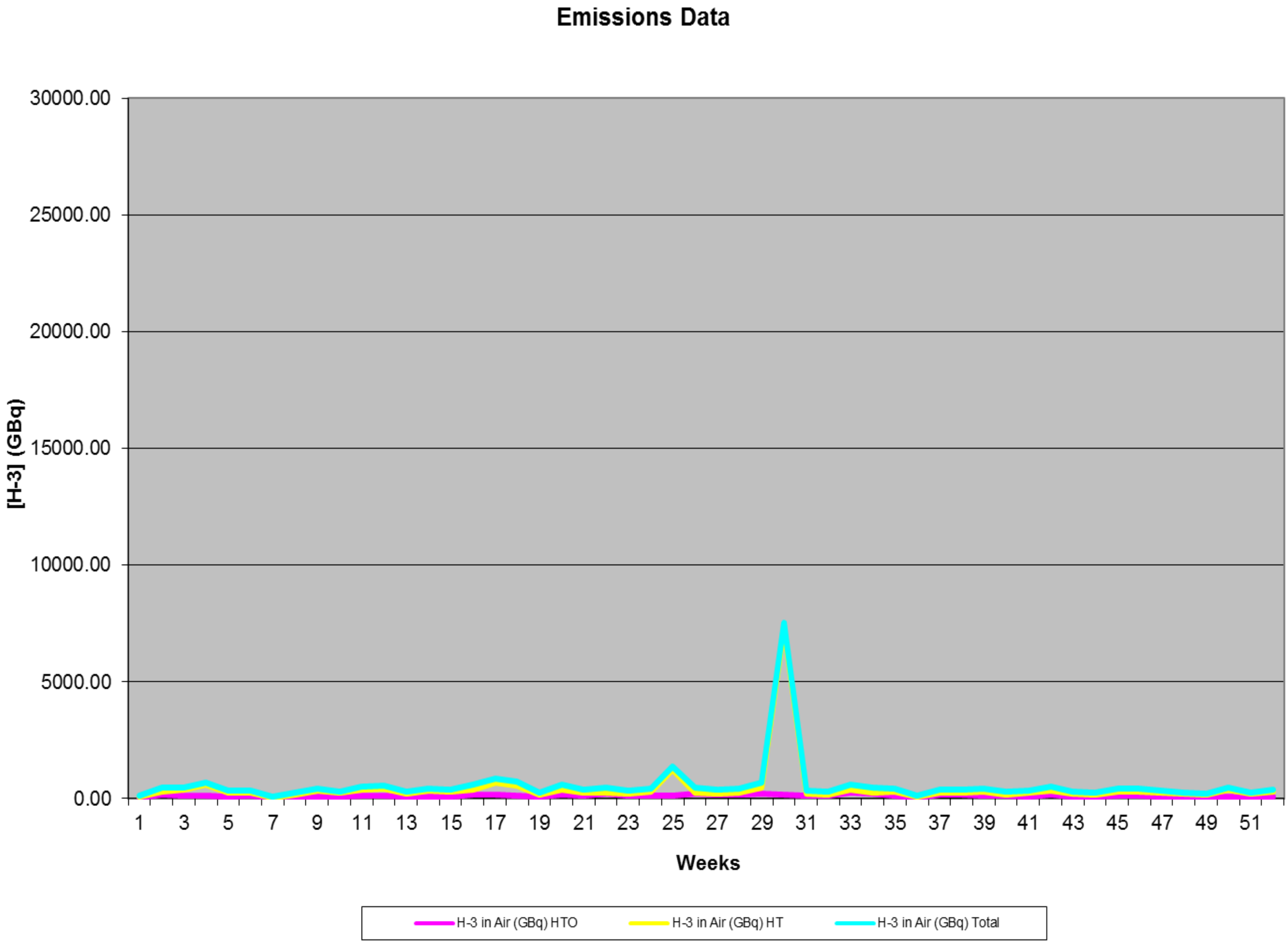
APPENDIX O

Gaseous Effluent Data for 2016

2016 Gaseous Effluent Data

Week	Date		H-3 in Air (GBq)			(GBq)		% 2016 SRBT DRL (12 hr. TJF Data)				Weekly Action Levels	
	Initial	Final	HTO	HT	Total	∑(HTO)	∑(HTO + HT)	1 year old	10 year old	Adult Resident	Adult Worker	HTO (840 GBq)	HTO+HT (7,753 GBq)
1	29/12/2015	05/01/2016	51.00	70.48	121.48	51.00	121.48	0.02	0.03	0.03	0.03	6%	2%
2	05/01/2016	12/01/2016	148.54	297.09	445.63	199.54	567.11	0.07	0.08	0.08	0.10	18%	6%
3	12/01/2016	19/01/2016	118.94	367.59	486.53	318.48	1053.64	0.06	0.07	0.06	0.08	14%	6%
4	19/01/2016	26/01/2016	117.93	582.41	700.34	436.41	1753.98	0.06	0.07	0.07	0.08	14%	9%
5	26/01/2016	02/02/2016	99.75	248.79	348.54	536.16	2102.52	0.05	0.06	0.05	0.07	12%	4%
6	02/02/2016	09/02/2016	103.62	240.86	344.48	639.78	2447.00	0.05	0.06	0.05	0.07	12%	4%
7	09/02/2016	16/02/2016	34.63	46.42	81.05	674.41	2528.05	0.02	0.02	0.02	0.02	4%	1%
8	16/02/2016	23/02/2016	58.32	172.32	230.64	732.73	2758.69	0.03	0.03	0.03	0.04	7%	3%
9	23/02/2016	01/03/2016	100.13	315.73	415.86	832.86	3174.55	0.05	0.06	0.05	0.07	12%	5%
10	01/03/2016	08/03/2016	80.54	233.57	314.11	913.40	3488.66	0.04	0.05	0.04	0.05	10%	4%
11	08/03/2016	15/03/2016	126.84	393.77	520.61	1040.24	4009.27	0.06	0.07	0.07	0.08	15%	7%
12	15/03/2016	22/03/2016	142.45	416.64	559.09	1182.69	4568.36	0.07	0.08	0.08	0.09	17%	7%
13	22/03/2016	29/03/2016	70.51	220.38	290.89	1253.20	4859.25	0.03	0.04	0.04	0.05	8%	4%
14	29/03/2016	05/04/2016	98.94	343.21	442.15	1352.14	5301.40	0.05	0.06	0.05	0.07	12%	6%
15	05/04/2016	12/04/2016	76.68	288.62	365.30	1428.82	5666.70	0.04	0.05	0.04	0.05	9%	5%
16	12/04/2016	19/04/2016	175.81	401.03	576.84	1604.63	6243.54	0.08	0.10	0.09	0.11	21%	7%
17	19/04/2016	26/04/2016	171.43	661.20	832.63	1776.06	7076.17	0.09	0.10	0.09	0.12	20%	11%
18	26/04/2016	03/05/2016	141.55	570.43	711.98	1917.61	7788.15	0.07	0.09	0.08	0.10	17%	9%
19	03/05/2016	10/05/2016	75.51	174.19	249.70	1993.12	8037.85	0.04	0.04	0.04	0.05	9%	3%
20	10/05/2016	17/05/2016	186.31	388.34	574.65	2179.43	8612.50	0.09	0.11	0.10	0.12	22%	7%
21	17/05/2016	24/05/2016	132.05	255.32	387.37	2311.48	8999.87	0.06	0.07	0.07	0.09	16%	5%
22	24/05/2016	31/05/2016	207.44	246.05	453.49	2518.92	9453.36	0.10	0.11	0.10	0.13	25%	6%
23	31/05/2016	07/06/2016	135.80	212.66	348.46	2654.72	9801.82	0.06	0.08	0.07	0.09	16%	4%
24	07/06/2016	14/06/2016	134.85	275.53	410.38	2789.57	10212.20	0.06	0.08	0.07	0.09	16%	5%
25	14/06/2016	21/06/2016	123.96	1246.73	1370.69	2913.53	11582.89	0.08	0.09	0.08	0.10	15%	18%
26	21/06/2016	28/06/2016	209.02	267.76	476.78	3122.55	12059.67	0.10	0.12	0.11	0.13	25%	6%
27	28/06/2016	05/07/2016	166.45	204.64	371.09	3289.00	12430.76	0.08	0.09	0.08	0.11	20%	5%
28	05/07/2016	12/07/2016	180.90	229.88	410.78	3469.90	12841.54	0.08	0.10	0.09	0.12	22%	5%
29	12/07/2016	19/07/2016	201.01	476.80	677.81	3670.91	13519.35	0.10	0.12	0.11	0.13	24%	9%
30	19/07/2016	26/07/2016	168.24	7374.92	7543.16	3839.15	21062.51	0.19	0.22	0.21	0.23	20%	97%
31	26/07/2016	02/08/2016	116.23	218.62	334.85	3955.38	21397.36	0.06	0.07	0.06	0.08	14%	4%
32	02/08/2016	09/08/2016	121.63	163.79	285.42	4077.01	21682.78	0.06	0.07	0.06	0.08	14%	4%
33	09/08/2016	16/08/2016	242.32	368.33	610.65	4319.33	22293.43	0.11	0.14	0.12	0.16	29%	8%
34	16/08/2016	23/08/2016	199.49	268.98	468.47	4518.82	22761.90	0.09	0.11	0.10	0.13	24%	6%
35	23/08/2016	30/08/2016	131.58	290.45	422.03	4650.40	23183.93	0.06	0.08	0.07	0.09	16%	5%
36	30/08/2016	06/09/2016	50.57	90.13	140.70	4700.97	23324.63	0.02	0.03	0.03	0.03	6%	2%
37	06/09/2016	13/09/2016	157.13	234.74	391.87	4858.10	23716.50	0.07	0.09	0.08	0.10	19%	5%
38	13/09/2016	20/09/2016	147.90	243.30	391.20	5006.00	24107.70	0.07	0.08	0.08	0.10	18%	5%
39	20/09/2016	27/09/2016	137.11	295.83	432.94	5143.11	24540.64	0.07	0.08	0.07	0.09	16%	6%
40	27/09/2016	04/10/2016	104.96	176.57	281.53	5248.07	24822.17	0.05	0.06	0.05	0.07	12%	4%
41	04/10/2016	11/10/2016	84.14	242.34	326.48	5332.21	25148.65	0.04	0.05	0.04	0.06	10%	4%
42	11/10/2016	18/10/2016	159.25	343.25	502.50	5491.46	25651.15	0.08	0.09	0.08	0.10	19%	6%
43	18/10/2016	25/10/2016	96.49	198.38	294.87	5587.95	25946.02	0.05	0.05	0.05	0.06	11%	4%
44	25/10/2016	01/11/2016	66.29	171.97	238.26	5654.24	26184.28	0.03	0.04	0.03	0.04	8%	3%
45	01/11/2016	08/11/2016	117.90	301.94	419.84	5772.14	26604.12	0.06	0.07	0.06	0.08	14%	5%
46	08/11/2016	15/11/2016	109.94	296.59	406.53	5882.08	27010.65	0.05	0.06	0.06	0.07	13%	5%
47	15/11/2016	22/11/2016	65.48	264.32	329.80	5947.56	27340.45	0.03	0.04	0.04	0.04	8%	4%
48	22/11/2016	29/11/2016	50.85	208.98	259.83	5998.41	27600.28	0.03	0.03	0.03	0.03	6%	3%
49	29/11/2016	06/12/2016	59.97	169.01	228.98	6058.38	27829.26	0.03	0.03	0.03	0.04	7%	3%
50	06/12/2016	13/12/2016	82.78	400.53	483.31	6141.16	28312.57	0.04	0.05	0.05	0.06	10%	6%
51	13/12/2016	20/12/2016	52.90	194.26	247.16	6194.06	28559.73	0.03	0.03	0.03	0.04	6%	3%
52	20/12/2016	27/12/2016	98.91	286.04	384.95	6292.97	28944.68	0.05	0.06	0.05	0.07	12%	5%
	Annual Total		6292.97	22651.71	28944.68			Average % DRL					
	Weekly Average		121.02	435.61	556.63			0.06	0.07	0.07	0.08		
				(Bq/a)	Release Limit			Projected Dose (uSv/a)					
% Annual Release Limit:			HTO	6.72E+13	9.36			0.61	0.72	0.66	0.82		
			HTO + HT	4.48E+14	6.46			1 year old	10 year old	Adult Resident	Adult Worker		
Derived Weekly HTO Release/Emission Limit (GBq/week)								2.24E+05	1.88E+05	2.08E+05	1.63E+05		
Derived Weekly HT Release/ Emission Limit (GBq/week)								6.32E+06	5.61E+06	5.54E+06	5.69E+06		

