Lower Little Susitna River Water Quality Assessment:

May, June and August 2014

Final Report June 2015

Prepared for:

Alaska Department of Environmental Conservation

ARRI
Aquatic Restoration & Research Institute

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Contents

Tables

Figures

Definitions and Acronyms

µg/L	Micrograms per liter, parts per billion
BTEX	Constituents of gasoline (Benzene, Toluene, Ethyl Benzene, and Xylene) used to calculate TAH
C	Temperature in centigrade or Celsius units
cfs	Units of flow or discharge in cubic feet per second
DEC	Alaska Department of Environmental Conservation
EPA	U.S. Environmental Protection Agency
Flow or Discharge	Measure of the volume of water in a river moving over time
Flux	Movement of mass over time
km	Kilometer
m	Meter
mg	Milligram
mg/L	Milligrams per liter, parts per million
mm	Millimeter
MQO	Measurement Quality Objective as described in the project's Quality Assurance Project Plan for acceptance of data
PUF	Public Use Facility and boat launch in the Lower Little Susitna River operated by the state Departments of Natural Resources and Fish and Game
QAPP	Quality Assurance Project Plan
TAH	Total aromatic hydrocarbons; sum of benzene, toluene, ethyl benzene, and xylene
Thalweg	The main channel of a stream or river. Portion of the stream that contains most of the flow
VOC	Volatile Organic Compound; includes petroleum hydrocarbons
WQC	Water quality criterion (parameter specific criteria contained within the WQS)
WQS	Alaska Water Quality Standards 18 AAC 70

1.0 Summary

Water samples were collected on the lower Little Susitna River in May, June and August 2014 and analyzed to determine the concentration of total aromatic hydrocarbons (TAH). TAH concentrations were used to evaluate water quality relative to Alaska water quality standards (18 AAC 70). This 2014 study is the latest of a series of water quality sampling studies started in 2007 by the Alaska Department of Environmental Conservation (DEC) on the lower Little Susitna River. Sampling was conducted to provide measures of TAH concentrations from sites located upstream and downstream from the state-operated Public Use Facility (PUF) boat launch during heavy use periods and to test for the relationship between TAH concentrations and boat use at the PUF during the Chinook and coho salmon sport fisheries. The purpose of this 2014 study was designed to evaluate whether TAH concentrations exceeded a 96-hour (or 4-day) average of 10 µg/L.

Samples were collected during 96-hour sampling events over weekends from May 21 to June 9 during the Chinook salmon fishery, and during 96-hour (4-day) to 120 hour (5-day) sampling events over weekends from August 1 to August 25 during the coho salmon fishery. Samples were collected 5 times in 24 hours at sites located at the PUF boat launch and 4 km (2.5 miles) downstream of the PUF boat launch. Samples were collected once in 24 hours at sites located from 4 km (2.5 miles) upstream to 12 km (7.5 miles) downstream from the PUF boat launch.

Results of 2014 sampling support previous results, concluding that the operation of motor boats in the lower Little Susitna River causes an increase in TAH concentrations. Daily average TAH concentrations are correlated with the total number of boats operating. Individual sample TAH concentrations often exceeded 10 µg/L, but the 96-hour average TAH concentrations did not.

In summary, the results of the sampling found the following:

- The 96-hour average concentration of TAH did not exceed the water quality criteria (WQC) for TAH of 10 µg/L at neither the PUF boat launch nor the 4 km (2.5 miles) downstream site;
- Daily TAH concentrations greater than 10 µg/L were recorded at sites from the PUF boat launch to 12 km (7.5 miles) downstream during the coho salmon fishery;
- The maximum TAH concentration recorded was 38.7 µg/L at the PUF boat launch on August 23;
- TAH concentrations increased when boat use increased during the sampling periods, which is consistent with previous results;
- An estimated daily total of 34 to 48 boats (depending on river discharge) counted operating at the boat launch will result in an average daily TAH concentration of 10 µg/L.
- Stop-action photography could be used to monitor boat use to determine if activity levels are likely to result in water quality exceedances.

