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CFB Comox Fire Fighting Training Area, PFAS Delineation and Water Treatment: A Case Study

May 10, 2019

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PFAS Delineation and Water Treatment: A Case Study

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Outline

- Background
- Conceptual Site Model
- Delineation Scope and Methodology
- Delineation Results
- Water Treatment Evaluation and Trials
- Summary
- Questions

Background

Site History and a Look at PFAS

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Background – CFB Comox FFTA, Site History

The Fire Fighting Training Area (FFTA) was first developed for training use in approximately 1968.

Some of the original features included:

- Drive over waste oil pit.
- Drummed fuel and oil waste storage.
- Retention Pond (since 1960s).
- Landfarm.
- Burn area.

Oils, fuels, and other debris were burned during training exercises. Water and AFFF was used until ~2009.

- Investigations completed since 1992.
- PFAS first sampled and detected in 2015.

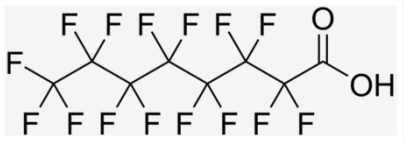
Stock Photo Copyright 2019 Fire Fighting in Canada, https://www.firefightingincanada.com

Background – PFAS

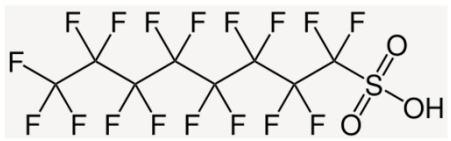
Chemical Background of PFAS:

Per- and Poly-Fluorinated Alkyl Substances

- Manufactured compounds with specific uses since 1940s,
- Hydrophobic carbon and fluorine alkyl chain with a hydrophilic end group.
- Commonly referenced compounds:
  - Perfluoro-octanoic acid (PFOA).
  - Perfluoro-octane sulfonate (PFOS).
  - Over 3,000 compounds including Precursors which can breakdown into regulated PFAS compounds (eg. PFOA and PFOS).
- Common product examples, Teflon, Scotch Guard, AFFF.



PFOA



PFOS

Background – PFAS and AFFF

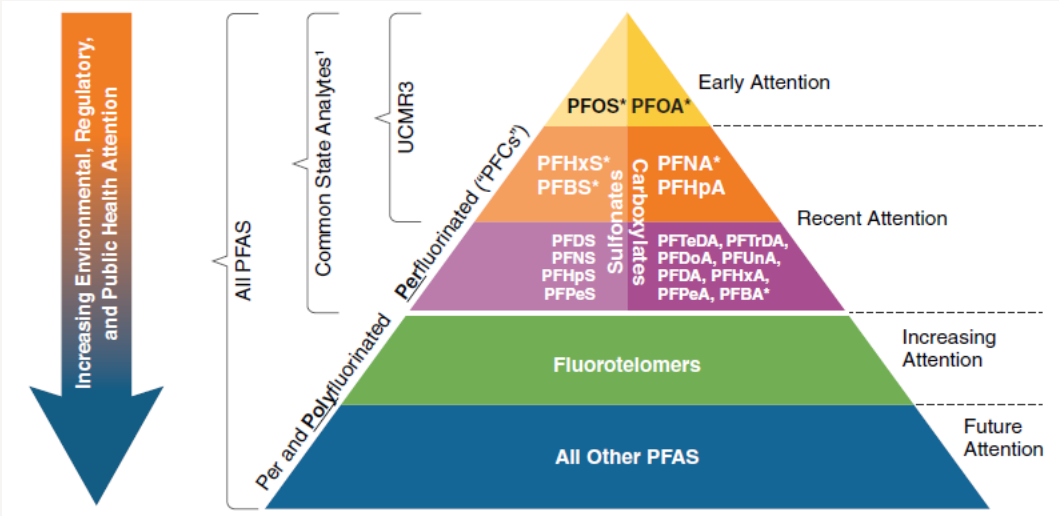
Aqueous Film-Forming Foams (AFFF)

- Commercial surfactants manufactured since the 1940s.
- Commonly used at airports and training facilities.
- Proven to be extremely effective fire fighting tool.
- AFFF phased out of production in 2002; however, millions of litres remain in inventories around the world.

Background – Regulatory Guidelines for PFAS

PFAS as Emerging Contaminants, changing regulatory landscape

- 17 PFAS compounds are commonly analyzed.
- Human and ecological health guidelines have been introduced since 2016.
- Health Canada – drinking water screening values (2017) with 9 regulated compounds.
- ECCC – Federal PFOS Guidelines (2017).
- Health Canada – updated soil screening values (2019) with 9 regulated compounds.
- CCME Draft PFOS Soil Guideline (2019).
- BC CSR Soil and GW Standards (PFOS, PFBS, PFOA).
- Regulations continue to change. New parameters and lower guidelines.



ITRC, History and Use of Per- and Polyfluorinated Substances (PFAS), November 2017