APPENDIX O


Emissions Data
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25000.00
20000.00
15000.00
10000.00
5000.00
0.00
[H-3] (GBq)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51
Weeks
H-3 in Air (GBq) HTO
H-3 in Air (GBq) HT
H-3 in Air (GBq) Total

APPENDIX O

APPENDIX P

Liquid Effluent Data for 2016

ANNUAL LIQUID EFFLUENT TRACKING TABLE			
Year = 2016			
WEEK ENDING	WEEKLY RELEASE (Bq)	WEEK	ANNUAL LICENCE LIMIT
			200,000,000,000
10-Jan-16	465,500	1	199,999,534,500
17-Jan-16	60,916,500	2	199,938,618,000
24-Jan-16	2,268,667	3	199,936,349,333
31-Jan-16	2,778,667	4	199,933,570,666
7-Feb-16	107,912,276	5	199,825,658,390
14-Feb-16	51,523,768	6	199,774,134,622
21-Feb-16	0	7	199,774,134,622
28-Feb-16	2,600,667	8	199,771,533,955
6-Mar-16	0	9	199,771,533,955
13-Mar-16	37,341,500	10	199,734,192,455
20-Mar-16	4,814,000	11	199,729,378,455
27-Mar-16	0	12	199,729,378,455
3-Apr-16	10,762,033	13	199,718,616,422
10-Apr-16	0	14	199,718,616,422
17-Apr-16	109,814,300	15	199,608,802,122
24-Apr-16	463,881,593	16	199,144,920,529
1-May-16	395,919,480	17	198,749,001,049
8-May-16	254,188,573	18	198,494,812,476
15-May-16	121,158,000	19	198,373,654,476
22-May-16	0	20	198,373,654,476
29-May-16	72,605,833	21	198,301,048,643
5-Jun-16	162,312,465	22	198,138,736,178
12-Jun-16	88,591,500	23	198,050,144,678
19-Jun-16	2,661,533	24	198,047,483,145
26-Jun-16	87,714,000	25	197,959,769,145
3-Jul-16	68,942,667	26	197,890,826,478
10-Jul-16	151,640,613	27	197,739,185,865
17-Jul-16	75,426,746	28	197,663,759,119
24-Jul-16	36,920,533	29	197,626,838,586
31-Jul-16	207,457,345	30	197,419,381,241
7-Aug-16	267,030,437	31	197,152,350,804
14-Aug-16	368,021,842	32	196,784,328,962
21-Aug-16	317,419,722	33	196,466,909,240
28-Aug-16	98,825,871	34	196,368,083,369
4-Sep-16	43,864,533	35	196,324,218,836
11-Sep-16	0	36	196,324,218,836
18-Sep-16	55,482,200	37	196,268,736,636
25-Sep-16	51,359,000	38	196,217,377,636
2-Oct-16	5,558,766	39	196,211,818,870
9-Oct-16	0	40	196,211,818,870
16-Oct-16	290,540	41	196,211,528,330
23-Oct-16	0	42	196,211,528,330
30-Oct-16	5,354,053	43	196,206,174,277
6-Nov-16	320,733	44	196,205,853,544
13-Nov-16	0	45	196,205,853,544
20-Nov-16	0	46	196,205,853,544
27-Nov-16	261,454,373	47	195,944,399,171
4-Dec-16	324,076,200	48	195,620,322,971
11-Dec-16	259,574,760	49	195,360,748,211
18-Dec-16	326,149,540	50	195,034,598,671
25-Dec-16	216,187,280	51	194,818,411,391
1-Jan-17	0	52	194,818,411,391
		53	194,818,411,391
Annual Total (Bq)	5,181,588,609		
Annual Total (GBq)	5.18		
Limit (GBq)	200		
% of limit	**2.59**		

Generated: January 6, 2017

Compiled by:
Jamie MacDonald, Manager HP

APPENDIX Q

Well Monitoring Results for 2016

WELL I.D.	DESCRIPTION		DISTANCE FROM STACKS (m)	Jan. 6, 2016	Feb. 2, 2016	Mar. 2, 2016	Apr. 6, 2016	May 4, 2016	June 1, 2016	July 5, 2016	Aug. 3, 2016	Sep. 1, 2016	Oct. 4, 2016	Nov. 1, 2016	Dec. 1, 2016	WELL I.D.
MW06-1	SRB SITE	IN SOIL	50	3,467	3,558	4,067	3,281	2,702	2,730	2,249	2,236	2,050	2,202	2,246	2,246	MW06-1
MW06-2	SRB SITE	IN SOIL	75	1,960	1,629	1,757	1,066	864	1,339	1,366	1,511	1,515	1,495	1,610	1,488	MW06-2
MW06-3	SRB SITE	IN SOIL	50	1,256	1,178	1,152	1,115	979	910	927	927	1,020	914	No Sample	940	MW06-3
MW06-8	SRB SITE	IN SOIL	55	899	883	894	No Sample	863	858	833	818	854	819	839	764	MW06-8
MW06-9	SRB SITE	IN SOIL	25	2,661	2,695	2,680	2,584	2,468	2,475	2,381	2,462	2,444	2,276	2,349	2,237	MW06-9
MW06-10	SRB SITE	SURFACE OF BEDROCK	0	52,969	54,058	57,623	37,084	25,740	32,201	43,643	60,571	54,982	55,401	53,311	50,689	MW06-10
MW07-11	SRB SITE	SURFACE OF BEDROCK	75	1,640	1,588	No Sample	1,254	1,036	1,007	1,264	1,372	1,456	1,414	1,420	1,332	MW07-11
MW07-12	SRB SITE	SURFACE OF BEDROCK	55	484	473	471	477	507	498	526	504	525	370	385	408	MW07-12
MW07-13	SRB SITE	SURFACE OF BEDROCK	50	11,971	12,133	11,725	10,245	10,149	10,159	10,380	10,443	10,500	9,919	9,869	9,419	MW07-13
MW07-15	SRB SITE	SURFACE OF BEDROCK	25	1,591	1,749	3,212	1,875	1,771	1,736	1,725	1,742	1,642	1,576	1,586	1,517	MW07-15
MW07-16	SRB SITE	SURFACE OF BEDROCK	15	1,963	2,008	1,978	2,016	1,955	1,770	1,838	1,856	1,885	1,794	1,753	1,730	MW07-16
MW07-17	SRB SITE	DEEPER BEDROCK	15	883	848	772	620	399	344	417	545	548	592	627	629	MW07-17
MW07-18	SRB SITE	SURFACE OF BEDROCK	10	4,811	4,017	4,566	3,238	3,397	2,972	3,623	3,860	3,552	3,518	3,500	3,223	MW07-18
MW07-19	SRB SITE	SURFACE OF BEDROCK	20	2,678	2,120	3,404	2,622	1,907	1,532	2,511	2,848	2,571	2,603	2,470	2,732	MW07-19
MW07-20	SUPERIOR PROPANE PROPERTY	SURFACE OF BEDROCK	90	704	770	703	702	705	646	720	666	601	612	639	567	MW07-20
MW07-21	SUPERIOR PROPANE PROPERTY	SURFACE OF BEDROCK	110	1,002	1,096	941	1,021	1,185	868	1,066	955	940	1,021	1,076	937	MW07-21
MW07-22	SRB SITE	SURFACE OF BEDROCK	70	1,178	1,200	1,172	1,128	1,118	981	1,135	1,190	1,146	1,103	1,127	1,089	MW07-22
MW07-23	SRB SITE	SURFACE OF BEDROCK	90	2,141	2,115	2,095	2,028	1,946	1,877	1,899	1,865	1,877	1,869	1,770	1,660	MW07-23
MW07-24	HARRINGTON PROPERTY	SURFACE OF BEDROCK	115	2,235	2,309	2,264	2,338	2,279	2,127	2,209	2,176	2,207	2,118	2,117	2,094	MW07-24
MW07-26	SRB SITE	SURFACE OF BEDROCK	50	1,844	1,802	1,860	No Sample	1,062	1,561	1,648	1,660	1,511	1,366	1,087	995	MW07-26
MW07-27	CITY PROPERTY	SURFACE OF BEDROCK	55	4769	4,660	4,655	No Sample	4,039	3,700	4,283	4,289	4,234	4,189	4,274	4,116	MW07-27
MW07-28	CITY PROPERTY	DEEPER BEDROCK	55	1,569	1,063	1,422	1,882	1,279	908	1,205	1,295	1,351	1,244	1,275	1,240	MW07-28
MW07-29	SRB SITE	DEEPER BEDROCK	10	4,034	4,003	3,502	2,578	2,718	2,723	3,279	2,653	3,411	3,291	4,243	4,308	MW07-29
MW07-31	SRB SITE	DEEPER BEDROCK	70	664	251	316	148	142	338	507	518	722	335	694	646	MW07-31
MW07-32	HARRINGTON PROPERTY	DEEPER BEDROCK	115	249	249	182	91	<80	<80	<81	<79	<77	<76	78	<80	MW07-32
MW07-34	SRB SITE	SHALLOW BEDROCK	10	3,236	3,002	2,716	3,066	3,043	2,637	2,891	2,656	2,783	2,735	2,560	2,540	MW07-34
MW07-35	CITY PROPERTY	SHALLOW BEDROCK	55	3,961	3,756	3,630	3,385	3,546	2,942	3,255	3,320	3,464	3,311	3,570	3,237	MW07-35
MW07-36	CITY PROPERTY	SHALLOW BEDROCK	80	3,026	2,960	3,037	2,055	1,840	2,085	2,691	2,832	2,753	No Sample	2,730	2,788	MW07-36
MW07-37	SRB SITE	SHALLOW BEDROCK	60	1,115	1,209	1,055	843	798	888	891	1,001	961	1,025	989	1,088	MW07-37
CN-1S	CN PROPERTY		125			No Sample	No Sample	450		No Sample				No Sample		CN-1S
CN-1D	CN PROPERTY		130			844		698		No Sample				No Sample		CN-1D
CN-2	CN PROPERTY		150			No Sample	No Sample	313		590				725		CN-2
CN-3S	CN PROPERTY		165			No Sample	300	205		282				No Sample		CN-3S
CN-3D	CN PROPERTY		160			No Sample	No Sample	166		181				No Sample		CN-3D
RW-1	413 BOUNDARY ROAD		465			N/A	N/A			N/A				N/A		RW-1
RW-2	185 MUD LAKE ROAD		1,100			Not Home	87			67				55		RW-2
RW-3	183 MUD LAKE ROAD		1,100			83				75				64		RW-3
RW-4	711 BRUHAM AVENUE		2,200			N/A	N/A			N/A				N/A		RW-4
RW-5	171 SAWMILL ROAD		2,300			9				8				10		RW-5
RW-6	40987 HWY 41		1,400			11				11				8		RW-6
RW-7	40925 HWY 41		1,600			Not Home	4			4				<4		RW-7
RW-8	204 BOUNDARY ROAD		700			174				170				180		RW-8
RW-9	206 BOUNDARY ROAD		650			60				93				8		RW-9
RW-10	208 BOUNDARY ROAD		625			<4				<3				<4		RW-10
RW-11	200 MUD LAKE ROAD		794			N/A	N/A			N/A				N/A		RW-11
RW-12	202 MUD LAKE ROAD		753			<3				<3				<3		RW-12
B-1	SUPERIOR PROPANE OFFICE		160			Closed	Closed			958				Closed		B-1
B-2	SUPERIOR PROPANE TRUCK WASH		250			985				1,111				934		B-2
B-3	INTERNATIONAL LUMBER OFFICE		385			<3				<3				<4		B-3