2.0 Introduction

The Little Susitna River, located in Southcentral Alaska, supports five species of Pacific salmon. Primary use of the lower Little Susitna River, from its mouth upstream to the Parks Highway (63 miles), is related to the salmon sport fishery. This part of the river is also a popular recreational area for motorized and non-motorized boating and for camping. The primary motorized boat access point to the lower Little Susitna River is the state-operated PUF boat launch located approximately 40 km (25 miles) upstream from the river’s mouth at Cook Inlet.

2.1 Historic Sampling

2.1.1 Historic Sample Collection

Water samples have been collected on the lower Little Susitna River since 2007 and analyzed for TAH concentrations. Water samples were collected mid-depth in the water column, adjacent to the thalweg, using a volatile organic compound (VOC) sampler and methods developed by the United States Geological Survey (USGS). All sampling followed a DEC-approved Quality Assurance Project Plan (QAPP) and sampling plan. Samples were analyzed for benzene, toluene, ethyl-benzene, and xylene (BTEX) at a certified laboratory using Environmental Protection Agency (EPA) analytical method 624. TAH concentration is the sum of the four BTEX compounds. TAH concentrations were compared against the state water quality criteria (WQC) of 10 µg/L described in 18 AAC 70. Two types of sampling were conducted: once per week (called weekly sampling); and sampling multiple times per day (called intensive sampling).

2.1.2 Historic Weekly Sampling

Starting in 2007, weekly sampling was conducted at sites from 1 km (0.6 miles) upstream to 4 km (2.5 miles) downstream of the PUF boat launch to evaluate the influence of motorized boat use on water quality. Sample sites were added as the project progressed in order to determine how far upstream and downstream from the PUF boat launch that TAH concentrations were present and if they exceeded WQC. The furthest downstream site was 32 km (20 miles) below the PUF boat launch and the furthest upstream site was 12 km (approximately 6 miles) above the PUF boat launch. From July 2007 through June 2011, the majority of the sampling was conducted once per week on either Saturday or Sunday (generally the highest use days of the week) between 12:00 and 16:00, May through September. The sampling was designed to identify the magnitude, exposure duration, and frequency of TAH concentrations exceeding 10 µg/L.

2.1.3 Intensive Sampling

Along with determining the longitudinal extent of potential exceedances, DEC conducted intensive sampling to determine the temporal variability of TAH concentrations over 48-hour and 72-hour sampling periods. This intensive sampling occurred on anticipated heavy-use weekends, with samples taken every three hours between 06:00 and 21:00, at the sample site location immediately downstream of the PUF boat launch (LS-0). The 48-hour intensive sample events were conducted in June 2010 and June 2011 coinciding with the Chinook salmon fishery. The 72-hour intensive sample events were conducted in August 2009 and August 2010 during the more popular coho salmon fishery. A 96-hour sampling event took place in August 2012 in order to determine a 4-day average TAH concentration. However, poor fish returns led the Alaska Department of Fish and Game (ADF&G) to close the salmon fishery and no further TAH sampling occurred.

2.1.4 Historic Sample results

Maximum TAH concentrations ranged from slightly over 10 µg/L to over 75 µg/L (recorded downstream of the PUF in spring 2008) (Table 1). TAH concentrations were highest downstream from the PUF boat launch. TAH concentrations greater than 10 µg/L were recorded at sites located from 4 km (2.5 miles) upstream from the PUF boat launch to 12 km (7.5 miles) downstream from the PUF boat launch. The source of the petroleum hydrocarbons in the Little Susitna River is motorized boats.

Table 1. Summary of previous TAH sampling results

WQC	Max Observed Value (µg/L)	# Samples Exceeding WQC	Total # Samples	Sampling Period
10 µg/L	10.17	1	15	July – Sept 2007
	75.2	29	72	May - Aug 2008
	12.7	2	49	May - June 2009
	27.2	11	70	July - Sept 2009
	15.8	4	52	May - June 2010
	30.4	14	40	Aug-10
	20.5	5	12	Jun-11*
	4.4	0	50	Aug-12*
Total	75	65	362	

*The Chinook salmon fishery was closed in June 2011 and the coho salmon fishery was closed in August 2012 due to low returns.