Conceptual Site Model

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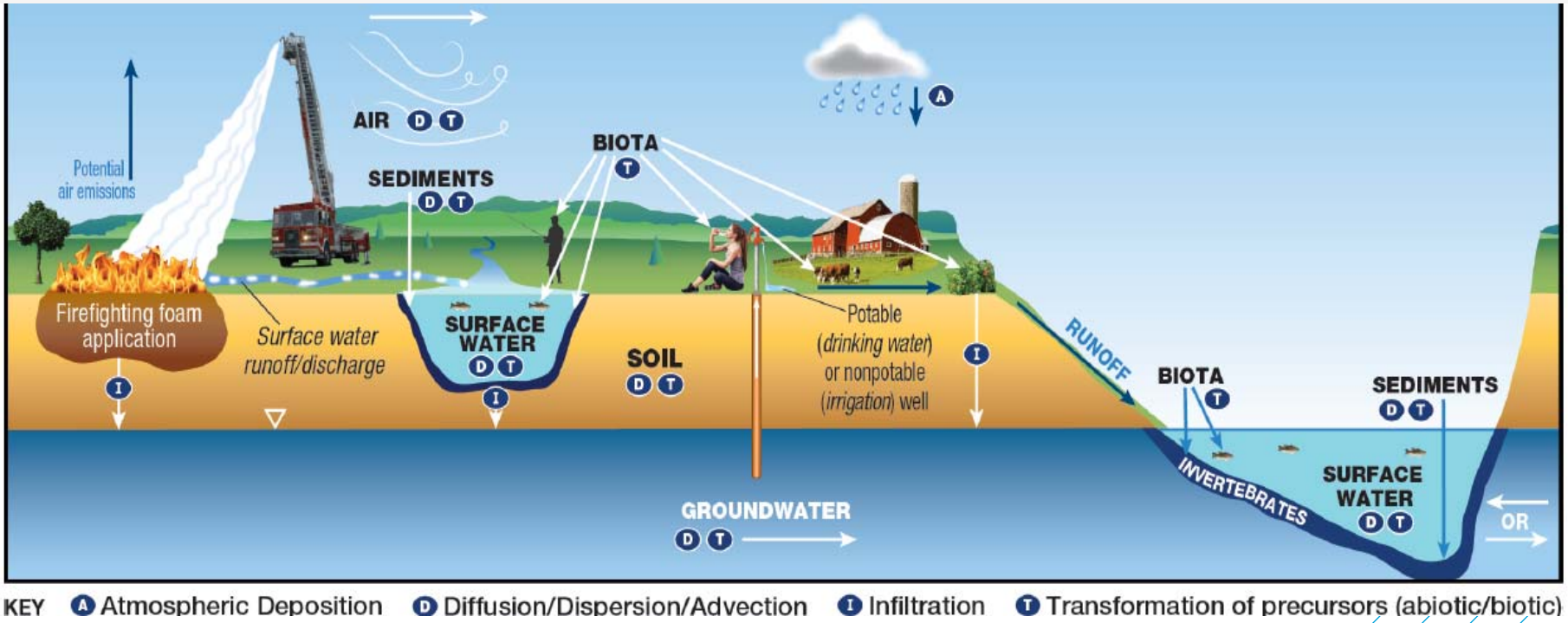
Site Setting – Graphical CSM

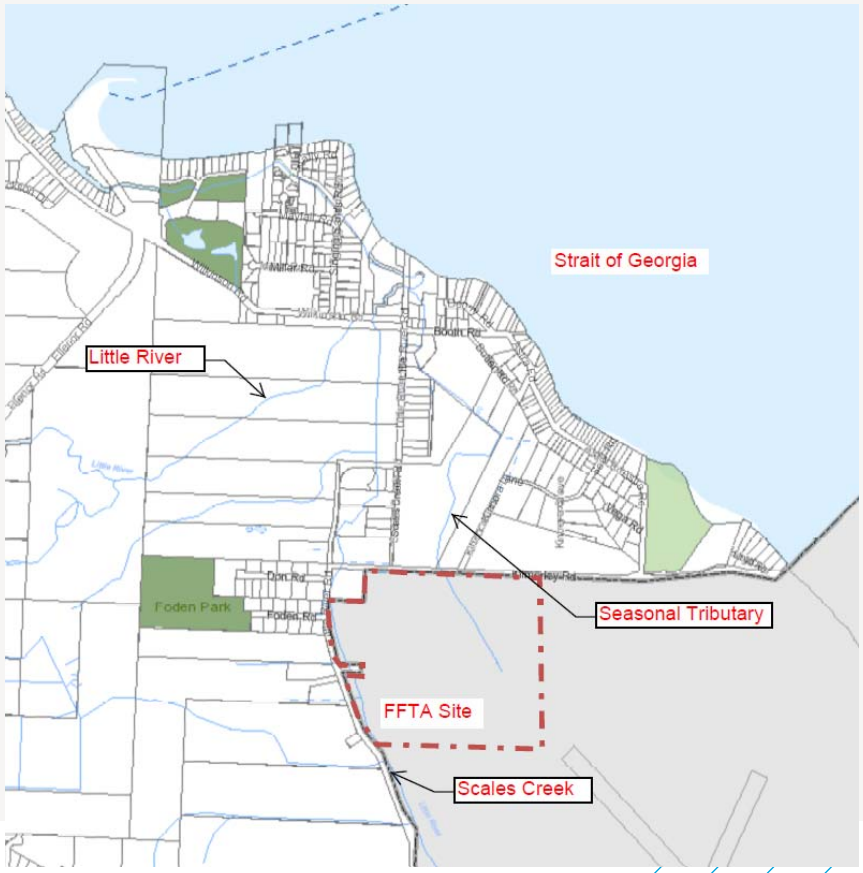


ITRC, Environmental Fate and Transport for Per- and Polyfluoroalkyl Substances, March 2018

CSM - Site Setting

FFTA Site Location

- The FFTA project site is located in the NW corner of CFB Comox.
- The area is generally flat with surrounding area gently sloping to the north.
- The land use around the FFTA is a mixture of residential, agricultural, light industrial, and commercial.
- Surface water bodies include the FFTA retention pond, a seasonal tributary, and Scales Creek which are all part of the Little River watershed.
- Soils are thin deposits of silt overlying dense silt till. The upper silt unit is seasonally saturated and the lower till unit has low permeability.
- Numerous private water wells exist in surrounding areas.
- Surface water drains from the FFTA towards the retention pond and swale and then directed north to a ditch on Kilmorley Road.

