

Canada-Alberta Joint Oil Sands Monitoring Program - Suspended Sediment Monitoring

Disclaimer & Notes

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This data has been made available after results were validated according to Environment and Climate Change Canada procedures; however, further quality assurance and quality control procedures may result in differences between what is available at present and what is recorded in the authoritative record in Environment and Climate Change Canada's databases.

Data Description

Parent and Alkylated Polycyclic Aromatic Hydrocarbons (PAHs) on a $\mu\text{g/g}$ dry weight basis

Physicals - % Total Carbon(TC), %Total Inorganic Carbon(TIC), %Total Organic Carbon(TOC), %Clay, %Silt, %Sand, %Gravel, and Total Suspended Sediments(TSS) (% mass basis, TSS mgL^{-1})

Metals – mg/Kg dry weight basis

Study Notes – Bulk Suspended Sediment Sampling via Continuous Flow Centrifugation

2012 -2013 Field Campaign Data

Following the Standard Operating Procedures (SOP) for bulk suspended sediment sampling (see SOP related file), and depending on the time of year, continuous flow centrifuges were deployed from a boat or on ice close to the thalweg of the river at all sites with the exception of M3. M3 required a flow integrated approach due to poor mixing of the upstream Clearwater River within the Athabasca River (centrifuges were operated at the centroid of 5 equal discharge increment panels as determined by the Water Survey of Canada prior to sampling). Depending on the suspended solid concentrations within the river at the time of sampling, centrifuges were run from 3 to 48 hours at each site. A minimum of 200g of sediment was required to obtain enough mass for all analytical requirements within the Phase 1 parameter list (appendix B) of the implementation plan (Environment and Climate Change Canada, 2011). Due to extreme weather not all sites have under ice samples.

As June high flow periods (high suspended sediment concentration) allowed for large volumes of sediment to be collected from two simultaneously operated centrifuges, duplicate samples were possible. During low flow periods (low suspended sediment concentration), however, sediments from both centrifuge bowls had to be combined to meet as many analytical requirements as possible.

All PAHs for 2012 were performed by the accredited laboratory, AXYS Analytical Services Ltd, Sidney, BC, Canada an ISO/IEC 17025:2005 laboratory using the method MLA-021 (note that methods can vary slightly and in this case high and low flow conditions followed MLA-021 rev10-ver04, while the under ice samples followed MLA-021 rev10-ver06. This information is available directly from AXYS Analytical Services Ltd).

All Physicals were performed by Prairie and Northern Laboratory for Environmental Testing (PNLET), Science and Technology Branch, Environment and Climate Change Canada using the following methods; Particle Size Analysis for Water – Method 180.2, Laser Diffraction, Particle Size Analysis for Sediment – Method 180.4, Laser Diffraction/Sieving; and Carbon (Solid) - Method 440.2 (Combustion). Details of these methods can be obtained by PNLET directly. Note that TSS was not determined by a certified lab, but were measured using accepted gravimetric methods (filtering a known volume of water through a tared 0.45 µm Millipore™ filter, drying for 1 hour at 100 degree C, followed by reweighing to determine mass of sediment within the samples – duplicate samples were collected). TSS values are not recorded under the listed database label and are provided here for additional information.

All metals for 2012 were performed by the National Laboratory for Environmental Testing, Burlington, Ontario, Canada using standard methods (SOP 02-2404).

2013-2014 Field Campaign Data

Following the Standard Operating Procedures (SOP) for bulk suspended sediment sampling (see SOP related file), and depending on the time of year, continuous flow centrifuges were deployed from a boat, on ice, or from water treatment intakes at sites M0, M2, M3, M4 and M9. All samples were collected from the thalweg with the exception of M3 which required a flow integrated approach due to poor mixing of the upstream Clearwater River within the Athabasca River (centrifuges were operated at the centroid of 5 equal discharge increment panels as determined by the Water Survey of Canada prior to sampling). Logistical issues necessitated that not every site could be sampled for every period (high flow, low flow and under ice). Depending on the suspended solid concentrations within the river at the time of sampling, centrifuges were run from 3 to 48 hours. A minimum of 200g of sediment was required to obtain enough mass for all analytical requirements within the Phase 1 parameter list (appendix B) of the implementation plan (Environment and Climate Change Canada, 2011). Due to extreme weather not all sites have under ice samples.