2.2 Current Project Objectives

State water quality criterion (WQS, 18 AAC 70) for "petroleum hydrocarbons, oils, and grease for freshwaters uses," are both narrative and numeric. For designated uses of water supply for drinking, culinary, and food processing; agriculture; and water recreation, the narrative criteria are based on observation of a visible sheen on the water or shoreline. The most stringent numeric criteria for TAH concentrations is 10 µg/L for the designated use of water supply for aquaculture and the growth and propagation of fish.

The lighter, more volatile hydrocarbons tend to have toxic, rather than mutagenic or carcinogenic effects. Current numeric criterion was based upon studies of acute toxicity and sub-lethal effects on Alaska species; however, results from an extensive literature review documents both acute and chronic effects at criterion levels.

The water quality criterion for TAH concentration is based on chronic effects. Therefore, measures of 96-hour average TAH concentrations are necessary to evaluate chronic effects to aquatic life and potential Category 5 water quality impairment listing of the Little Susitna River.

The purpose of this project is to obtain additional measures of TAH concentrations for aquatic life chronic exposure. The objectives of this project are:

1. To determine if the 96-hour average TAH concentration of 10 µg/L was exceeded during either the spring Chinook salmon fishery in late May through early June or the coho salmon fishery during the month of August.

2. To correlate motor craft numbers with TAH concentrations by gathering motorized boat usage information from the Department of Natural Resources (DNR) Little Susitna River PUF entrance booth.

3.0 Methods

3.1 Sampling locations

Water samples were collected at seven locations from 4 km (2.5 miles) upstream to 12 km (7.5 miles) downstream of the PUF boat launch (Figure 1; Table 2). Previous sampling has documented TAH concentrations above 10 µg/L at each of these locations on at least one sampling date.

The sampling site immediately downstream of the PUF boat launch (LS-0 PUF) provided a location with easy access that was used to monitor TAH concentrations over time. LS-0 PUF also reflects a combination of upstream TAH concentrations and inputs at the boat launch. Motor inefficiencies (fuel discharged/fuel burned) are higher when motors are idling. Even though fuel use rates are low during idling, high inefficiencies and direct inputs from fueling and boat ramp runoff from bilge pumping/draining can result in high TAH concentrations at this location.

Intensive sampling was also conducted at 4 km (2.5 miles) downstream (LS-4 km dn) because historically this site often had samples with TAH concentration over 10 µg/L, with TAH concentrations ranging from below detection limits to 27.7 µg/L. Monitoring water quality over time at this location helps describe the influence of downstream transport and the rate at which hydrocarbons are lost from the water column.

Sampling locations distributed downstream from the PUF boat launch were necessary to determine the longitudinal extent of exceedances. Downstream TAH concentrations are a combination of downstream transport within the water column plus additional boat inputs minus losses. If inputs exceed loss rates, concentrations will increase downstream. The limited boat activity 12 km (7.5 miles) downstream of the PUF boat launch (site LS-12 km dn) reduces the likelihood that 96-hour average TAH concentrations will exceed WQC downstream of this sampling location. Therefore, LS-12 km dn was the farthest downstream sampling location. Appendix A has representative photos of sampling sites and activities.

3.2 Sampling frequency

Sampling dates were selected to provide 96-hour or 120-hour sampling events during peak activity on weekends through the Chinook and coho salmon sport fisheries. Sampling dates for 2014 and sample collection times for each sampling location are shown in Tables 3 and 4. Samples were collected through three 96-hour (4-day) sampling events during the Chinook salmon fishery and through one 96-hour sampling (4-day) event and three 120-hour (5-day) sampling events during the coho salmon fishery. The 120-hour sampling period provides two 96-hour periods to use for data analyses.

At each of the intensive sampling locations (LS-0 and LS-4 km dn), samples were collected five times per day for a total of 20 samples per 96-hour sampling event and 25 samples per 120-hour sampling event, beginning at LS-0 PUF and followed by LS-4 km dn. The first sample time was 07:00. TAH concentrations in historic sampling at 05:00 were below detection limits and before most boat use, which begins around 06:00. The 07:00 sample documented inputs from initial daily boat activity. Three sampling events occurred during the time of day most boats are present: 10:00, 13:00, and 16:00. The final sample was collected at 20:00, in order to document the declining limb of daily TAH concentrations.