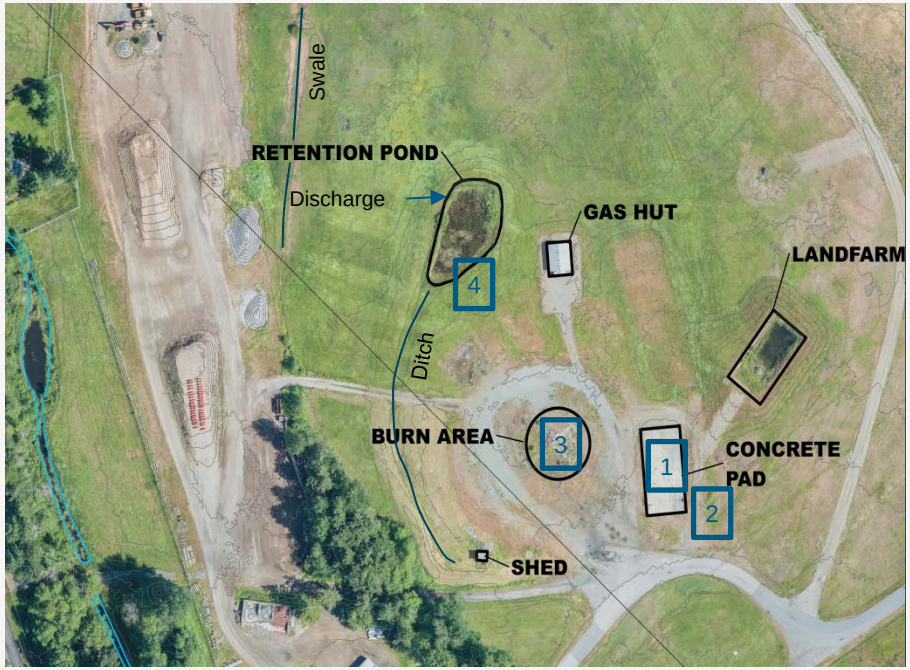


Contaminant Sources

- AFFF and accelerants were used in training until ~2009.
- AFFF historically released to exposed soil surfaces and migrated into groundwater or flowed overland to retention pond.

Previous reports identified 4 main contaminant sources

- 1) Historical hydrocarbon storage in oil tanks.
- 2) Historical waste oil pit.
- 3) Historical fire fighting training (deposition of fuels and AFFF).
- 4) Waste water generated from fire fighting training.



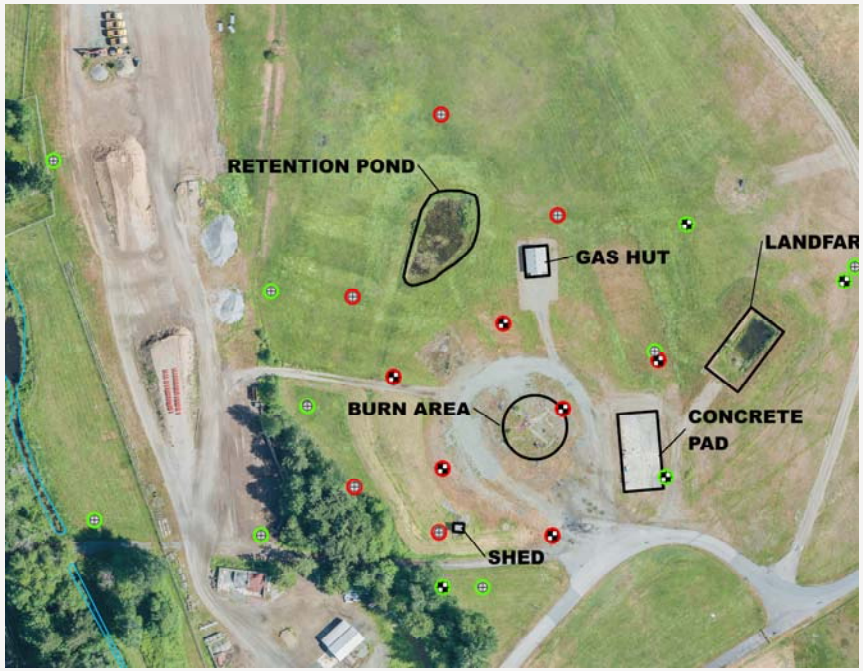
Prior Environmental Quality

Soil:

- Soil COCs include BETX, F2-F4, PAH, arsenic, and PFOS greater than federal guidelines.
- Centered around FFTA area in all directions.
- Generally undelineated vertically and laterally.
- PFOS was the only PFAS compound greater than guidelines and generally found within top meter but extending to a depth of 2.5 m within the FFTA.

Groundwater:

- PFAS plume undelineated vertically and laterally.
- VOCs present near former waste oil pit.
- Dissolved metals are wide spread and undelineated.



Delineation

Scope and Methodology

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2018 / 2019 Scope of Work

Delineation Scope

- Data gap review and sampling analysis plan design.
- Conceptual Site Model update.
- Delineation site investigation.

Water Treatment Scope

- Assessment of existing water treatment system.
- Transportation of system to CFB Comox.
- Installation and configuration.
- System performance testing and evaluation (GAC trials).
- Advanced oxidation trial.

PFAS Sampling Methodology




Drilling and Soil Sampling

- Hydrovac pre-clearing of boreholes.
- Drilling and well installation with auger or sonic drill rig.
- Soil sampling from auger flights or sonic cores.
- Use of PFAS free containers.

Groundwater Sampling

- Samples collected with a peristaltic pump and new HDPE tubing.
- Sampling anticipated low concentration wells first and progress toward high concentration PFAS wells.
- Samples collected in laboratory prepared jars.

