FOCUSED STUDY ACTIVITY WORK PLAN

General Information

***Decision Pool C: Activity paused.** *Funding in 2018/19 is dependent upon key project members participating in Oil Sands Process Water release discussions occurring provincially and federally. The Oil Sands Monitoring Program Secretariat will coordinate a meeting with the lead of the Alberta Environment and Parks OSPW Science Team for discussion. If these science discussions indicate work is warranted, activity will be considered for further funding.		
Work Plan Unique Identifier:	*W-MD-2-1718*	
Focused Study Activity Title:	Develop a method that accurately measures seepage from tailings ponds and evaluate its toxicological significance.	
Focused Study Category:	Investigation of Cause or Potential Ecological Impact	
Geographic Location (*choose from drop-down menu. If Project Location is in more than one area choose from second drop-down***)**	Athabasca Oil Sands Region	Athabasca Oil Sands Region
Monitoring Site(s) Coordinates *(latitude and longitude)*		
Project Leader:	Mark Hewitt and Richard Frank	
Organization and contact information:	**Environment and Climate Change Canada** **Water Science and Technology Directorate** **Burlington ON** **mark.hewitt@canada.ca** **richard.frank@canada.ca**	
Date Study initiated:		
Monitoring Category: *(From OSM long-term plan; choose from drop-down menu)*	Watershed Monitoring	
Strategic Objective of Focused Study: *(From OSM long-term plan; choose from drop-down menu)*	Objective W2: Aquatic Contaminant Source Identification	
Hypotheses: *(Briefly outline the specific hypotheses that your focused study is aiming to address)*	1. *The Source Identification methodologies being employed are capable of differentiating complex mixtures from different sources of industrial process waters as well as from natural bitumen sources.* 2. *Effects-Directed Analysis (EDA) methods being employed are identifying toxic compounds of interest as well as sensitive*	

	species and endpoints. This information will narrow the focus of chemical and biological monitoring.
Deliverables: *What tangible goal (s) and/or product(s) will the monitoring produce and when?*	*The deliverables and detailed study plan below have been modified from the existing, approved work plan in order to incorporate 2017-18 findings and progress. Further adjustments have also been made based on:* *i) OS Secretariat feedback requesting the results from this project be used to guide and inform management for policy decisions in relation to Naphthenic Acids (including CCME guideline development, potential addition to NPRI, analytical method development), as well as development of Oil Sands Effluent Regulations, and* ii) *Informing and enabling federal and provincial enforcement agencies to investigate potential legislative violations by briefing and technology transfer of the OSPW seepage methodologies developed.* 1. **Assessment of Chemical Variability of OSPW** – Tailings water collected for the OSPW Certified Reference Mixture (Project W-MD-1-1718) was collected from multiple locations from within ~10 different containments in 17/18. Employing recently developed methods, the range of chemical variability within OSPW can now be assessed and a library of chemicals unique to each pond and/or operator can be established. This information is critical for monitoring and enforcement initiatives. 2. **Effects-Directed Analysis of Bitumen-Derived Chemicals** – Bitumen-influenced waters collected for Reference Mixtures will be further fractionated and acutely assayed with previously identified sensitive species. Chronic assays will also commence to further identify sensitive endpoints. Isolated organic and inorganic mixtures will be assayed together and independently to better understand organic/inorganic interactive effects discovered in 17/18 to better understand the environmental impacts of tailings seepage. The identified chemical drivers of toxicity, and most sensitive species and endpoints, will contribute information vital to monitoring, enforcement, future effluent regulations, and reclamation initiatives by focusing efforts beyond highly complex mixtures and random toxicological endpoints. In addition this work will support the development of CCME guidelines for Naphthenic Acids.