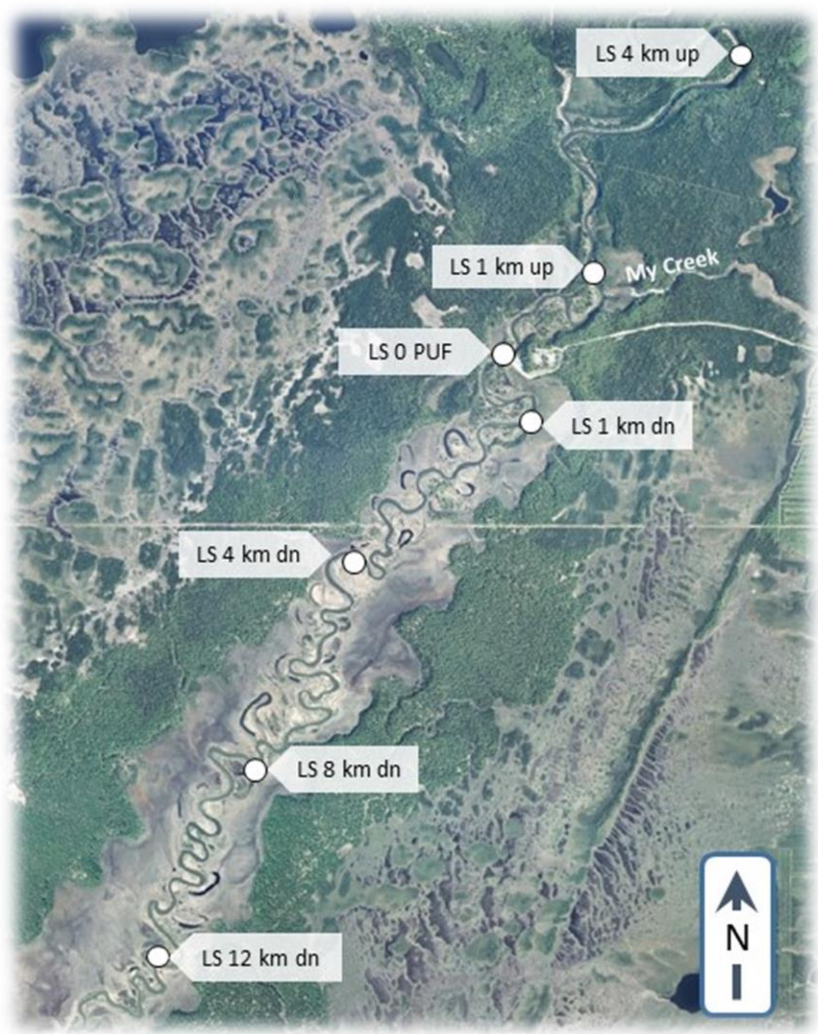


Figure 1. Aerial photograph of the lower Little Susitna River showing sampling locations.

All other sites were sampled once each day between 13:00 and 17:00, beginning at the upstream location LS-4 km up and working downstream to LS-12 km dn. Daily sampling at the additional sampling locations provided information necessary to assess the extent of exceedances along the river corridor. In addition, daily samples from sites 4 km (2.5 miles) upstream of the PUF boat launch (LS-4 km up) to 12 km (7.5 miles) downstream of the PUF boat launch (LS-12 km dn) provided for calculations of cumulative increase or decrease in concentrations downstream relative to boat activity and for estimates of the number of boats necessary for inputs to exceed TAH concentration loss rates.

Table 2. Little Susitna River sampling locations, names, descriptions, distance from the PUF boat launch, and latitude and longitude.