Sample Submission

- Maxxam Analytics using EPA Method 537 by solid phase extraction, liquid chromotography/mass spectrometry.
- Reporting Maxxam Full PFAS Package list of 25 parameters.
- Selected samples further analyzed for TOPs assays.

PFAS Sampling Methodology

Do Not	Do
Wear high-vis and/or fire retardant clothing.	Wear well used/washed cotton or wool clothing (e.g., dedicated cotton coveralls).
Wear anything with a waterproof/breathable membrane (eg., Gore-tex).	Wear polyvinyl chloride (PVC) or polyurethane rain gear and steel-toe gum boots.
Wear anything with a durable water repellant (eg., Scotchguard spray).	Cover vehicle seats with well laundered sheets or towels.
Apply sunscreen or bug repellants.	Remove outerwear before leaving area to eat lunch or take breaks.
Use any moisturizers, shampoos, coated dental floss.	Shower/wash with only water and plain bar soap.
Touch any commercial food wrap or packaged foods.	Prepare lunches prior to field work in cleaned re-useable containers.
Use waterproof paper, felt markers, or post-it notes.	Use ball-point pens or pencils for labeling.

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PFAS Sampling Methodology

Decontamination Procedures

› Strict cleaning of equipment or sampling instruments between boreholes, wells or samples.

Decontamination Procedure
1) Wash in solution of Alconox detergent and PFAS free water (from CFB Comox base water supply);
2) Rinse with PFAS free water;
3) Rinse with methanol;
4) Repeat #1 to #3; and,
5) Final rinse with PFAS free water. When an equipment rinsate sample is collected, the final rinse water is retained in a laboratory-provided sample jar.

PFAS Sampling Methodology

Quality Assurance / Quality Control

Analysis of blanks and duplicates is a key step to the PFAS analytical program. Ensures the accuracy and reliability of data.

Blanks	Duplicates
Travel Blanks – lab provided, custody sealed sample bottles with PFAS free water, unopened. Shipped with samples.	**Blind field duplicates** were collected at selected locations. Relative percent difference of blind duplicate and sample pair calculated. Target quality objective was 40%. Results with RPD greater than 40% require follow up request to the lab for data quality investigation.
Field Blanks – lab provided, PFAS free water, transferred to clean bottles during field activities and sent for analysis.	
Equipment Rinsate Samples – CFB Comox potable water used as final rinse during decontamination. Collected and analyzed to confirm decontamination procedures. Rinsate samples collected from hydrovac sampling shovel, hydrovac dig tube, sonic sample core, and solid stem auger.	

Delineation

Results

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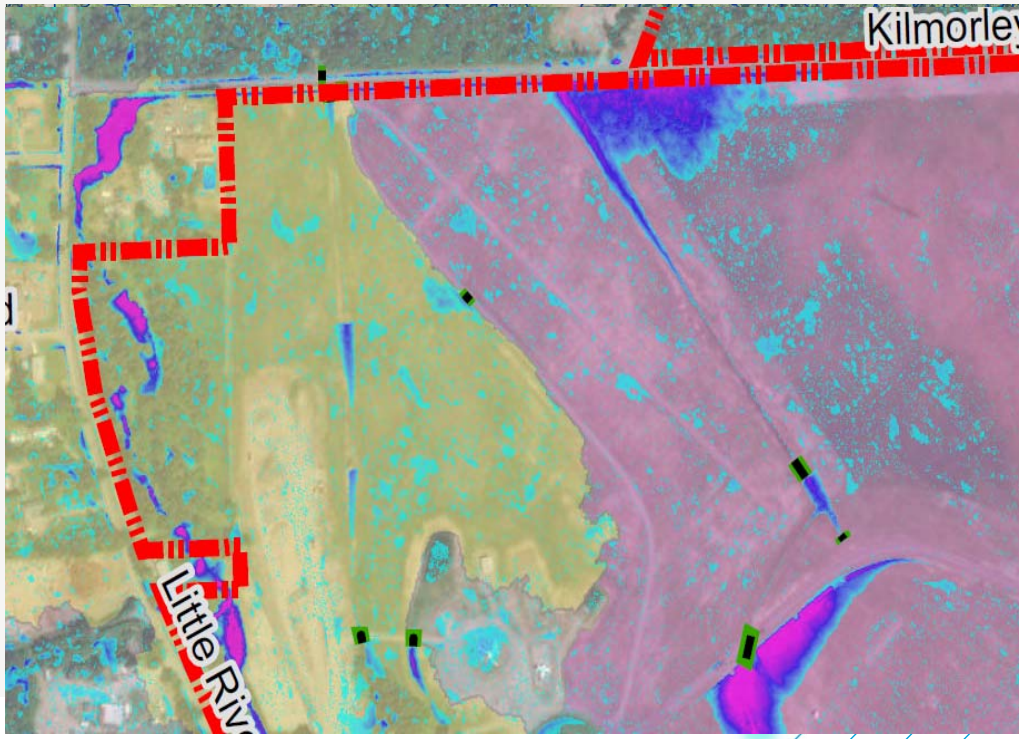
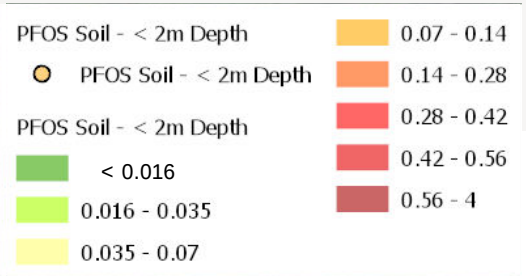
Site Conditions