	3. **Finalizing Analytical Methodologies to Assess Tailings Seepage** – Chemicals or chemical classes identified from the Goals described above as being compounds of interest (i.e., proposed tracers of OSPW seepage, bioactive, etc.) will be assessed for their presence in biological samples, including fish bile, as evidence of exposure. Furthermore, these chemicals will be investigated for their ability to be synthesized as Certified Reference Materials. This work supports the risk based framework by identifying which compounds and/or chemical classes within those sources pose the greatest risk to aquatic ecosystems and should be integrated into the OSM framework, and is critical for enforcement, monitoring, future regulations development for effluent discharges, Naphthenic Acid chemical method development and CCME Guidelines for Naphthenic Acids. Products: 1. **Assessment of Chemical Variability of OSPW** – First identification of organic compounds that are unique to OSPW and/or individual operators, should any exist. 2. **Effects-Directed Analysis of Bitumen-Derived Chemicals** – Further identification of sensitive species and endpoints, including chronic –omics endpoints, and further elucidation of drivers of toxicity within industrial and natural sources. 3. **Finalizing Analytical Methodologies to Assess Tailings Seepage** – If possible, compounds of interest (i.e., proposed tracers of OSPW seepage, bioactive substances, etc.) will be synthesized and made available to all stakeholders for quantitative and qualitative analyses. Also, first assessment of biological samples to detect presence of seepage compounds of interest in wild organisms. 4. **Publications** in peer-reviewed literature for all sub-studies described above. 5. **Formal briefing with ECCC and Alberta Enforcement** departments on seepage detection methodologies and toxicological assessments for communication and potential technology transfer.

Detailed Study Plan

(Please provide detailed information on the specifics of your focused study including – (**keywords, hypothesis and the assumptions and constraints behind your hypothesis**)

Provide a maximum of 10 key words that describe this project. Use commas to separate them:

analytical methodology, tailings pond seepage, source identification, groundwater, bitumen soluble organics, toxicological significance, certified reference materials, effects directed analysis, technology transfer,

Describe how you will test your hypothesis:

Methods developed in16/17 and 17/18 will be applied to the proposed hypotheses for 18/19, enabling the identification of the sources, pathways and environmental levels of migratory waterborne oil sands mixtures beyond tailings containments, at sites where migrations have been documented or indicated (Roy et al. 2016). Effects directed analysis, a powerful tool used widely in monitoring programs (Brack et al. 2016) will assess the toxicological significance of the chemical classes of interest within migratory mixtures. These mixtures include, but are not limited to, acid extractable organics (AEOs), perfluorinated flame retardants, artificial sweeteners (Hewitt et al. 2018) and new unknown substances recently identified as unique to oil sands process-affected water (OSPW) and groundwater containing migratory OSPW-derived mixtures (Milestone et al. 2018). We will accomplish these objectives according to the 3 sub-projects described below.

1. **Assessment of Chemical Variability of OSPW** – Tailings water collected in 17/18 for the OSPW Certified Reference Mixture (Project W-MD-1-1718, utilizing extraction protocol developed in 17/18 Bauer et al. 2018a) were collected from multiple locations from within ~10 different containments in an unprecedented sampling campaign. Employing recently developed methods, the range of chemical variability within OSPW (all soluble organics, metals, major ions) will be assessed and a library of chemicals unique to each pond and/or operator can be established (Frank et al. 2016). These analyses will also be applied to the 2 other bitumen influenced water sources targeted by Strub project (surface water, groundwater, Project W-MD-1-1819) that are proposed to be sampled in 18/19.

2. **Effects-Directed Analysis of Bitumen-Derived Chemicals** – Bitumen-influenced waters collected for Reference Mixtures (OSPW, groundwater, surface water Project W-MD-1-1718); will be fractionated in a two Tier approach (Tier 1, Frank et al. 2018; Tier 2 method developed in 17/18) and acutely assayed with sensitive species identified in 16/17 and 17/18 (Bauer et al 2018b,c). Chronic assays will commence in 18/19 to identify sensitive endpoints. Isolated organic and inorganic mixtures will be assayed together and independently to better understand interactive effects between organics and inorganics discovered in 17/18 to better understand the environmental impacts of tailings seepage and proposed initiatives on tailings effluent discharges.

3. **Finalizing Analytical Methodologies to Assess Tailings Seepage** – Chemicals or chemical classes identified in 17/18 (Hewitt et al. 2018; Milestone et al. 2018) and from the Goals described above as

being compounds of interest (i.e., proposed tracers unique to OSPW, bioactive, etc.) will be assessed for their presence in biological samples including fish bile, as evidence of exposure. Furthermore, these chemicals are proposed to be synthesized as authentic standards for Naphthenic Acid method development, for use by federal and provincial enforcement agencies investigating OSPW seepage and also as additional Certified Reference Materials. We propose a formal briefing or workshop with ECCC and Alberta Enforcement agencies to update them on both the chemical methods and toxicological assessments so that they may undertake appropriate action (e.g. technology transfer). This briefing was committed to in the Government of Canada's response to the Tailings Pond Seepage submission to Commission on Environmental Cooperation (November 2017). We anticipate that beyond the briefing and as part of the technology transfer, our participation in sample analysis and data interpretation of initial enforcement investigations using the methodology will be required going into 19/20.