Site ID	Description	Distance from PUF Launch km/mi	Latitude	Longitude
LS-4 km up	Sampling location 4.0 km upstream from PUF. Upper extent of detectable levels of TAH during previous sampling.	4.0/2.5	61.45900	-150.14273
LS-1 km up	Sampling station 1.0 km upstream from the PUF. Location where discharge is measured. Site located upstream of My Creek.	1.15/0.71	61.44238	-150.16205
LS-0 PUF km	Sampling location located immediately downstream from the PUF boat launch. Intensive sampling site.	0.00	61.43721	-150.17657
LS-1 km dn	Sampling location 1.0 km downstream from the PUF.	-1.35/-0.84	61.43283	-150.17506
LS-4 km dn	Sampling location 4.0 km downstream from the PUF. Intensive sampling site.	-3.87/-2.40	61.42336	-150.19395
LS-8 km dn	Sampling location 8.0 km downstream from the PUF.	-8/-4.97	61.40973	-150.20883
LS-12 km dn	Water quality sampling location 12.0 km downstream from the PUF. Lower extent of TAH exceedances during previous historic sampling.	-12/-7.5	61.39668	-150.22345

Table 3. Sampling dates and sampling times during the 2014 Chinook salmon fishery. Differences in shading denotes 4 day sampling events.

Date	Day	Intensive sampling times at sites LS-0 and LS-4 km dn	All other sites sampling times
May 24, 2014	Saturday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
May 25, 2014	Sunday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
May 26, 2014 Memorial Day Holiday	Monday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
May 27, 2014	Tuesday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
May 30, 2014	Friday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
May 31, 2014	Saturday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
June 1, 2014	Sunday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
June 2, 2014	Monday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
June 6, 2014	Friday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
June 7, 2014	Saturday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
June 8, 2014	Sunday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
June 9, 2014	Monday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00

Table 4. Sampling dates and sampling times during the 2014 coho salmon fishery. Differences in shading denotes 4 and 5 day sampling events.

Date	Day	Intensive sampling times at sites LS-0 and LS-4 km dn	All other sites sampling times
Aug 1, 2014	Friday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 2, 2014	Saturday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 3, 2014	Sunday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 4, 2014	Monday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 6, 2014	Wednesday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 7, 2014	Thursday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 8, 2014	Friday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 9, 2014	Saturday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 10, 2014	Sunday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 14, 2014	Thursday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 15, 2014	Friday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 16, 2014	Saturday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 17, 2014	Sunday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 18, 2014	Monday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 21, 2014	Thursday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 22, 2014	Friday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 23, 2014	Saturday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 24, 2014	Sunday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00
Aug 25, 2014	Monday	07:00, 10:00, 13:00, 16:00, 20:00	13:00 – 17:00

3.3 Field data collection

All field data and sample collection was conducted following the methods described in a DEC-approved QAPP and sampling plan available from DEC. The latitude and longitude of sampling locations were recorded and photographs taken upstream, downstream, and across the river channel at each site for each sampling event (See Appendix A for a selection of site photographs). The presence of oil sheens, if any, was noted. If sheens were present they were evaluated to determine if they fracture on disturbance, indicating a natural source. If they did not fracture, their presence was recorded and photographed. Water samples were collected from a well-mixed area of the water column at each sampling site, as unmixed, layered, or stagnant water can yield results which do not reflect TAH concentrations present in the main waterbody. TAH sampling was conducted using the sampler equipment and methods described below.

3.3.1 Total aromatic hydrocarbons

Samples were collected in accordance with the USGS report "Field guide for collecting samples for analysis of volatile organic compounds in stream water for the national Water Quality Assessment Program (USGS Open File Report 97-401)" found in Appendix A of the project QAPP on file with DEC. This field guide contains detailed instructions on sample collection procedures using the USGS-designed VOC sampler distributed by Wildco and used by DEC in petroleum hydrocarbon studies throughout Alaska. Prior to sample collection, the VOC sampler was decontaminated in Alconox and rinsed thoroughly with stream water at each site.