APPENDIX R

Compilation of Water Level Measurements for 2016

RSO-026-F-02: Well Level Tracking Sheet (Rev. A)

	MW06-1	MW06-2	MW06-3	MW06-8	MW06-9	MW06-10	MW07-11	MW07-12	MW07-13	MW07-15
Easting	335449	335478	335363	335464	335401	335408	335478	335465	335448	335403
Northing	5074615	5074578	5074535	5074590	5074605	5074506	5074576	5074588	5074616	5074605
TOP Elevation (m)	130.99	130.03	133.09	130.30	131.15	131.32	130.06	130.41	130.92	130.84
GS Elevation (m)	130.17	129.24	132.32	129.58	129.86	130.24	129.15	129.58	130.03	129.93
Well Diameter (m)	0.051	0.051	0.051	0.032	0.032	0.032	0.032	0.032	0.032	0.032
Well Depth (m)	5.165	5.330	6.130	6.700	5.930	7.770	7.215	7.450	6.615	7.230
Stick-up (m)	0.820	0.788	0.767	0.720	1.290	1.077	0.905	0.835	0.893	0.910
dd/mm/yyyy										
05-Jan-16	128.32	127.61	127.77	126.64	128.02	127.34	126.70	126.60	126.50	127.35
01-Feb-16	128.39	127.42	127.87	126.56	127.82	127.35	126.59	126.53	126.57	127.34
01-Mar-16	127.66	127.17	127.50	126.14	127.23	126.74	126.10	126.11	125.93	126.62
05-Apr-16	129.09	128.38	130.41	128.21	129.81	129.66	128.21	128.24	128.29	129.56
03-May-16	128.98	128.06	129.95	128.01	129.62	129.32	128.03	128.05	128.05	129.26
31-May-16	128.71	127.77	128.65	127.35	128.95	128.37	127.37	127.35	127.29	128.35
04-Jul-16	128.22	127.49	127.36	126.43	127.75	127.75	126.47	126.38	126.28	127.12
02-Aug-16	127.40	127.19	127.26	126.09	127.21	126.63	126.25	126.03	125.77	126.54
31-Aug-16	128.09	127.09	127.49	126.45	127.79	127.09	126.51	126.42	126.31	127.11
03-Oct-16	127.20	127.11	127.06	126.01	127.08	126.47	126.09	125.95	125.62	126.37
31-Oct-16	127.29	127.09	127.06	125.91	127.03	126.53	126.01	125.88	125.42	126.50
30-Nov-16	127.61	127.36	127.06	126.07	127.39	126.71	126.16	126.00	125.57	126.68

	MW07-16	MW07-17	MW07-18	MW07-19	MW07-20	MW07-21	MW07-22	MW07-23	MW07-24	MW07-26
Easting	335393	335392	335387	335378	335296	335522	335472	335492	335519	335357
Northing	5074599	5074599	5074595	5074587	5074616	5074584	5074584	5074560	5074530	5074567
TOP Elevation (m)	130.98	131.08	131.23	131.61	130.70	129.51	130.25	130.04	129.03	132.42
GS Elevation (m)	130.16	130.16	130.37	130.79	129.85	128.78	129.05	129.29	128.22	131.85
Well Diameter (m)	0.032	0.051	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
Well Depth (m)	7.050	14.610	7.250	7.400	7.820	7.580	7.465	5.905	6.525	7.310
Stick-up (m)	0.822	0.915	0.868	0.815	0.850	0.730	1.200	0.750	0.810	0.570
dd/mm/yyyy										
05-Jan-16	127.28	121.87	127.26	127.31	125.92	125.22	126.51	127.43	126.56	127.18
01-Feb-16	127.27	122.52	127.26	127.34	125.91	125.23	126.42	127.30	126.49	127.33
01-Mar-16	126.57	121.98	126.39	126.70	125.47	124.57	125.99	126.84	126.15	126.80
05-Apr-16	129.60	125.48	129.77	129.88	127.86	127.35	128.14	128.29	127.50	130.46
03-May-16	129.28	125.04	129.41	129.50	127.56	127.11	127.93	128.10	127.36	129.89
31-May-16	128.33	123.47	128.36	128.45	126.69	125.95	127.26	127.76	126.84	128.61
04-Jul-16	127.04	121.86	126.98	127.04	125.49	124.43	126.27	127.10	126.15	126.77
02-Aug-16	126.49	121.67	126.50	126.55	125.11	124.10	125.94	126.80	125.89	126.44
31-Aug-16	127.04	121.75	127.00	127.05	125.50	124.63	126.32	127.12	126.25	126.76
03-Oct-16	126.31	121.44	126.32	126.36	124.70	123.95	125.87	126.76	125.92	126.16
31-Oct-16	126.42	120.87	126.40	126.41	124.41	123.78	125.79	126.67	125.84	126.09
30-Nov-16	126.62	120.72	126.56	126.61	124.62	124.04	125.92	126.92	126.11	126.34

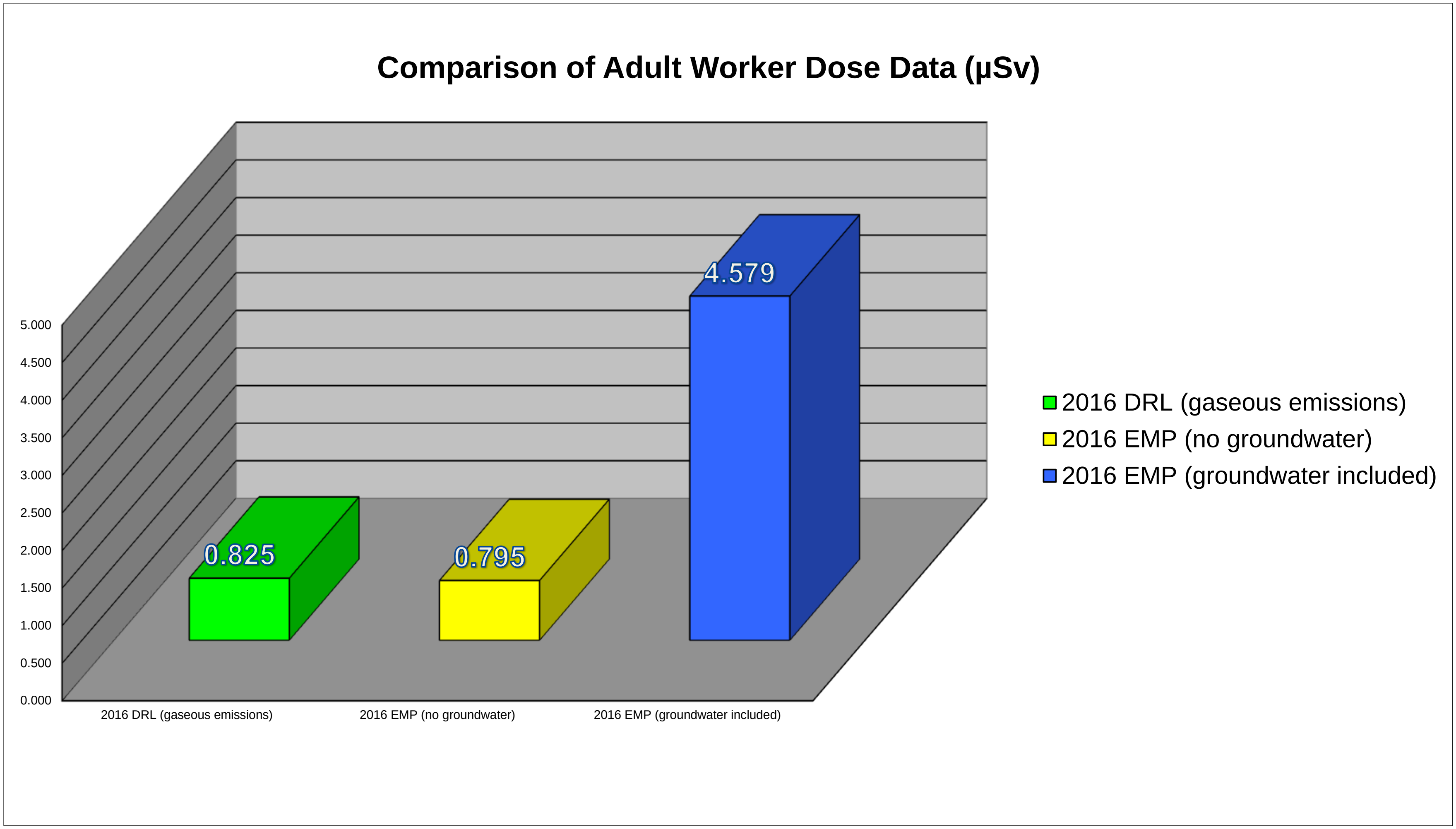
	MW07-27	MW07-28	MW07-29	MW07-31	MW07-32	MW07-34	MW07-35	MW07-36	MW07-37
Easting	335354	335352	335384	335471	335517	335393	335354	335338	335468
Northing	5074611	5074612	5074592	5074583	5074530	5074591	5074613	5074629	5074589
TOP Elevation (m)	132.89	132.71	131.09	130.16	128.86	131.12	132.89	133.10	130.06
GS Elevation (m)	132.02	132.04	130.57	129.38	128.23	130.71	132.16	132.31	129.47
Well Diameter (m)	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
Well Depth (m)	8.330	14.400	13.000	13.240	13.090	9.110	9.390	9.330	8.590
Stick-up (m)	0.870	0.670	0.520	0.780	0.630	0.410	0.730	0.790	0.590
dd/mm/yyyy									
05-Jan-16	126.61	121.95	121.96	121.09	121.08	126.39	126.19	125.35	126.69
01-Feb-16	126.64	122.44	122.43	122.00	122.00	126.41	126.23	125.35	126.61
01-Mar-16	125.95	121.92	122.38	121.47	121.46	125.83	125.61	124.97	126.19
05-Apr-16	129.95	125.11	125.10	125.92	125.91	129.02	129.51	128.65	128.33
03-May-16	129.50	124.80	124.87	125.01	124.99	128.68	129.08	128.23	128.13
31-May-16	127.14	123.47	123.47	122.39	122.39	127.55	127.71	126.74	127.44
04-Jul-16	126.36	121.95	121.96	120.71	120.71	126.11	125.93	125.05	126.46
02-Aug-16	125.89	121.75	121.75	120.59	120.48	125.68	125.49	124.82	126.13
31-Aug-16	126.38	121.88	121.88	120.49	120.48	126.13	125.94	125.13	126.50
03-Oct-16	125.59	151.57	121.57	120.09	120.08	125.48	125.29	124.75	126.06
31-Oct-16	125.47	121.00	121.01	119.77	119.76	125.47	125.14	124.66	125.96
30-Nov-16	125.60	120.82	120.84	119.67	119.66	125.54	125.23	124.72	126.11