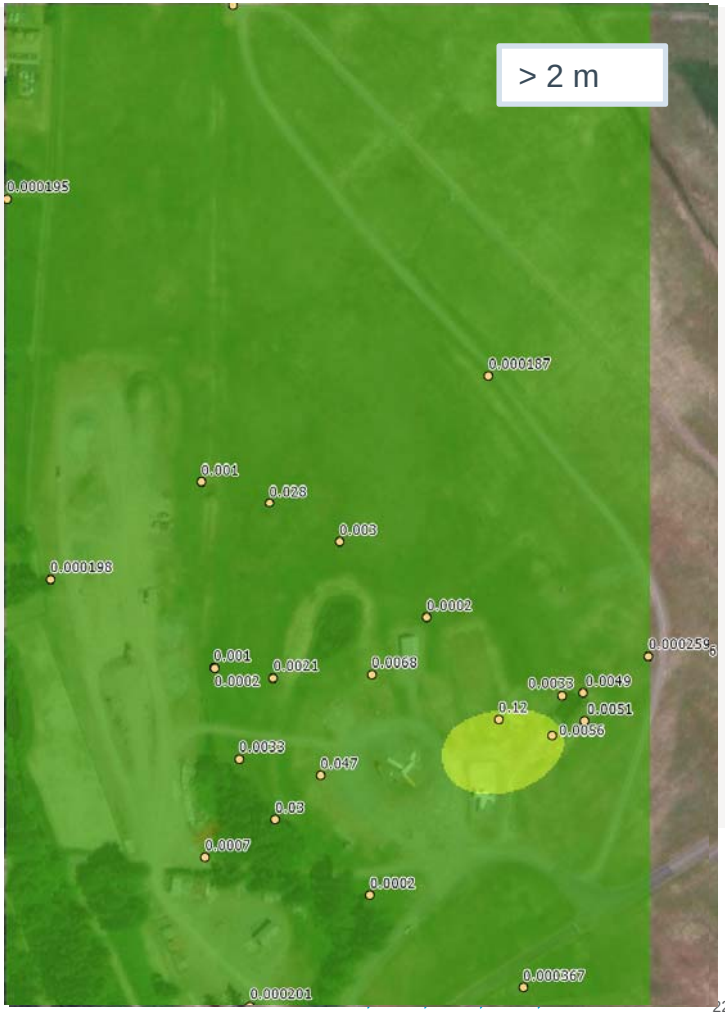
- Used available LIDAR data to map surface water flow across the site.
- Stratigraphy identified as a thin deposit of silt overlying a dense silt till (with varying sand, clay, and gravel).
- Groundwater and surface water is highly seasonal with high water and flows in wet winter/spring months and low water and flows in dry summer/fall months.
- LIDAR data shows surface flow migrating toward the north/northwest.
- Two distinct sub-catchments are visible separated by a road.
- Storage areas/depressions are shown by the blue to bright pink.



Soil Investigation Results

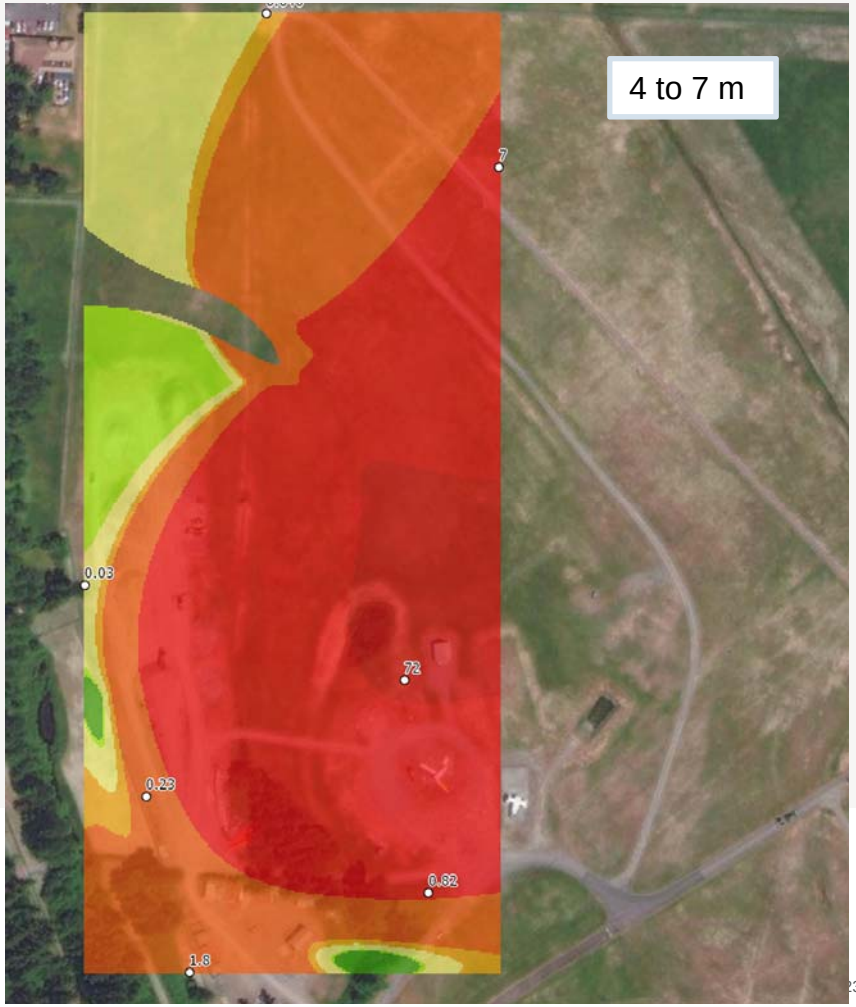
- Concentrations of PFOS were identified greater than the CCME Draft Soil Guideline (0.14 mg/kg).
- All other PFAS compounds were less than the available guidelines and screening values.
- Concentrations of PFOS were plotted using the ArcGIS Kernel Interpolation with Barrier analytical tool.
- Map Results were plotted at 3 different depths
  - 0 to 1 m;
  - 1 to 2 m; and,
  - > 2 m.
- The 2018/2019 field activities were generally successful at delineating PFAS and other COCs.