As winter logistics made centrifuging water for extended periods of time (>48 hours) very difficult, an alternate approach in 2014 was taken for sites M0 and M2. Centrifuges were directly connected into the water intake lines of the water treatment plants at the Towns of Athabasca (M0) and Fort McMurray (1km downstream of M2)(intakes close to thalweg of river). As June high flow periods (high suspended sediment concentration) and winter samples with extended 48 hours pumping allowed for large volumes of sediment to be collected from two simultaneously operated centrifuges, duplicate samples were possible. Further for 2014, an on-ice sample was collected at M4 to semi-compensate for not being able to sample the northern M9 site. During low flow periods (low suspended sediment concentration), sediments from both centrifuge bowls had to be combined to meet as many analytical requirements as possible.

Note that due to a change in laboratories for analysis, the 2013-2014 data had a higher level of detection, resulting in non-detections that were not observed with the higher resolution data of 2012-2013.

All PAHs from April 2013 to March 2014 were performed by the Pacific and Yukon Laboratory for Environmental Testing, Environment and Climate Change Canada using a GC-MS (HP 7890A from Agilent Technologies, Palo Alto, CA, USA) following the SOP-PAHMSMS and SOP-ALKPAH [also described in Shang et al. (2014)].

All Physicals were performed by Prairie and Northern Laboratory for Environmental Testing (PNLET), Science and Technology Branch, Environment and Climate Change Canada using the following methods; Particle Size Analysis for Water – Method 180.2, Laser Diffraction, Particle Size Analysis for Sediment – Method 180.4, Laser Diffraction/Sieving; and Carbon (Solid) - Method 440.2 (Combustion). Details of these methods can be obtained by PNLET directly. Note that TSS was not determined by a certified lab, but were measured using accepted gravimetric methods (filtering a known volume of water through a tared 0.45 µm Millipore™ filter, drying for 1 hour at 100 degree C, followed by reweighing to determine mass of sediment within the samples – duplicate samples were collected). TSS values are not recorded under the listed database label and are provided here for additional information.

All metals for April 2013-March 2014 were performed by the National Laboratory for Environmental Testing, Burlington, Ontario, Canada using standard methods (SOP 02-2404).

2014 – 2015 Field Campaign Data

Following the Standard Operating Procedures (SOP) for bulk suspended sediment sampling (see SOP related file), and depending on the time of year, continuous flow centrifuges were deployed from a boat, on ice, or from water treatment intakes at sites M0, M2, M3 and M9. All samples were collected from the thalweg with the exception of M3 which required a flow integrated approach due to poor mixing of the upstream Clearwater River within the Athabasca River (centrifuges were operated at the centroid of 5 equal discharge increment panels as determined by the Water Survey of Canada prior to sampling). Logistical issues necessitated that not every site could be sampled for every period (high flow, low flow and under ice). Depending on the suspended solid concentrations within the river at the time of sampling, centrifuges were run from 1 to 35 hours. A minimum of 200g of sediment was required to obtain enough mass for all analytical requirements within the Phase 1 parameter list (appendix B) of the implementation plan (Environment and Climate Change Canada, 2011). No under ice sampling occurred in the winter of 2015.

As June high flow periods (high suspended sediment concentration) and extended pumping times for September low flow periods allowed for large volumes of sediment to be collected from two simultaneously operated centrifuges, each bowl was analyzed individually. Bulk sediment sample volumes within each centrifuge bowl for the September 2014 samples were also large enough to allow for replicate samples within centrifuge bowl duplicates.

Note that due to a change in laboratories for analysis, the 2014 data had a higher level of detection, resulting in non-detections that were not observed with the higher resolution data of 2012-2013.

All PAHs from April 2013 to March 2014 were performed by the Pacific and Yukon Laboratory for Environmental Testing, Environment and Climate Change Canada using a GC-MS (HP 7890A from Agilent

Technologies, Palo Alto, CA, USA) following the SOP-PAHMSMS and SOP-ALKPAH [also described in Shang et al. (2014)].