APPENDIX S

Data and Calculations for Public Dose in 2016

ADULT WORKER

Dose Calculation	2016 µSv
2016 DRL (gaseous emissions)	0.825
2016 EMP (no groundwater)	0.795
2016 EMP (groundwater included)	4.579



ADULT WORKER

Stack Emissions

	2016 SRBT DRL	
	ADULT RESIDENT	
Sample End	% weekly DRL	(uSv)
05/01/2016	0.03	0.0058
12/01/2016	0.10	0.0192
19/01/2016	0.08	0.0154
26/01/2016	0.08	0.0154
02/02/2016	0.07	0.0135
09/02/2016	0.07	0.0135
16/02/2016	0.02	0.0038
23/02/2016	0.04	0.0077
01/03/2016	0.07	0.0135
08/03/2016	0.05	0.0096
15/03/2016	0.08	0.0154
22/03/2016	0.09	0.0173
29/03/2016	0.05	0.0096
05/04/2016	0.07	0.0135
12/04/2016	0.05	0.0096
19/04/2016	0.11	0.0212
26/04/2016	0.12	0.0231
03/05/2016	0.10	0.0192
10/05/2016	0.05	0.0096
17/05/2016	0.12	0.0231
24/05/2016	0.09	0.0173
31/05/2016	0.13	0.0250
07/06/2016	0.09	0.0173
14/06/2016	0.09	0.0173
21/06/2016	0.10	0.0192
28/06/2016	0.13	0.0250
05/07/2016	0.11	0.0212
12/07/2016	0.12	0.0231
19/07/2016	0.13	0.0250
26/07/2016	0.23	0.0442
02/08/2016	0.08	0.0154
09/08/2016	0.08	0.0154
16/08/2016	0.16	0.0308
23/08/2016	0.13	0.0250
30/08/2016	0.09	0.0173
06/09/2016	0.03	0.0058
13/09/2016	0.10	0.0192
20/09/2016	0.10	0.0192
27/09/2016	0.09	0.0173
04/10/2016	0.07	0.0135
11/10/2016	0.06	0.0115
18/10/2016	0.10	0.0192
25/10/2016	0.06	0.0115
01/11/2016	0.04	0.0077
08/11/2016	0.08	0.0154
15/11/2016	0.07	0.0135
22/11/2016	0.04	0.0077
29/11/2016	0.03	0.0058
06/12/2016	0.04	0.0077
13/12/2016	0.06	0.0115
20/12/2016	0.04	0.0077
27/12/2016	0.07	0.0135
Sum (uSv)		0.825
Ave. (%DRL)	0.08	
Annual Dose Est.	0.825 uSv/a	

Adult Worker

ADULT WORKER
EMP Factors for Dose

Pathways Analysis of Dose to the Public		
		per annum
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.430
Surface HTO ingestion	P(i)29	3.784
Surface HTO immersion	P(e)29	0.000
External soil exposure	P39	0.000
Forage & crop ingestion	P49	0.353
Animal produce ingestion	P59	0.012
Aquatic animal ingestion	P69	0.000
Aquatic plant ingestion	P79	0.000
External sediment exposure	P89	0.000
Total	**(uSv)**	**4.579 uSv/a**
Total without P_{29}	**(uSv)**	**0.795 uSv/a**

ADULT WORKER
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m3)	Time (hr/a)	DCF (uSv/Bq)	Sum1,4 (uSv/a)	Sum 2,4 (uSv/a)	Sum 13,4 (uSv/a)	Maximum (uSv/a)	
1	0.197	3.300	1994.496	3.000E-05	0.197				
2	0.174	2.910	1994.496	3.000E-05		0.174			
3	0.000			3.000E-05					
4	0.233	1.210	6405.504	3.000E-05	0.233	0.233	0.233		
5	0.000			3.000E-05					
6	0.000			3.000E-05					
7	0.000			3.000E-05					
8	0.000			3.000E-05					
9	0.000			3.000E-05					
10	0.000			3.000E-05					
11	0.000			3.000E-05					
12	0.000			3.000E-05					
13	0.123	2.060	1994.496	3.000E-05			0.123		
			P(i)19	**Sum**	**0.430**	**0.407**	**0.356**	**0.430**	**uSv/a**

ADULT WORKER
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)
1	0.000	0	1081.1	2.00E-05
2	1.506	70	1081.1	2.00E-05
3	1.600	74	1081.1	2.00E-05
4	0.000	0	1081.1	2.00E-05
5	0.195	9	1081.1	2.00E-05
6	0.000	0	1081.1	2.00E-05
7	0.086	4	1081.1	2.00E-05
8	3.784	175	1081.1	2.00E-05
9	1.160	54	1081.1	2.00E-05
10	0.000	0	1081.1	2.00E-05
11	0.000	0	1081.1	2.00E-05
12	0.000	0	1081.1	2.00E-05
Avg P(i)29	**0.694**	**uSv/annum**		

Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
Jan. 6, 2016												
Feb. 2, 2016												
Mar. 2, 2016			83.0		9.0	11.0		174.0	60	Non-Detect		Non-Detect
Apr. 6, 2016		87.0					4.0					
May 4, 2016												
Jun. 1, 2016												
Jul. 5, 2016		67.0	75.0		8.0	11.0	4.0	170	93	Non-Detect		Non-Detect
Aug. 3, 2016												
Sep. 1, 2016												
Oct. 4, 2016												
Nov. 1, 2016		55.0	64.0		10.0	8.0	Non-Detect	180	8	Non-Detect		Non-Detect
Dec. 1, 2016												
Average		**70**	**74**		**9**		**4**	**175**	**54**	**0**		**0**

Well 1, RW-1	413 Boundary Road
Well 2, RW-3	183 Mud Lake Road
Well 3, RW-2	185 Mud Lake Road
Well 4, RW-7	40925 Highway 41
Well 5, RW-5	171 Sawmill Road
Well 6, RW-4	711 Bruham Avenue
Well 7, RW-6	40987 Highway 41
Well 8, RW-8	204 Boundary Rd.
Well 9, RW-9	206 Boundary Rd
Well 10, RW-10	208 Boudary Rd
Well 11, B-1	Superior Office
Well 12, B-3	Intern. Lumber Office

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2016 were measured as <detectable.

RW-8	**P(i)29**	**3.784**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**3.784**	**uSv/mo**

P(e)29 = 0.000 uSv/mo

ADULT WORKER
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)

Source	Market						Home												
Type	Cucumber	Potato	Zucchini	Tomato	Onion	Average	LOCATION	Beet	Green Pepper	Rhubarb Leaf	Carrot	Apple	Tomato	Potato	Cucumber	Swiss Chard	Onion	Zucchini	Average
H-3	8.00		7.00	8.00		7.7	413 SWEEZEY COURT	75.00			75.00	106.00			118.00				94
							408 BOUNDARY ROAD						45.00						45
							406 BOUNDARY ROAD					65.00							65
							611 MOSS DRIVE				36.00		59.00						48
							416 BOUNDARY ROAD					71.00							71.0
Average	**8.00**	**#DIV/0!**	**7.00**	**8.00**	**#DIV/0!**	**7.7**		**75.00**	**#DIV/0!**	**#DIV/0!**	**55.50**	**80.67**	**52.00**	**#DIV/0!**	**118.00**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	64

Produce Sample Results (Bq organically bound tritium / kg fresh weight)

Source Type	Cucumber	Potato	Zucchini	Tomato	Onion	Average	LOCATION	Beet	Green Pepper	Rhubarb Leaf	Carrot	Apple	Tomato	Potato	Cucumber	Swiss Chard	Onion	Zucchini	Average
H-3				2.00		**2.0**	413 SWEEZEY COURT				13.00								13
							408 BOUNDARY ROAD						4.00						4
																			8.5

Produce Consumption

100%=	**413.300 kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	289.310 **kg/a**	7.7	2227.69	2.00	578.62
30%	123.990 **kg/a**	94	11655.06	8.50	1053.92