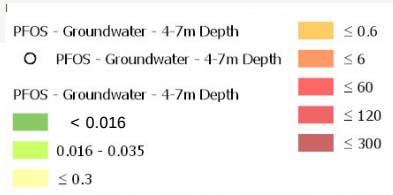




Groundwater Investigation Results

- Concentrations of several PFAS compounds were identified greater than the available drinking water guidelines.
- Concentrations of PFOS were plotted using Inverse Distance Weighting methods.
- Map Results were plotted for 3 different screen depths
  - 0 to 2 m;
  - 2 to 4 m; and,
  - 4 to 7 m.
- Following 2018/2019 field activities concentrations of PFAS compounds greater than drinking water guidelines were undelineated to the north, west, southwest, and south to the property lines.
- Offsite investigations are being completed by others





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Water Treatment

Evaluation and Trials

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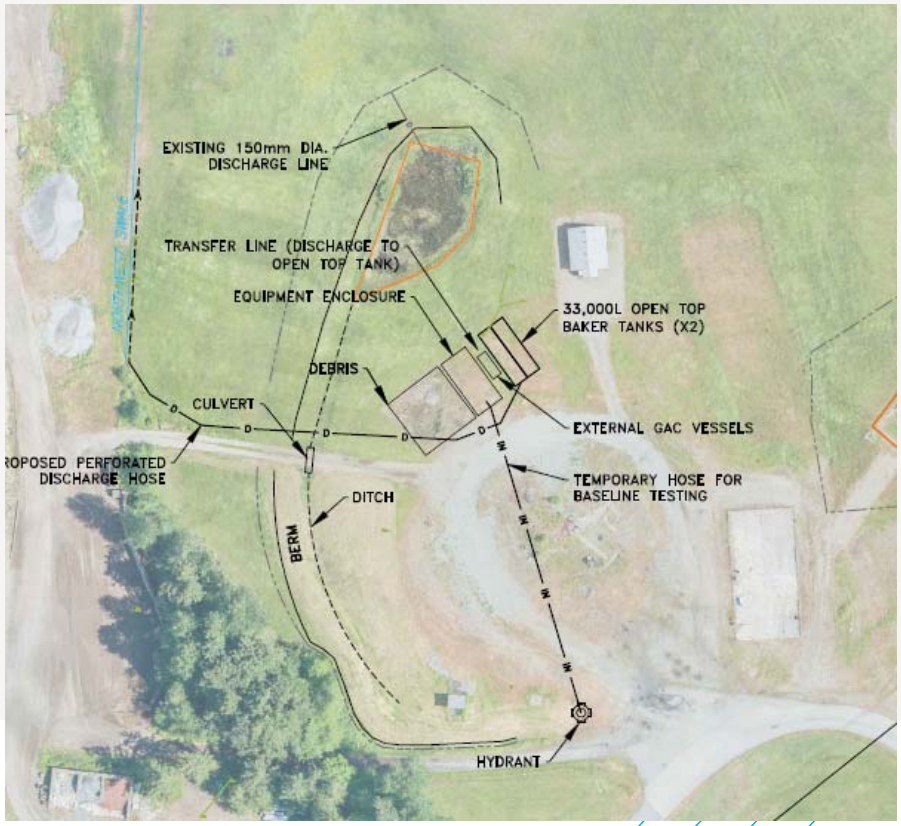
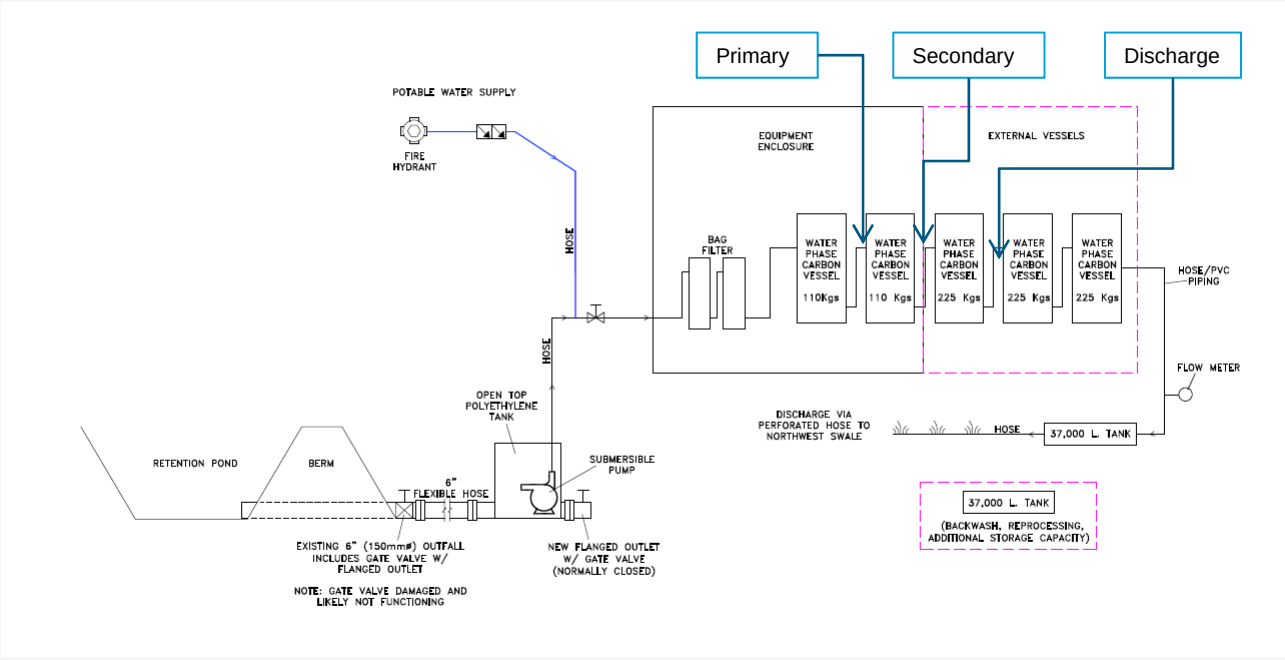
Multi-Phase Extraction System