All Physicals were performed by Prairie and Northern Laboratory for Environmental Testing (PNLET), Science and Technology Branch, Environment and Climate Change Canada using the following methods; Particle Size Analysis for Water – Method 180.2, Laser Diffraction, Particle Size Analysis for Sediment – Method 180.4, Laser Diffraction/Sieving; and Carbon (Solid) - Method 440.2 (Combustion). Details of these methods can be obtained by PNLET directly. Note that TSS was not determined by a certified lab, but were measured using accepted gravimetric methods (filtering a known volume of water through a tared 0.45 µm Millipore™ filter, drying for 1 hour at 100 degree C, followed by reweighing to determine mass of sediment within the samples – duplicate samples were collected). TSS values are not recorded under the listed database label and are provided here for additional information.

All metals were performed by the National Laboratory for Environmental Testing, Burlington, Ontario, Canada using standard methods (SOP 02-2404).

Study Notes – Bulk Suspended Sediment Sampling via Phillips Tube Samplers

There is no accepted Standard Operating Procedures (SOP) for the Phillips Tube (PT) sampler. These instruments were developed for long term (days to months) time-integrated bulk suspended sediment sampling. Unlike standard USGS finite volume point or depth integrated samplers, these are not isokinetic, and are designed to provide a large volume of sediment to support multiple analytical requirements. The operational principle (see Figure 1) is that the ambient water/sediment mixture enters the nozzle at the front end of the tube (pointed into the direction of flow) at which point there is a reduction in velocity and the suspended particles settle out with the cleaner water flowing out the back port on the sampler. Given the long duration of collection time, the PT samplers are considered to provide a representative sample of the average sediment size and mass transported during the period of collection and therefore an average Appendix B parameter concentration (ECCC, 2011) [for river sediment in northern British Columbia, Smith and Owens (2014) showed that the PT sampler provides an 87% representative sample based on mass]. The reader is referred to the following publications for additional information on the Phillips Tube sampler operation and performance [Smith and Owens (2014), Phillips, Russel and Walling (2000) and Russel, Walling and Hodgkinson (2000)].