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	**[HTO] pro (Bq/a)**	**DCF (uSv/Bq)**	**[OBT] pro (Bq/a)**	**DCF (uSv/Bq)**
0.353	**13882.75**	2.00E-05	**1632.54**	4.60E-05

P49	**0.353**	**uSv/mo**

ADULT WORKER
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2016 Sample Results

Local Producer	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	3.33

Local Distributor	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	3.33

TOTAL AVERAGE	3.33	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	L/kg	Bq/kg
3.33	0.97	3.233

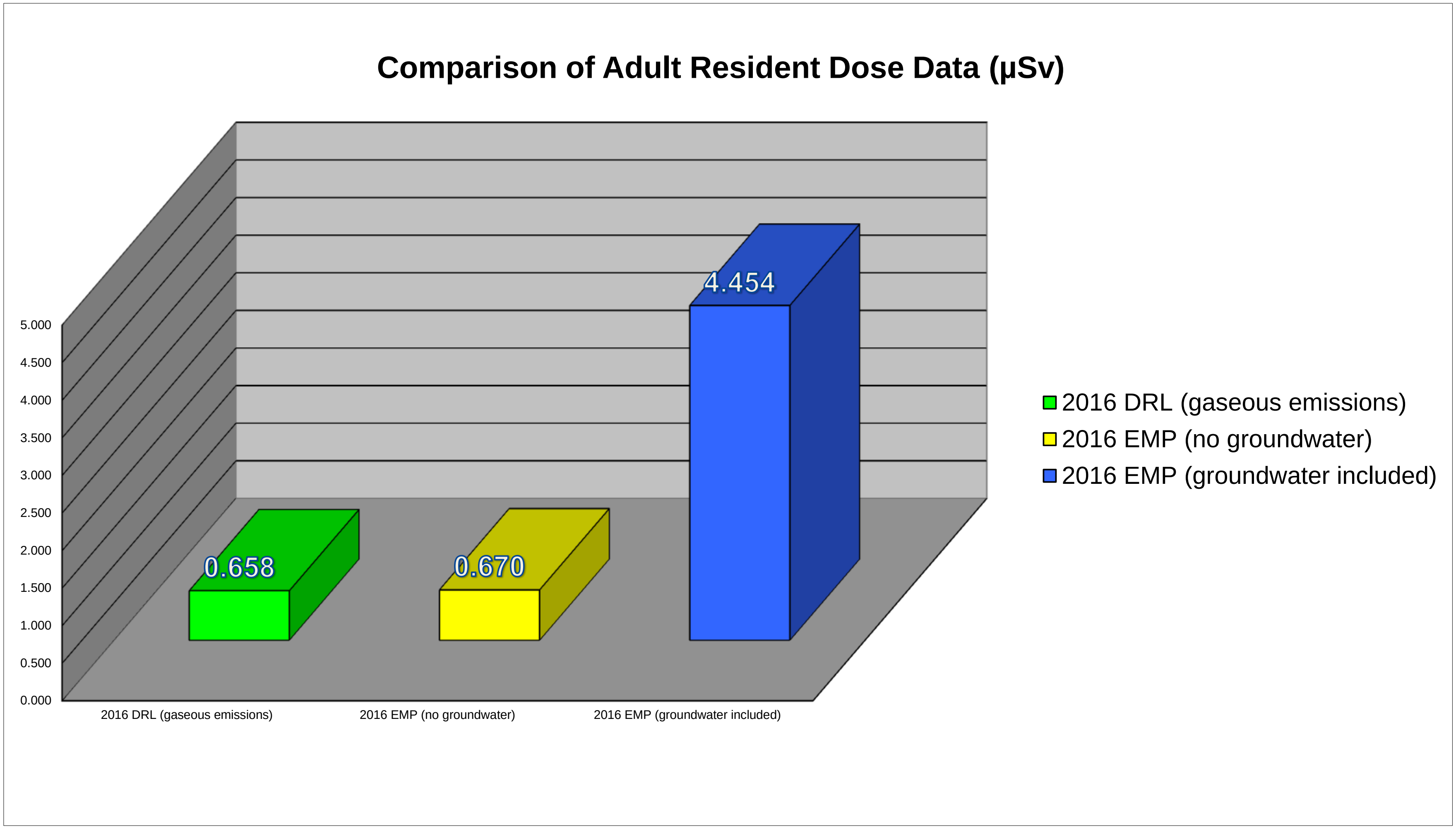
Consumption		
kg/da x da/a = kg/a		
kg/da)	(da/a)	(kg/a)
0.516	365.25	188.5

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	[HTO]	Ingested	DCF	
(uSv/a)	(Bq/kg)	(kg/a)	(uSv/Bq)	
0.012	3.23	188.5	2.00E-05	

P59	0.012	uSv/a

ADULT RESIDENT

Dose Calculation	2016 µSv
2016 DRL (gaseous emissions)	0.658
2016 EMP (no groundwater)	0.670
2016 EMP (groundwater included)	4.454



DRL's and EMP Data to Annual Dose ADULT RESIDENT

Stack Emissions

	2016 SRBT DRL	
	ADULT RESIDENT	
Sample End	% weekly DRL	(uSv)
05/01/2016	0.03	0.0058
12/01/2016	0.08	0.0154
19/01/2016	0.06	0.0115
26/01/2016	0.07	0.0135
02/02/2016	0.05	0.0096
09/02/2016	0.05	0.0096
16/02/2016	0.02	0.0038
23/02/2016	0.03	0.0058
01/03/2016	0.05	0.0096
08/03/2016	0.04	0.0077
15/03/2016	0.07	0.0135
22/03/2016	0.08	0.0154
29/03/2016	0.04	0.0077
05/04/2016	0.05	0.0096
12/04/2016	0.04	0.0077
19/04/2016	0.09	0.0173
26/04/2016	0.09	0.0173
03/05/2016	0.08	0.0154
10/05/2016	0.04	0.0077
17/05/2016	0.10	0.0192
24/05/2016	0.07	0.0135
31/05/2016	0.10	0.0192
07/06/2016	0.07	0.0135
14/06/2016	0.07	0.0135
21/06/2016	0.08	0.0154
28/06/2016	0.11	0.0212
05/07/2016	0.08	0.0154
12/07/2016	0.09	0.0173
19/07/2016	0.11	0.0212
26/07/2016	0.21	0.0404
02/08/2016	0.06	0.0115
09/08/2016	0.06	0.0115
16/08/2016	0.12	0.0231
23/08/2016	0.10	0.0192
30/08/2016	0.07	0.0135
06/09/2016	0.03	0.0058
13/09/2016	0.08	0.0154
20/09/2016	0.08	0.0154
27/09/2016	0.07	0.0135
04/10/2016	0.05	0.0096
11/10/2016	0.04	0.0077
18/10/2016	0.08	0.0154
25/10/2016	0.05	0.0096
01/11/2016	0.03	0.0058
08/11/2016	0.06	0.0115
15/11/2016	0.06	0.0115
22/11/2016	0.04	0.0077
29/11/2016	0.03	0.0058
06/12/2016	0.03	0.0058
13/12/2016	0.05	0.0096
20/12/2016	0.03	0.0058
27/12/2016	0.05	0.0096
Sum (uSv)		0.658
Ave. (%DRL)	0.07	
Annual Dose Est.	0.658 uSv/a	

Adult Worker

ADULT RESIDENT
EMP Factors for Dose

Pathways Analysis of Dose to the Public		
		per annum
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.305
Surface HTO ingestion	P(i)29	3.784
Surface HTO immersion	P(e)29	0.000
External soil exposure	P39	0.000
Forage & crop ingestion	P49	0.353
Animal produce ingestion	P59	0.012
Aquatic animal ingestion	P69	0.000
Aquatic plant ingestion	P79	0.000
External sediment exposure	P89	0.000
Total (uSv)		**4.454 uSv/a**
Total without P_{29} (uSv)		**0.670 uSv/a**

ADULT RESIDENT
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m3)	Time (hr/a)	DCF (uSv/Bq)	Sum1,4 (uSv/a)	Sum 2,4 (uSv/a)	Sum 13,4 (uSv/a)	Maximum (uSv/a)
1	0.000			3.000E-05	0.000			
2	0.000			3.000E-05		0.000		
3	0.000			3.000E-05				
4	0.305	1.210	8400.000	3.000E-05	0.305	0.305	0.305	
5	0.000			3.000E-05				
6	0.000			3.000E-05				
7	0.000			3.000E-05				
8	0.000			3.000E-05				
9	0.000			3.000E-05				
10	0.000			3.000E-05				
11	0.000			3.000E-05				
12	0.000			3.000E-05				
13	0.000			3.000E-05			0.000	
			P(i)19	**Sum**	**0.305**	**0.305**	**0.305**	**0.305** uSv/a

ADULT RESIDENT
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)
1	0.000	0	1081.1	2.00E-05
2	1.506	70	1081.1	2.00E-05
3	1.600	74	1081.1	2.00E-05
4	0.000	0	1081.1	2.00E-05
5	0.195	9	1081.1	2.00E-05
6	0.000	0	1081.1	2.00E-05
7	0.086	4	1081.1	2.00E-05
8	3.784	175	1081.1	2.00E-05
9	1.160	54	1081.1	2.00E-05
10	0.000	0	1081.1	2.00E-05
11	0.000	0	1081.1	2.00E-05
12	0.000	0	1081.1	2.00E-05
Avg P(i)29	**0.694**	**uSv/annum**		

Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
Jan. 6, 2016												
Feb. 2, 2016												
Mar. 2, 2016			83.0		9.0	11.0		174.0	60	Non-Detect		Non-Detect
Apr. 6, 2016		87.0					4.0					
May 4, 2016												
Jun. 1, 2016												
Jul. 5, 2016		67.0	75.0		8.0	11.0	4.0	170	93	Non-Detect		Non-Detect
Aug. 3, 2016												
Sep. 1, 2016												
Oct. 4, 2016												
Nov. 1, 2016		55.0	64.0		10.0	8.0	Non-Detect	180	8	Non-Detect		Non-Detect
Dec. 1, 2016												
Average		**70**	**74**		**9**		**4**	**175**	**54**	**0**		**0**

Well 1, RW-1	413 Boundary Road
Well 2, RW-3	183 Mud Lake Road
Well 3, RW-2	185 Mud Lake Road
Well 4, RW-7	40925 Highway 41
Well 5, RW-5	171 Sawmill Road
Well 6, RW-4	711 Bruham Avenue
Well 7, RW-6	40987 Highway 41
Well 8, RW-8	204 Boundary Rd.
Well 9, RW-9	206 Boundary Rd
Well 10, RW-10	208 Boudary Rd
Well 11, B-1	Superior Office
Well 12, B-3	Intern. Lumber Office

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2016 were measured as <detectable.