Assumptions and Constraints behind the hypothesis and the testing method:

Assumptions

1. We can apply the analytical methodologies developed for tracking OSPW migrations to biological samples (fish bile).
2. Methodology for fractionating groundwater to identify the chemical classes of interest at sites contaminated by tailings and natural bitumen-influenced sites are valid with existing standard protocols and protocols that were developed in 17/18.

Constraints

1. Continued financial support and ability to secure and maintain human resources (2 postdoctoral fellows proposed under O&M salary in existing NSERC VF program. May have to change to salary in new proposed RES term option that is to be finalized at the Departmental level), and laboratory consumables, including extraction resins, is essential.
2. Ability to maintain analytical instrumentation for analysis.
3. Ability to conduct complete range of bioassays contingent upon generation of sufficient quantities of fractions from existing samples.

References:

Alberta Tailings Pond II, Response to Submission SEM-17-001 to the Commission for Environmental Cooperation. Environment and Climate Change Canada, November 2017. 37p.

Bauer AE, Farwell AJ, Frank RA, Hewitt LM, DG Dixon. 2018. Risk assessment of oil sands acid-extractable organics to aquatic organisms. (Expected submission: March 2018).

Bauer AE, Hewitt LM, Parrott JL, Bartlett AE, Gillis PL, Rudy MD, Vanderveen R, Barrett SE, Campbell SD, Rodrigues MR, Brown L, Deeth LE, Roy JW, Bickerton G, Farwell AJ, DG Dixon, Frank RA. 2018. Toxicity of bitumen-influenced groundwater fractions to a suite of aquatic organisms. (Expected submission: March 2018).

Bauer AE, Hewitt LM, Parrott JL, Bartlett AE, Gillis PL, Rudy MD, Vanderveen R, Barrett SE, Campbell SD, Brown L, Deeth LE, Farwell AJ, Dixon DG, Frank RA. 2018. Toxicity of aged oil sands process-affected water fractions to a suite of aquatic species. (Expected submission: March 2018).

Bauer AE, Frank RA, Headley JV, Milestone CB, Batchelor S, Peru KM, Rudy MD, Barrett SE, Vanderveen R, Dixon DG, Hewitt LM. 2018. A preparative method for the isolation and fractionation of dissolved organics from bitumen-influenced waters. (Expected submission: March 2018).

Brack, W., S. Ait-Aissac, R.M. Burgess, N. Creusot, C. Di Paolo, E. B.I., L.M. Hewitt, K. Hilscherova, J. Hollender, H. Hollert, W. Jonker, J. Kool, M. Lamoree, M. Muschket, S. Neumann, P. Rostkowski, C. Ruttkies, J. Schollee, E.L. Schymanski, T. Schulze, T.-B. Seiler, A.J. Tindall, G. De Aragão Umbuzeiro, B. Vrana and M. Krauss. 2016. Effect-directed analysis supporting monitoring of aquatic environments – An in-depth overview. *Sci. Tot. Environ*. **544**: 1017-1118.

Frank RA, Bauer AE, Rudy MD, Vanderveen R, Batchelor S, Barrett SE, Milestone CB, Roy JW, Bickerton G, Farwell AJ, Dixon DG, Hewitt LM. 2018. Preparative isolation and fractionation of the soluble organic mixtures of bitumen-influenced groundwater. (Expected submission: March 2018).

Frank R.A., Milestone C., Kavanagh R.J., Headley J.V., Rowland S.J., Scarlett A.G., West C.E., Peru K.M. and L.M. Hewitt. 2016. Assessing variability of acid extractable organics within two containments of oil sands process-affected water. *Chemosphere*, **160**: 303-313.