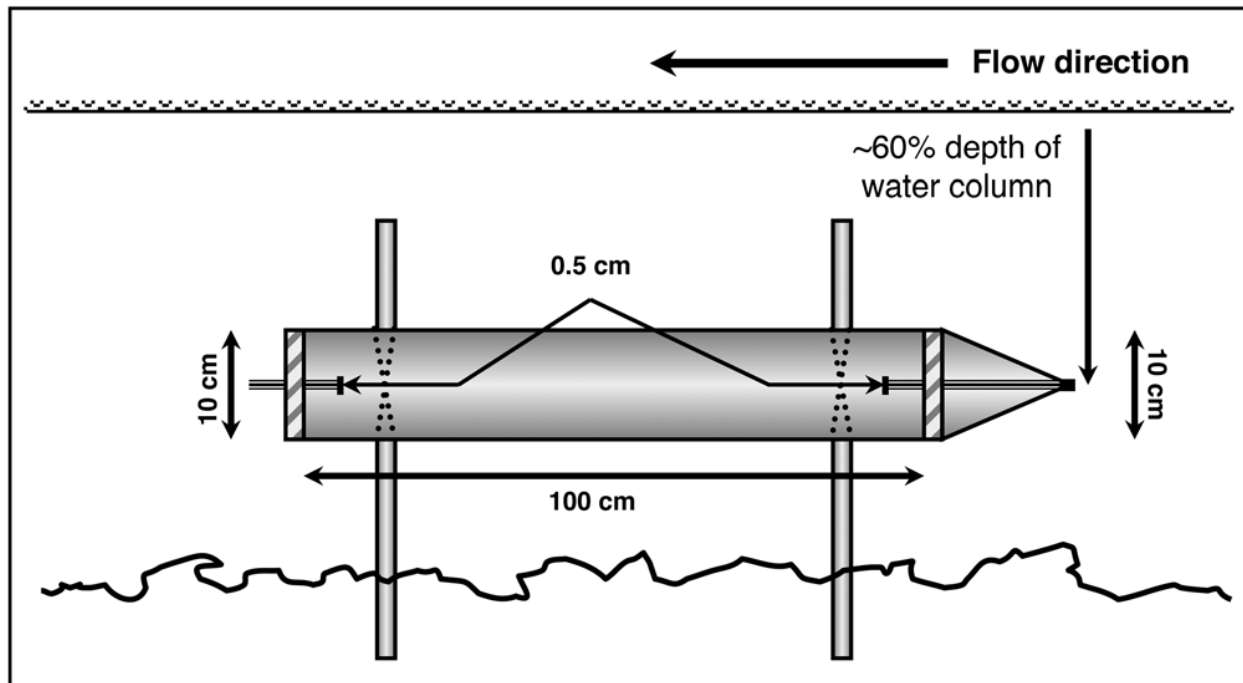


Figure 1. Cross-section of Phillips time-integrated bulk suspended sediment sampler. Flow velocity within the sampling tube is reduced by a factor of about 600 compared to ambient flow (Smith and Owens, 2014; Phillips et al., 2000; Russell et al., 2000) (figure not to scale).

PT samplers were deployed, often in duplicate, at 3 (ELLS RIFF 5, ELLS RIFF 2, ELLS RIFF4) and 4 (STB RIFF 10, STB RIFF 7, STB RIFF WSC, STB RIFF 1) sites for the ELLs and Steepbank Rivers respectively [because of operational or sampler loss (due to high flow or debris) some sites were not consistently sampled]. Even with the long integration time (22 to 64 day deployments in 2013 and 2014) there was only enough sediment (even when combining both PT collected samples) to analyze the Appendix B PAH concentrations (ECCC, 2011) and a non-certified measurement of grain size distribution.

All PAH analysis was performed by the Pacific and Yukon Laboratory for Environmental Testing, Environment and Climate Change Canada using a GC-MS (HP 7890A from Agilent Technologies, Palo Alto, CA, USA) following the SOP-PAHMSMS and SOP-ALKPAH [also described in Shang et al. (2014)].

The volume of sediment that was required to analyze the physicals (as per the centrifuge sampling) was not available. As such, only grain-size analysis of the PT samples was performed on small volumes using a CILAS™ laser particle sizer within ECCC's, Burlington hydraulics laboratory. Grain-size results are therefore not from a certified laboratory and should be viewed as such.

References

Environment and Climate Change Canada. 2011. Lower Athabasca Water quality Monitoring Plan – Phase 1. ISBN 978-1-100-18471-5

Phillips, J.M., Russel, M.A. and Walling, D.E. 2000. Time-integrated sampling of fluvial suspended sediment: a simple methodology for small catchments. *Hydro Proc.*, 14: 2589-2602

Russel, M.A., Walling, D.E. and Hodgkinson, R.A. 2000. Appraisal of a simple sampling device for collecting time-integrated fluvial suspended sediment samples. In: *The Role of Erosion and Sediment Transport in Nutrient and Contaminant Transfer*. IAHS Publication No 263. IAHS Press: Wallingford, UK; 119-127.

Smith, T.B. and Owens, P.N. 2014. Flume- and field-based evaluation of a time-integrated suspended sediment sampler for the analysis of sediment properties. *Earth Surf. Proces. Landforms*, 39: 1197-1207.

Standard operating procedure using a continuous flow centrifuge for the collection of bulk water and suspended samples for the lower Athabasca River (see uploaded file).

Shang, D., Kim, M., Haberl, M. 2014. Rapid and sensitive method for the determination of polycyclic aromatic hydrocarbons in soils using pseudo multiple reaction monitoring gas chromatography/tandem mass spectrometry. *J. Chromatog. A.*, 1334, 118-125.

SOP PAHMSMS – version 3.1, Standard operating procedures for polycyclic aromatic hydrocarbons by gas chromatography / tandem mass spectrometry. Unpublished. Pacific and Yukon Laboratory for Environmental Testing (PYLET), Pacific Environmental Science Centre, Vancouver, BC, Canada.

SOP ALKPAH – version 3.0 and 3.1, Standard operating procedures for alkylated polycyclic aromatic hydrocarbons by gas chromatography / tandem mass spectrometry. Unpublished. Pacific and Yukon Laboratory for Environmental Testing (PYLET), Pacific Environmental Science Centre, Vancouver, BC, Canada.