P(e)29 = 0.000 uSv/mo

RW-8			
	P(i)29	**3.784**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**3.784**	**uSv/mo**

ADULT RESIDENT
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)

Source Type	Market: Cucumber	Market: Potato	Market: Zucchini	Market: Tomato	Market: Onion	Market: Average	LOCATION	Home: Beet	Home: Green Pepper	Home: Rhubarb Leaf	Home: Carrot	Home: Apple	Home: Tomato	Home: Potato	Home: Cucumber	Home: Swiss Chard	Home: Onion	Home: Zucchini	Average
H-3	8.00		7.00	8.00		7.7	413 SWEEZEY COURT	75.00			75.00	106.00			118.00				94
							408 BOUNDARY ROAD						45.00						45
							406 BOUNDARY ROAD					65.00							65
							611 MOSS DRIVE				36.00		59.00						48
							416 BOUNDARY ROAD					71.00							71.0
Average	8.00	#DIV/0!	7.00	8.00	#DIV/0!	7.7		75.00	#DIV/0!	#DIV/0!	55.50	80.67	52.00	#DIV/0!	118.00	#DIV/0!	#DIV/0!	#DIV/0!	64

Produce Sample Results (Bq organically bound tritium / kg fresh weight)

Source Type	Market: Cucumber	Market: Potato	Market: Zucchini	Market: Tomato	Market: Onion	Market: Average	LOCATION	Home: Beet	Home: Green Pepper	Home: Rhubarb Leaf	Home: Carrot	Home: Apple	Home: Tomato	Home: Potato	Home: Cucumber	Home: Swiss Chard	Home: Onion	Home: Zucchini	Average
H-3				2.00		2.0	413 SWEEZEY COURT				13.00								13
							408 BOUNDARY ROAD						4.00						4
																			8.5

Produce Consumption

100%=	413.300 kg/a	[HTO] (Bq/kg)	(Bq/a)	[OBT] (Bq/kg)	(Bq/a)
70%	289.310 kg/a	7.7	2227.69	2.00	578.62
30%	123.990 kg/a	94	11655.06	8.50	1053.92

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	[HTO] pro (Bq/a)	DCF (uSv/Bq)	[OBT] pro (Bq/a)	DCF (uSv/Bq)
0.353	13882.75	2.00E-05	1632.54	4.60E-05

P49	0.353	uSv/mo

ADULT RESIDENT
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2016 Sample Results

Local Producer	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	3.33

Local Distributor	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	3.33

TOTAL AVERAGE	3.33	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.33	0.97	3.233

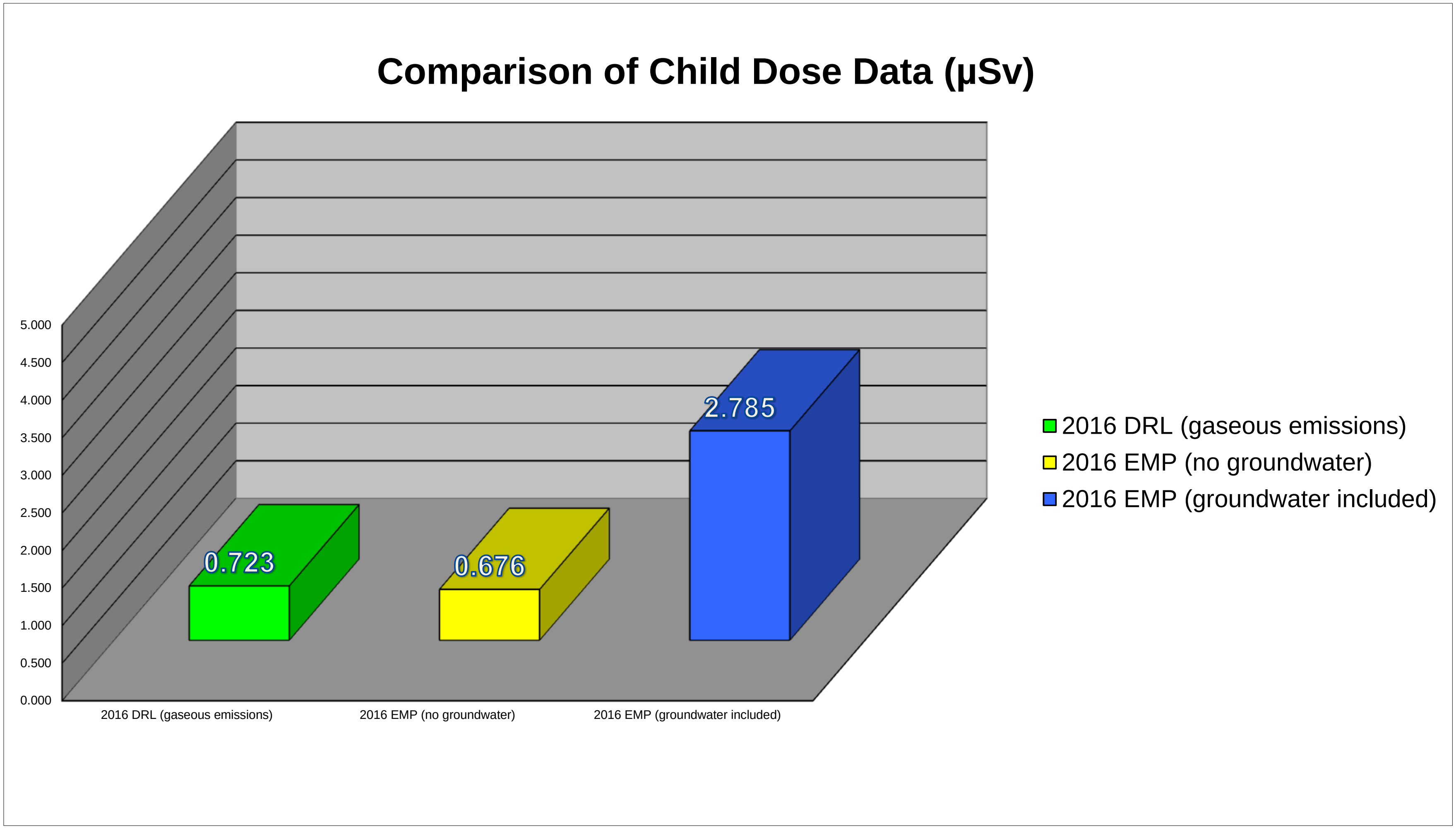
Consumption kg/da x da/a = kg/a		
kg/da)	**(da/a)**	**(kg/a)**
0.516	365.25	188.5

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.012	3.23	188.5	2.00E-05	

P59	0.012	**uSv/a**

CHILD RESIDENT

Dose Calculation	2016 µSv
2016 DRL (gaseous emissions)	0.723
2016 EMP (no groundwater)	0.676
2016 EMP (groundwater included)	2.785



CHILD RESIDENT

Stack Emissions

	2016 SRBT DRL	
	CHILD RESIDENT	
Sample End	**% weekly DRL**	**(uSv)**
05/01/2016	0.03	0.0058
12/01/2016	0.08	0.0154
19/01/2016	0.07	0.0135
26/01/2016	0.07	0.0135
02/02/2016	0.06	0.0115
09/02/2016	0.06	0.0115
16/02/2016	0.02	0.0038
23/02/2016	0.03	0.0058
01/03/2016	0.06	0.0115
08/03/2016	0.05	0.0096
15/03/2016	0.07	0.0135
22/03/2016	0.08	0.0154
29/03/2016	0.04	0.0077
05/04/2016	0.06	0.0115
12/04/2016	0.05	0.0096
19/04/2016	0.10	0.0192
26/04/2016	0.10	0.0192
03/05/2016	0.09	0.0173
10/05/2016	0.04	0.0077
17/05/2016	0.11	0.0212
24/05/2016	0.07	0.0135
31/05/2016	0.11	0.0212
07/06/2016	0.08	0.0154
14/06/2016	0.08	0.0154
21/06/2016	0.09	0.0173
28/06/2016	0.12	0.0231
05/07/2016	0.09	0.0173
12/07/2016	0.10	0.0192
19/07/2016	0.12	0.0231
26/07/2016	0.22	0.0423
02/08/2016	0.07	0.0135
09/08/2016	0.07	0.0135
16/08/2016	0.14	0.0269
23/08/2016	0.11	0.0212
30/08/2016	0.08	0.0154
06/09/2016	0.03	0.0058
13/09/2016	0.09	0.0173
20/09/2016	0.08	0.0154
27/09/2016	0.08	0.0154
04/10/2016	0.06	0.0115
11/10/2016	0.05	0.0096
18/10/2016	0.09	0.0173
25/10/2016	0.05	0.0096
01/11/2016	0.04	0.0077
08/11/2016	0.07	0.0135
15/11/2016	0.06	0.0115
22/11/2016	0.04	0.0077
29/11/2016	0.03	0.0058
06/12/2016	0.03	0.0058
13/12/2016	0.05	0.0096
20/12/2016	0.03	0.0058
27/12/2016	0.06	0.0115
Sum (uSv)		**0.723**
Ave. (%DRL)	**0.07**	
Annual Dose Est.	**0.723 uSv/a**	

CHILD RESIDENT
EMP Factors for Dose

Pathways Analysis of Dose to the Public		
		per annum
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.361
Surface HTO ingestion	P(i)29	2.109
Surface HTO immersion	P(e)29	0.000
External soil exposure	P39	0.000
Forage & crop ingestion	P49	0.289
Animal produce ingestion	P59	0.026
Aquatic animal ingestion	P69	0.000
Aquatic plant ingestion	P79	0.000
External sediment exposure	P89	0.000
Total (uSv)		**2.785 uSv/a**
Total without P_{29} (uSv)		**0.676 uSv/a**

CHILD RESIDENT
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m3)	Time (hr/a)	DCF (uSv/Bq)	Sum1,4 (uSv/a)	Sum 2,4 (uSv/a)	Sum 13,4 (uSv/a)	Maximum (uSv/a)	
1	0.000			3.800E-05	0.000				
2	0.000			3.800E-05		0.000			
3	0.000			3.800E-05					
4	0.361	1.210	7850.000	3.800E-05	0.361	0.361	0.361		
5	0.000			3.800E-05					
6	0.000			3.800E-05					
7	0.000			3.800E-05					
8	0.000			3.800E-05					
9	0.000			3.800E-05					
10	0.000			3.800E-05					
11	0.000			3.800E-05					
12	0.000			3.800E-05					
13	0.000			3.800E-05			0.000		
			P(i)19	**Sum**	**0.361**	**0.361**	**0.361**	**0.361**	**uSv/a**