Hewitt LM, Roy JW, Bickerton G, De Silva A, Rowland SJ, Headley JV, Scarlett AG, West CE, Peru KM, Frank RA. 2018. Analytical methodologies to identify industrially influenced groundwater in the McMurray Formation of northern Alberta, Canada. (Expected submission: March 2018).

Milestone, C.B, Sun, A., Roy, J.W., Martin, J., Bickerton, G., Frank R.A. and L.M. Hewitt. 2018. Untargeted profiling of bitumen influenced waters for the identification of tracers of oil sands processed water (OSPW) migrations in the Athabasca watershed of Alberta Canada. (Expected submission: March 2018).

Roy, J.W., Bickerton G., Frank R.A., Grapentine L. and L.M. Hewitt. 2016. Assessing risks associated with constituents detected in shallow riparian groundwater near a tailings pond in the Athabasca oil sands region of northern Alberta, Canada. *Groundwater,* **51**(4): 545-558.

Data Management

If this work generates data please summarize your project-level data management plan.

Deliverables	Timeframe
Data Collection Period: *Field work*	Start : 2018-05-01 End: 2018-10-31
Data Analysis Period: *Laboratory analysis and QA/QC of data*	Start : 2018-04-01 End: 2019-03-31
Data Release Date: *Metadata and data consistent, complete and meet basic standard format for publication in Open Data; on or linked to JOSM portal*	2019-03-31

Reporting and Publications

Provide information on the anticipated reports / publications. (Insert additional rows if needed)

Expected Subject/Titles of Publications or Reports	Short Description of Publication or Report	Expected Year of Publication
Effects-directed analysis of organic mixtures from bitumen influenced waters. (Rodrigues et al. 2019).	Bioactive fractions identified in 17/18 are being sub-fractionated and toxicologically assessed.	2019
Toxicological assessments of chronic endpoints from bitumen-influenced waters (Frank et al. 2019).	Assessing chronic toxicity endpoints (i.e., reproduction, -omics, etc.) in Daphnia magna exposed to bitumen-derived organics from industrial and natural sources.	2019
Analytical methodologies to identify industrially influenced groundwater in the McMurray Formation of northern Alberta, Canada. (Hewitt et al. 2018)	Analytical toolbox for measuring OSPW migrations.	2018

Untargeted profiling of bitumen influenced waters for the identification of tracers of oil sands processed water (OSPW) migrations in the Athabasca watershed of Alberta Canada. (Milestone et al. 2017).	Chemometric analysis of bitumen influenced waters to identify new tracer compounds for OSPW migrations.	2018
EDA analysis of bitumen-influenced groundwaters. (Frank et al. 2018).	2nd Tier EDA of groundwaters in-house.	2018
EDA of OSPW CRM (Postdoctoral fellow et al. 2019).	Multi-tier EDA analysis.	2019
Assessing chemical variability of organic mixtures in active oil sands tailings ponds (Postdoctoral fellow et al. 2019)	Water for OSPW organic Certified Reference Material was collected from multiple locations within each of ~10 active tailings. The chemical variability of soluble bitumen-derived organics will be assessed along with the identification of chemicals unique to OSPW and or specific operators.	2019

Technical / Professional Roles and Responsibilities

Identify members of the monitoring team/organization, their roles and responsibilities. Identify monitoring organization leads if different from overall monitoring activity lead. (Insert additional rows if needed)

Role/Resource Name/Organization	Responsibilities
Project Lead (ECCC)	Hewitt: Project coordination, organic acid and chemometric analyses, effects-directed analyses (chemical fractionation and characterization). Frank: Effects-directed analyses (chemical fractionation and bioassay coordination)
Component Lead (ECCC)	Project oversight
Co-Investigators (ECCC)	-Fire suppressing PFCs analyses -2D GC analyses of monoaromatic acids -Early life stage fish bioassays -Invertebrate bioassays

Technical Support (ECCC)	-Technical support for completion of analyses described above in EC laboratories -PDF#1: Projects include non-target data synthesis, Effects-directed analysis, chemical characterizations of bioactive substances -PDF#2: Projects include Effects-directed analysis, chronic toxicity studies

Deliverables (Year 2) If your Focus Study is longer than 1 year then complete **Appendix C** for multi-year deliverables breakdown

Provide a summary of tangible quarterly deliverables. Identify major project areas (deliverables) and results that can be identified as a tangible goal. This could include: field work, lab work/ analysis, evaluation, data, reports, publications, SOPs etc. Do not define process as your Deliverable e.g. 'fly to Ft. McMurray to conduct fieldwork' or 'seek Director approval for report'.