Sampling locations were accessed by boat. The boat was anchored and the motor turned off for 10 minutes prior to a sample being collected. Samples were collected in bottles obtained from the contract laboratory. One sample to be analyzed for TAH concentration was collected (2 vials) from each lowering of the sampler. A rope was attached to the sampler cables and the sampler lowered into the flowing water off of the bow of the boat, and upstream of the motor. Samples were collected below the water surface at 0.5 times stream depth, adjacent to the thalweg, and away from any observable sheen. The attached rope and weighted sampler were used to keep the sampler upright. Hydrochloric acid (HCl), provided by the contract laboratory, was added to each vial after sample collection for preservation (~1 drop). Clean vinyl gloves were worn at all times when handling sampling bottles. The samples were checked to ensure that there were no air bubbles after capping. The sample bottles were dried, labeled using adhesive labels, placed within a cooler on frozen gel-paks and shipped to the contract laboratory.

Sample temperatures were recorded by the contract laboratory upon receipt using an in-certification National Institute of Standards and Technology (NIST) traceable laser thermometer readable to 0.01°C and accurate to at least 0.2°C. Trip blanks provided by the contract laboratory accompanied the sample bottles during collection, shipping, and analyses. Field blanks were collected at the end of each sampling event by submerging the sampler in a stainless steel pot filled with artesian well water. Well water had been sampled previously and was found to be hydrocarbon-free.

3.3.2 Water temperature

Water temperature was measured concurrent with sample collection using an Omega HH801A temperature logger with thermistor or YSI 63 conductivity probe. Additionally, Onset ProV2 temperature loggers were deployed at the PUF boat launch, 4 km (2.5 miles) downstream and 8 km (5 miles) downstream of the PUF boat launch to record water temperature at 0.5 hour intervals from May 24th through August 25th.

3.3.3 Discharge

River discharge was measured on every sampling day at 1 km (0.7 miles) upstream of the PUF (LS-1 km up). River discharge measurements provide average water velocities and can be used to calculate dilution of TAH concentrations due to changes in water volume, and to calculate flow times between sampling sites. Stream discharge was also measured in My Creek, directly upstream of its confluence with the Little Susitna River at 1 km (0.7 miles) upstream of the PUF boat launch, to further evaluate TAH concentration dilution due to added water volume by tributaries not affected by boat use.

Discharge was measured directly using a Swoffer 3000 velocity meter and wading top-set rod. Lateral distance was measured using a distance finder.

3.3.4 Boat use surveys

Boat counts were necessary to examine the relationship between TAH concentrations and the number of boats operating on the Little Susitna River. Boat use data was obtained from the PUF entrance booth and supplemented with stop-action photography of the boat launch area. The PUF entrance booth recorded horse power, motor type (2-stroke, 4 stroke, 2-stroke direct inject), and length of each boat exiting the recreation area daily during booth operating hours (approximately 08:00 to 17:00). ARRI staff electronically scanned the booth records daily within the sampling period.

ARRI augmented booth count data with stop-action photography of the boat launch. The entrance booth is not usually operated prior to 08:00 or after 17:00. Boat activity prior to 08:00 could influence TAH concentrations in the 07:00 sample and activity following 17:00 could influence TAH concentrations in the 20:00 sample. The number of boats passing the entrance booth also is not a measure of boat activity as some boats spend more time on the water than others. A camera was installed with a view of the boat launch and mooring area but out of view of the general public. The camera was set to take an exposure every 5 minutes. The camera was downloaded at the end of each sampling period. Boat use counts were obtained by recording the time and number of boats operating in each photograph.

3.4 Water sample analysis

Samples were cooled to below 6° C, placed in a cooler, and shipped overnight to AM Test, Inc. located in Kirkland, Washington. Samples were analyzed for BTEX concentrations using EPA method 624.

Laboratory analytical results for concentrations of BTEX were used to calculate TAH concentrations for each sampling date, time, and sample location. TAH was calculated as the sum of the concentration of these constituents. If concentrations were below Practical Quantitation Limits, values were reported as below the detection limit (DL), but a value of 0.5 x DL was used to calculate TAH concentration.

Daily average concentration at the intensive sampling locations was calculated as the arithmetic mean of 5 samples collected from 07:00 to 20:00. The 96-hour average concentration was calculated using the daily averages. When samples were collected over a 120-hour period, two 96-hour average concentrations were calculated. 96-hour average concentrations for each site were evaluated for exceedances of the WQC of 10 µg/L.