CHILD RESIDENT
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)	Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
1	0.000	0	482.1	2.50E-05	Jan. 6, 2016												
2	0.840	70	482.1	2.50E-05	Feb. 2, 2016												
3	0.892	74	482.1	2.50E-05	Mar. 2, 2016			83.0		9.0	11.0		174.0	60	Non-Detect		Non-Detect
4	0.000	0	482.1	2.50E-05	Apr. 6, 2016		87.0					4.0					
5	0.108	9	482.1	2.50E-05	May 4, 2016												
6	0.000	0	482.1	2.50E-05	Jun. 1, 2016												
7	0.048	4	482.1	2.50E-05	Jul. 5, 2016		67.0	75.0		8.0	11.0	4.0	170	93	Non-Detect		Non-Detect
8	2.109	175	482.1	2.50E-05	Aug. 3, 2016												
9	0.647	54	482.1	2.50E-05	Sep. 1, 2016												
10	0.000	0	482.1	2.50E-05	Oct. 4, 2016												
11	0.000	0	482.1	2.50E-05	Nov. 1, 2016		55.0	64.0		10.0	8.0	Non-Detect	180	8	Non-Detect		Non-Detect
12	0.000	0	482.1	2.50E-05	Dec. 1, 2016												
Avg P(i)29	**0.387**	**uSv/annum**															
					Average		**70**	**74**		**9**		**4**	**175**	**54**	**0**		**0**

Well 1, RW-1	413 Boundary Road
Well 2, RW-3	183 Mud Lake Road
Well 3, RW-2	185 Mud Lake Road
Well 4, RW-7	40925 Highway 41
Well 5, RW-5	171 Sawmill Road
Well 6, RW-4	711 Bruham Avenue
Well 7, RW-6	40987 Highway 41
Well 8, RW-8	204 Boundary Rd.
Well 9, RW-9	206 Boundary Rd
Well 10, RW-10	208 Boudary Rd
Well 11, B-1	Superior Office
Well 12, B-3	Intern. Lumber Office

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2016 were measured as <detectable.

P(e)29 =	**0.000**	**uSv/mo**

RW-8	**P(i)29**	**2.109**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**2.109**	**uSv/mo**

CHILD RESIDENT
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)

Source Type	Market: Cucumber	Potato	Zucchini	Tomato	Onion	Average	LOCATION	Home: Beet	Green Pepper	Rhubarb Leaf	Carrot	Apple	Tomato	Potato	Cucumber	Swiss Chard	Onion	Zucchini	Average
H-3	8.00		7.00	8.00		7.7	413 SWEEZEY COURT	75.00			75.00	106.00			118.00				94
							408 BOUNDARY ROAD						45.00						45
							406 BOUNDARY ROAD					65.00							65
							611 MOSS DRIVE				36.00		59.00						48
							416 BOUNDARY ROAD					71.00							71.0
Average	**8.00**	**#DIV/0!**	**7.00**	**8.00**	**#DIV/0!**	**7.7**		**75.00**	**#DIV/0!**	**#DIV/0!**	**55.50**	**80.67**	**52.00**	**#DIV/0!**	**118.00**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**64**

Produce Sample Results (Bq organically bound tritium / kg fresh weight)

Source Type	Market: Cucumber	Potato	Zucchini	Tomato	Onion	Average	LOCATION	Home: Beet	Green Pepper	Rhubarb Leaf	Carrot	Apple	Tomato	Potato	Cucumber	Swiss Chard	Onion	Zucchini	Average
H-3				2.00		**2.0**	413 SWEEZEY COURT				13.00								13
							408 BOUNDARY ROAD						4.00						4
																			8.5

Produce Consumption

100%=	**265.200**	**kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	185.640	**kg/a**	7.7	1429.43	2.00	371.28
30%	79.560	**kg/a**	94	7478.64	8.50	676.26

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	**[HTO] pro (Bq/a)**	**DCF (uSv/Bq)**	**[OBT] pro (Bq/a)**	**DCF (uSv/Bq)**
0.289	**8908.07**	2.50E-05	**1047.54**	6.30E-05

P49	**0.289**	**uSv/mo**

CHILD RESIDENT
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2016 Sample Results

Local Producer	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	**3.33**

Local Distributor	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	**3.33**

TOTAL AVERAGE	**3.33**	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.33	0.97	**3.233**

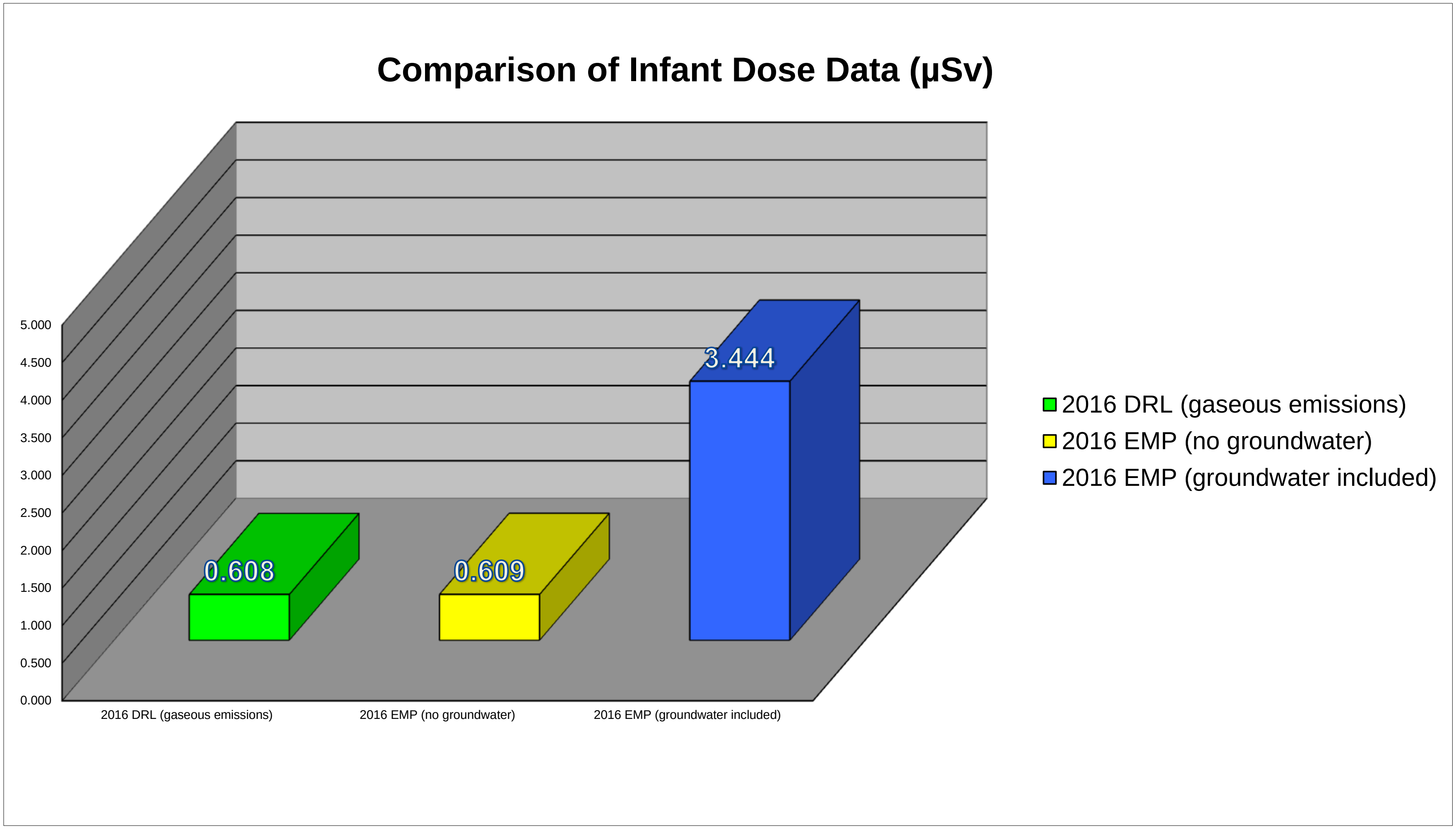
Consumption kg/da x da/a = kg/a		
kg/da)	**(da/a)**	**(kg/a)**
0.875	365.25	**319.6**

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.026	**3.23**	**319.6**	2.50E-05	

P59	**0.026**	**uSv/a**

INFANT RESIDENT

Dose Calculation	2016 µSv
2016 DRL (gaseous emissions)	0.608
2016 EMP (no groundwater)	0.609
2016 EMP (groundwater included)	3.444



INFANT RESIDENT

Stack Emissions

	2016 SRBT DRL	
	INFANT RESIDENT	
Sample End	% weekly DRL	(uSv)
05/01/2016	0.02	0.0038
12/01/2016	0.07	0.0135
19/01/2016	0.06	0.0115
26/01/2016	0.06	0.0115
02/02/2016	0.05	0.0096
09/02/2016	0.05	0.0096
16/02/2016	0.02	0.0038
23/02/2016	0.03	0.0058
01/03/2016	0.05	0.0096
08/03/2016	0.04	0.0077
15/03/2016	0.06	0.0115
22/03/2016	0.07	0.0135
29/03/2016	0.03	0.0058
05/04/2016	0.05	0.0096
12/04/2016	0.04	0.0077
19/04/2016	0.08	0.0154
26/04/2016	0.09	0.0173
03/05/2016	0.07	0.0135
10/05/2016	0.04	0.0077
17/05/2016	0.09	0.0173
24/05/2016	0.06	0.0115
31/05/2016	0.10	0.0192
07/06/2016	0.06	0.0115
14/06/2016	0.06	0.0115
21/06/2016	0.08	0.0154
28/06/2016	0.10	0.0192
05/07/2016	0.08	0.0154
12/07/2016	0.08	0.0154
19/07/2016	0.10	0.0192
26/07/2016	0.19	0.0365
02/08/2016	0.06	0.0115
09/08/2016	0.06	0.0115
16/08/2016	0.11	0.0212
23/08/2016	0.09	0.0173
30/08/2016	0.06	0.0115
06/09/2016	0.02	0.0038
13/09/2016	0.07	0.0135
20/09/2016	0.07	0.0135
27/09/2016	0.07	0.0135
04/10/2016	0.05	0.0096
11/10/2016	0.04	0.0077
18/10/2016	0.08	0.0154
25/10/2016	0.05	0.0096
01/11/2016	0.03	0.0058
08/11/2016	0.06	0.0115
15/11/2016	0.05	0.0096
22/11/2016	0.03	0.0058
29/11/2016	0.03	0.0058
06/12/2016	0.03	0.0058
13/12/2016	0.04	0.0077
20/12/2016	0.03	0.0058
27/12/2016	0.05	0.0096
Sum (uSv)		**0.608**
Ave. (%DRL)	**0.06**	
Annual Dose Est.	**0.608 uSv/a**	