Deliverable(s) (please provide enough information to support status reporting)
Q1 – April to June
1. Continue chemical variability assessments of OSPW samples collected for CRM preparation in 2017/18. (Project W-MD-1-1718 led by R. Strub). 2. Coordinate sample collection of required source waters (ground/surface waters) with Alberta Environment and Parks. (Project W-MD-1-1718 led by R. Strub). 3. Continue drafts of publication(s), commenced in 2017/18, related to effects-directed analyses and chemical characterization of bitumen-influenced waters. 4. Initiate effects-directed analysis of OSPW CRM, incorporating new endpoints and methodologies developed. 5. Coordinate procurement of chemical synthesis of new tracer compounds for detecting OSPW seepage. 6. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.
Q2 – July to September
1. Continue chemical variability assessments of OSPW samples collected for CRM preparation in 2017/18. (Project W-MD-1-1718 led by R. Strub). 2. Conduct sample collection of required source waters (ground/surface waters) with Alberta Environment and Parks. (Project W-MD-1-1718 led by R. Strub). 3. Continue drafts of publication(s), commenced in 2017/18, related to effects-directed analyses and chemical characterization of bitumen-influenced waters. 4. Coordinate/conduct briefing and/or workshop with ECC and Alberta Enforcement groups on methodologies for detecting tailings seepage and associated toxicological assessments. 5. Continue effects-directed analysis on OSPW CRM. 6. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.

Q3 – October to December
1. Continue chemical variability assessments of OSPW samples collected for CRM preparation in 2017/18. (Project W-MD-1-1718 led by R. Strub). 2. Initiate chemical variability assessments of ground/surface waters collected for CRM preparation in previous quarter. (Project W-MD-1-1718 led by R. Strub). 3. Continue drafts of publication(s), commenced in 2017/18, related to effects-directed analyses and chemical characterization of bitumen-influenced waters. 4. Continue effects-directed analysis on OSPW CRM. 5. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.
Q4 – January to March
1. Conduct confirmation studies of synthesized tracer compounds, to determine if they are present in OSPW. 2. Complete chemical variability assessments of OSPW samples collected for CRM preparation in 2017/18. (Project W-MD-1-1718 led by R. Strub). 3. Complete chemical variability assessments of ground/surface waters collected for CRM preparation in previous quarter. (Project W-MD-1-1718 led by R. Strub). 4. Complete drafts of publication(s), commenced in 2017/18, related to effects-directed analyses and chemical characterization of bitumen-influenced waters. 5. Continue effects-directed analysis on OSPW CRM. 6. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.

Detailed Financial Breakdown – Year 2 of 3 (2018-2019)

Also complete **Appendix B** for the multi-year financial breakdown

Budget requirements – List areas that require budget expenditures: (ADD OR DELETE BUDGET CATEGORIES AS REQUIRED)	**OS Funding**	**External Funding (*outside JOSM*)**
O&M - Operations and Maintenance:		
Helicopter Costs	**$**	**$**
Field Costs	**$**	**$**
Data Management	**$4,000**	**$**
Internal Lab Analysis (NLET)	**$25,000**	**$**
Consumable Materials & Supplies	**$110,000**	**$**
Sub-Total	**$139,000**	**$**
O&M - Travel		
Conferences (*SETAC, 2 individuals*)	**$8,000**	**$**
Enforcement Brief/workshop (*Calgary, 4 individuals*)	**$8,000**	**$**
Sub-Total	**$16,000**	**$**
O&M - External Contracts :		
Snieckus Innovations chemical synthesis of OSPW tracers- $15.5K *Agilent QToF maintenance contract - $25.0K*	**$40,500**	**$**
External Lab Analysis	**$**	**$**
Sub-Total	**$40,500**	**$**
O&M Salaries:		
2 Postdoctoral Fellows (aiming to start NSERC VF Fellows Spring 2018 but may shift to RES-01 terms in 19/20)	**$106K**	**$**
Sub-Total	**$106,000**	**$**
Total Salaries	**$0**	**$**
Total O&M	**$301,500**	**$**
2018-2019 GRAND TOTAL (***before other related costs)	**$301,500**	**$**