System Inspection and Transport

- Evaluation of existing MPE system at a BC Airport.
- System was inspected on October 19, 2018.
- Using a crane and transport subcontractor, the equipment was loaded on December 19, 2018 and delivered to CFB Comox on December 21, 2018.
- System was re-purposed to water treatment at CFB Comox and the following equipment was set up:
  - 2 x Bag Filters.
  - 2 x 110 kgs Carbon Vessels.
  - 3 x 225 Kgs Carbon Vessels.
  - Pumps and flow meters.
    - 2 x 33,000 L Baker Tanks (open top).
    - 6 kVA generator with secondary containment.



Multi-Phase Extraction System



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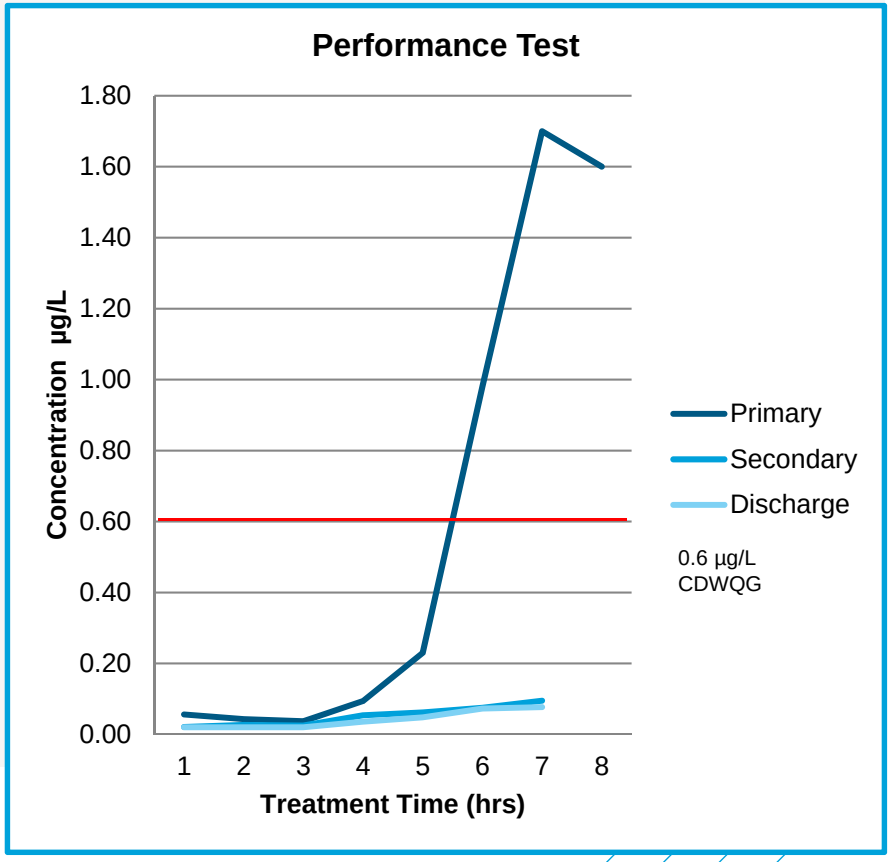
GAC Performance Testing

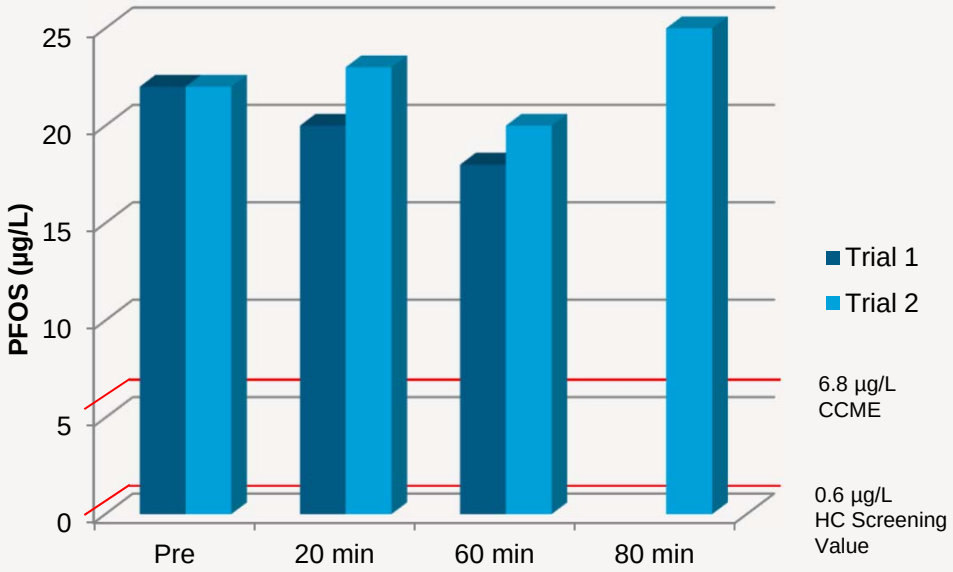
- Baseline testing of system with 19,000 L of PFAS free water.
  - Analytical results post treatment were less than laboratory detection.
- GAC performance review (2019).
  - Treatment of 34,000 L of FFTA pond water using MPE, bag filters, and three liquid-phase GAC vessels.
  - Pond inlet pump was screened to protect biota.
  - Objective to observe break-through of PFAS compounds.
  - Sample collection and analysis from three points in the system.
    - *Primary – After 1st Carbon Vessel*
    - *Secondary – After 2nd Carbon Vessel*
    - *Discharge – After 3rd Carbon Vessel*
  - Review sample results to determine maximum mass of PFAS that can be absorbed by the treatment system.