INFANT RESIDENT
EMP Factors for Dose

Pathways Analysis of Dose to the Public		
		per annum
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.265
Surface HTO ingestion	P(i)29	2.835
Surface HTO immersion	P(e)29	0.000
External soil exposure	P39	0.000
Forage & crop ingestion	P49	0.286
Animal produce ingestion	P59	0.058
Aquatic animal ingestion	P69	0.000
Aquatic plant ingestion	P79	0.000
External sediment exposure	P89	0.000
Total (uSv)		**3.444 uSv/a**
Total without P_{29} (uSv)		**0.609 uSv/a**

INFANT RESIDENT
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m3)	Time (hr/a)	DCF (uSv/Bq)	Sum1,4 (uSv/a)	Sum 2,4 (uSv/a)	Sum 13,4 (uSv/a)	Maximum (uSv/a)	
1	0.000			8.000E-05	0.000				
2	0.000			8.000E-05		0.000			
3	0.000			8.000E-05					
4	0.265	1.210	2740.000	8.000E-05	0.265	0.265	0.265		
5	0.000			8.000E-05					
6	0.000			8.000E-05					
7	0.000			8.000E-05					
8	0.000			8.000E-05					
9	0.000			8.000E-05					
10	0.000			8.000E-05					
11	0.000			8.000E-05					
12	0.000			8.000E-05					
13	0.000			8.000E-05			0.000		
			P(i)19	**Sum**	**0.265**	**0.265**	**0.265**	**0.265**	**uSv/a**

INFANT RESIDENT
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)	Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
1	0.000	0	305.7	5.30E-05	Jan. 6, 2016												
2	1.129	70	305.7	5.30E-05	Feb. 2, 2016												
3	1.199	74	305.7	5.30E-05	Mar. 2, 2016			83.0		9.0	11.0		174.0	60	Non-Detect		Non-Detect
4	0.000	0	305.7	5.30E-05	Apr. 6, 2016		87.0					4.0					
5	0.146	9	305.7	5.30E-05	May 4, 2016												
6	0.000	0	305.7	5.30E-05	Jun. 1, 2016												
7	0.065	4	305.7	5.30E-05	Jul. 5, 2016		67.0	75.0		8.0	11.0	4.0	170	93	Non-Detect		Non-Detect
8	2.835	175	305.7	5.30E-05	Aug. 3, 2016												
9	0.870	54	305.7	5.30E-05	Sep. 1, 2016												
10	0.000	0	305.7	5.30E-05	Oct. 4, 2016												
11	0.000	0	305.7	5.30E-05	Nov. 1, 2016		55.0	64.0		10.0	8.0	Non-Detect	180	8	Non-Detect		Non-Detect
12	0.000	0	305.7	5.30E-05	Dec. 1, 2016												
Avg P(i)29	**0.520**	**uSv/annum**															
					Average		**70**	**74**		**9**		**4**	**175**	**54**	**0**		**0**

Well 1, RW-1	413 Boundary Road
Well 2, RW-3	183 Mud Lake Road
Well 3, RW-2	185 Mud Lake Road
Well 4, RW-7	40925 Highway 41
Well 5, RW-5	171 Sawmill Road
Well 6, RW-4	711 Bruham Avenue
Well 7, RW-6	40987 Highway 41
Well 8, RW-8	204 Boundary Rd.
Well 9, RW-9	206 Boundary Rd
Well 10, RW-10	208 Boudary Rd
Well 11, B-1	Superior Office
Well 12, B-3	Intern. Lumber Office

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2016 were measured as <detectable.

P(e)29 = 0.000 uSv/mo

RW-8			
	P(i)29	**2.835**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**2.835**	**uSv/mo**

INFANT RESIDENT
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)

Source Type	Market: Cucumber	Market: Potato	Market: Zucchini	Market: Tomato	Market: Onion	Market: Average	LOCATION	Home: Beet	Home: Green Pepper	Home: Rhubarb Leaf	Home: Carrot	Home: Apple	Home: Tomato	Home: Potato	Home: Cucumber	Home: Swiss Chard	Home: Onion	Home: Zucchini	Home: Average
H-3	8.00		7.00	8.00		7.7	413 SWEEZEY COURT	75.00			75.00	106.00			118.00				94
							408 BOUNDARY ROAD						45.00						45
							406 BOUNDARY ROAD					65.00							65
							611 MOSS DRIVE				36.00		59.00						48
							416 BOUNDARY ROAD					71.00							71.0
Average	8.00	#DIV/0!	7.00	8.00	#DIV/0!	7.7		75.00	#DIV/0!	#DIV/0!	55.50	80.67	52.00	#DIV/0!	118.00	#DIV/0!	#DIV/0!	#DIV/0!	64

Produce Sample Results (Bq organically bound tritium / kg fresh weight)

Source Type	Market: Cucumber	Market: Potato	Market: Zucchini	Market: Tomato	Market: Onion	Market: Average	LOCATION	Home: Beet	Home: Green Pepper	Home: Rhubarb Leaf	Home: Carrot	Home: Apple	Home: Tomato	Home: Potato	Home: Cucumber	Home: Swiss Chard	Home: Onion	Home: Zucchini	Home: Average
H-3				2.00		2.0	413 SWEEZEY COURT				13.00								13
							408 BOUNDARY ROAD						4.00						4
																			8.5

Produce Consumption

100%=	124.800	kg/a	[HTO] (Bq/kg)	(Bq/a)	[OBT] (Bq/kg)	(Bq/a)
70%	87.360	kg/a	7.7	672.67	2.00	174.72
30%	37.440	kg/a	94	3519.36	8.50	318.24

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	[HTO] pro (Bq/a)	DCF (uSv/Bq)	[OBT] pro (Bq/a)	DCF (uSv/Bq)
0.286	4192.03	5.30E-05	492.96	1.30E-04

P49	0.286	uSv/mo

INFANT RESIDENT
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2016 Sample Results

Local Producer	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	**3.33**

Local Distributor	
	(Bq/L)
1	3.00
2	3.00
3	4.00
Average	**3.33**

TOTAL AVERAGE	**3.33**	Bq/L

Milk Density Adjustment Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.33	0.97	**3.233**

Consumption kg/da x da/a = kg/a		
kg/da)	**(da/a)**	**(kg/a)**
0.931	365.25	**339.9**

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.058	**3.23**	**339.9**	5.30E-05	

P59	**0.058**	**uSv/a**

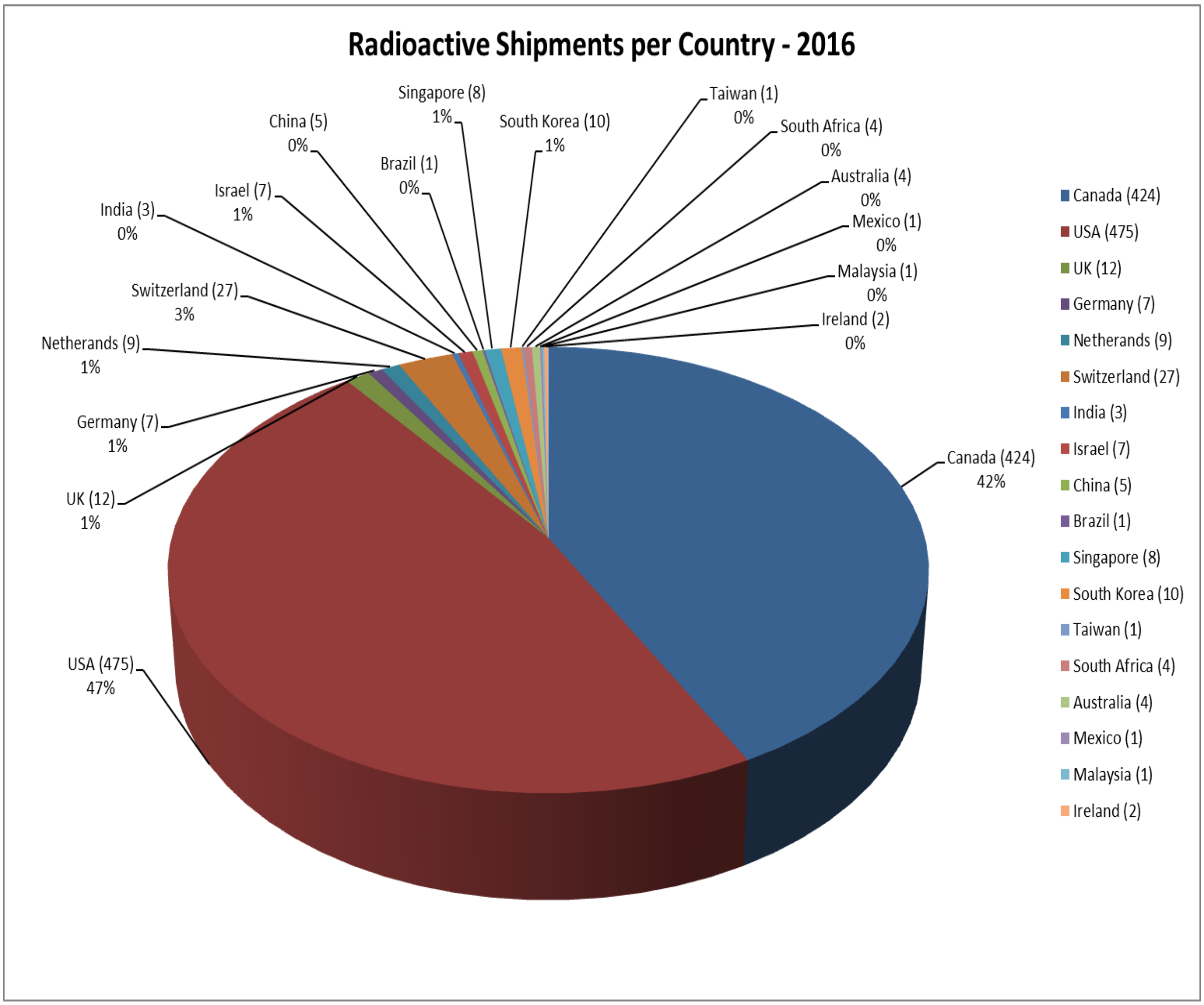
APPENDIX T

Outgoing Shipments Containing Radioactive Material for 2016

SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2016

Month / 2016	Number of Shipments
January	96
February	91
March	88
April	90
May	77
June	73
July	86
August	82
September	75
October	81
November	87
December	75
Total Shipments	**1001**
2016 Monthly Average:	***83***

DISTRIBUTION OF SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2016



APPENDIX U

Incoming Shipments Containing Radioactive Material for 2016

INCOMING SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2016

Month / 2016	Number of Shipments
January	42
February	38
March	54
April	43
May	51
June	51
July	44
August	47
September	68
October	42
November	49
December	33
Total Shipments	***562***
2016 Monthly Average:	***47***

ORIGIN OF INCOMING SHIPMENTS FOR 2016