Appendix A – Approvals

Project Submitted by:		
Name: Mark Hewitt and Richard Frank		
Organization: ECCC	Signature:	Date:

Project Approved by:		
Signature		Signature
Date		Date

Activity Planning Review and Evaluation

To be completed by OSM Administration

Date Completed	**Review type**	**Validated by** (insert name and title)
	Program Management review completed	

APPENDIX B – Detailed Multi-year Financial Breakdown (Complete the following detailed financial breakdown; add or delete categories as required)

Budget requirements	Year 2 (2018- 2019)		Year 3 (2019- 2020)		Year X (20XX- 20YY)	
	Cash	In-kind	Cash	In-kind	Cash	In-kind
1) Salaries and benefits						
a) Investigators						
b) Technical/professional assistants (2 PDFs)	$72,800		106,000		106,000	
c) Field Staff						
d)						
2) Operations and maintenance						
a) Facilities						
b) Equipment						
c) Lab analysis	$15,000		25,000		25,000	
d) Data management	$4,000					
e) Field work						
3) Consumable Materials and supplies						
a)	$90,200		110,000		110,000	
b)						
4) Travel						
a) Conferences and meetings	$8,000		$8,000		$8,000	
b) Field work					$15,000	

c) Project-related travel						
5) Dissemination & Engagement						
a) Publications/Reports						
b) Translation (if required)						
c) Communications			$4,000		$4,000	
d) Stakeholder Engagement			$8,000		$7,000	
e) Indigenous Peoples Engagement						
6) External Contracts						
a) Agilent b) Sneickus Innovations	$60,000		$40,500		$20,000	
Grand Total (*before other related costs)	$250,000		$301,500		$295,000	

*Total O&M ($301,500) for ECCC in 2018-19 with other related costs is $313,682. **The Grand Total cost is $313,862.**

APPENDIX C –Years 2 and 3 Deliverables (Complete the following detailed breakdown. Provide a summary of tangible quarterly deliverables and your anticipated expenditures. Identify major project areas (deliverables) and results that can be identified as a tangible goal.)

Year 3 (2019- 2020)	
Deliverable(s) (please provide enough information to support status reporting)	**Budget**
Q1 – April to June	
1. Continue drafts of publication(s), commenced in 2018/19, related to effects-directed analyses and chemical characterization of bitumen-influenced waters. 2. Continue confirmation studies of synthesized tracer compounds, to determine if they are present in OSPW and other sources of bitumen-influenced waters. 3. Coordinate additional briefings/workshops with federal and provincial enforcement agencies on tailings seepage methodology technology transfer, as necessary. 4. Continue bile analysis for evidence of OSPW exposure. 5. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.	$73.8 K
Q2 – July to September	
1. Continue effects-directed analysis on OSPW CRM. 2. Continue confirmation studies of synthesized tracer compounds, to determine if they are present in OSPW and other sources of bitumen-influenced waters. 3. Coordinate sample collections with federal and provincial enforcement agencies on tailings seepage investigations as part of technology transfer of seepage methodology.	$73.8 K

4. Continue bile analysis for evidence of OSPW exposure. 5. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.	
Q3 – October to December	
1. Continue effects-directed analysis on OSPW CRM. 2. Initiate effects-directed analysis of groundwater and surface water CRMs. 3. Complete confirmation studies of synthesized tracer compounds, to determine if they are present in OSPW and other sources of bitumen-influenced waters. 4. Initiate sample analysis with federal and provincial enforcement agencies on tailings seepage investigations as part of technology transfer of seepage methodology. 5. Complete bile analysis for evidence of OSPW exposure. 6. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.	$73.8 K
Q4 – January to March	
1. Compare results from effects-directed analysis on OSPW CRM to groundwater and surface water CRMs. Determine if bioactive substances are unique to OSPW or are also naturally derived. 2. Complete sample analysis and technology transfer with federal and provincial enforcement agencies on tailings seepage methodology.	$73.8 K

3. Continue to inform management and contribute to ongoing Naphthenic Acid initiatives (NPRI, CCME, method development) and OS Effluent Regulation initiative via teleconferences/videoconferences/briefing notes, as appropriate.	
Total Annual Budget	$295.0K