Advanced Oxidation Water Treatment Trial

Advanced oxidation ex-situ batch treatment trials

- Selective chemical oxidation through reactions with hydroxyl radicals using proprietary chemicals.
- Two trials completed:
  - Pre-treatment with oxidant and citric acid.
  - Trial 1, 60 minute circulation with 50 L of pond water.
  - Trial 2, 80 minute circulation with 50 L of pond water, with post treatment sulphite solution and sodium hydroxide.
- Sample analysis:
  - Trial 1 – Pre-treatment, 20 min, Post-treatment
  - Trial 2 – Pre-treatment, 20 min, 60 min, Post-treatment
  - Trial 2 post treatment also analyzed for toxicity



Advanced Oxidation Water Treatment Trial

Rainbow Trout LC50 Toxicity

- Pre treatment – No effect.
- Post treatment – No effect.

Ceriodaphnia dubia Sub-lethal Toxicity

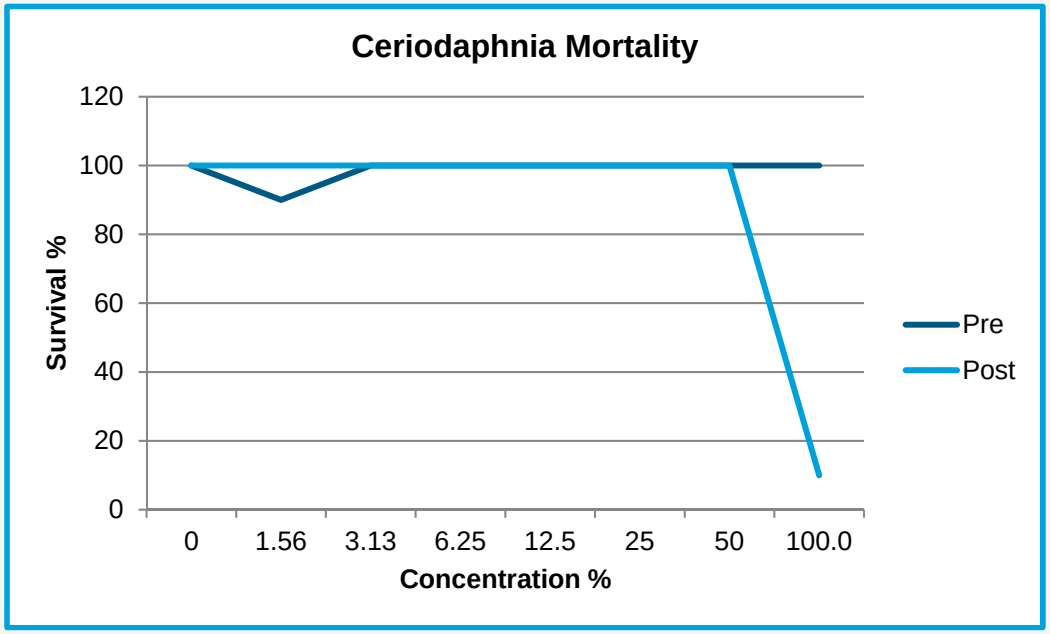
- 10 replications, mean individual counts at increasing concentrations.

Reproductive effect

- Pre-treatment – no effect.
- Post treatment – significant negative effect at 100%.

Mortality

- Pre treatment – no effect.
- Post treatment – significant negative effect at 100%.



Summary

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Summary

Delineation

- PFOS and all COCs successfully delineated in soil.
- PFAS compounds in groundwater extend to site boundaries to the north, northwest, and are not fully delineated to the southwest, or south within CFB Comox.
- GW delineation is ongoing and not yet complete.
- Offsite investigations being completed by others.

Water Treatment Trial – Advanced Oxidation

- Minor reduction of PFAS observed in Trial 1 and no reduction seen in Trial 2.
- Results suggest that the treatment method was not viable to achieving regulatory compliance.
- No toxicity observed in untreated water.
- Toxicity observed in treated water likely due to amendments and increased Cd, Cu, SO_4, Na.

Water Treatment System GAC trials

- Potable water trial successful; PFAS results were non-detect.
- GAC performance testing completed with pond water. Breakthrough achieved after first carbon vessel.

Next Steps

- Final Reporting.
- Providing data and support to other consultant teams completing offsite investigation, HHERA, and remedial options analysis.
- Additional groundwater monitoring onsite.
- Additional groundwater delineation.
- Optimization of water treatment system and GAC configuration.
- Source control water treatment of FFTA retention pond.
- Water treatment from other remediation projects at CFB Comox.

Questions?

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Our values are the essence of our company's identity. They represent how we act, speak and behave together, and how we engage with our clients and stakeholders.

SAFETY

We put safety at the heart of everything we do, to safeguard people, assets and the environment.

INTEGRITY

We do the right thing, no matter what, and are accountable for our actions.

COLLABORATION

We work together and embrace each other's unique contribution to deliver amazing results for all.

INNOVATION

We redefine engineering by thinking boldly, proudly and differently.

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