4.0 Results

4.1 Quality assurance objectives and variations from study plan

Quality assurance results showed that 90.7% of sample replicates met Measurement Quality Objectives (MQOs) of precision and 98.7% met MQOs of laboratory accuracy, as detailed in the QAPP. All samples and field measures met MQOs of completeness. The percentage of samples meeting MQOs is reported in Table 5. Relative percent difference between samples and replicate BTEX measurements is likely increased by reporting low precision when comparing detected and non-detected measures between samples and respective replicates. Non-detected samples could have hydrocarbon values ranging between 0 and 0.49 µg/L, however they are reported at 0.5 x DL. Therefore, low precision resulted when one sample replicate was just over DL and the second replicate was below DL.

To ensure viability of samples, all samples were immediately transferred to a cooler following collection and kept cool until transported to the ARRI lab for refrigeration until shipment to the analytical laboratory (AM Test). In-field cooler temperatures ranged from 1° to 6°C during all sampling periods. Upon arrival at AM Test, sample cooler temperatures were measured. Cooler temperatures remained below 6°C with the exception of samples collected between August 1 and August 4, which arrived at the analytical laboratory with a cooler temperature of 9.4°C. The potential for TAH to be lost from samples increases when temperatures are over 6°C; however, it is very unlikely that this slightly warmer temperature significantly affected study results.

Table 5. Percentage of measures meeting MQOs of precision and laboratory accuracy.

Measure	Total measures with replicates	% within precision objective	% within laboratory accuracy objective
Stop-action photo boat count	76	100	N/A
Discharge	5	100	N/A
Benzene	31	93.5	100
Toluene	31	87.1	98.4
Ethylbenzene	31	93.5	96.9
meta & para Xylene	31	90.3	96.9
o-Xylene	31	90.3	100
Xylene	31	87.1	98.4

Discharge was not measured on August 1, due to equipment failure; however the discharge value for this day was obtained by USGS gauge measurement on the Little Susitna River collected closer to the headwaters in Hatcher Pass and by extrapolation used to complete analysis of the effects of different water volumes on TAH concentrations.

The study plan stated that boat use data from the PUF entrance booth would be used to describe the correlation between boat numbers and TAH concentrations, however booth data were not accurate enough to provide significant statistical correlations (R^2 values ranged 0.003 – 0.236; p-values ranged 0.15 – 0.78). The entrance booth boat counts were inconsistent because the booth was not operational daily and did not operate during all hours boats were entering and exiting the PUF. Also, entrance booth boat counts do not represent actual boat activity on the river, as it cannot record where and when boats are operating. In many cases, a boat may launch and stay in one location, while another boat may travel up and down the river multiple times, and still some may not launch at all, but instead, park and stay in the campground. Stop-action photography is a better tool for documenting real-time boat activity throughout the day at the boat launch. Therefore, boat count data from stop-action photography were used for data analysis.

4.2 Water quality evaluation

A total of 465 water samples were collected from the lower Little Susitna River for TAH analysis in 2014. A total of 180 samples were collected during the Chinook salmon fishery, 0 (0%) of which were >10 µg/L. A total of 285 samples were collected during the coho salmon fishery, 51 (17.9%) of which were > 10-µg/L. TAH concentrations ranged from below detection limits to 38.71 µg/L. A summary of water sampling is provided in Table 6.

4.2.1 Daily TAH concentration

TAH concentration was variable throughout the day, with concentrations ranging from below detection limits to over 30 µg/L. All water sampling results, in terms of TAH concentration, are presented in Appendix B. The maximum TAH concentration observed was 38.7 µg/L at site LS-0 PUF on August 23. Daily maximum, minimum, and average TAH concentrations for intensive sites LS-0 PUF and LS-4 km dn are shown in Figures 2 and 3.

Table 6. Summary of 2014 water sampling.

WQC	Max. Observed Value (µg/L)	# Samples Exceeding WQC	Total # Samples	Sampling Period
10 µg/L	5.29	0	180	May-June 2014
	38.72	51	285	August 2014
Total	38.72	51	465	

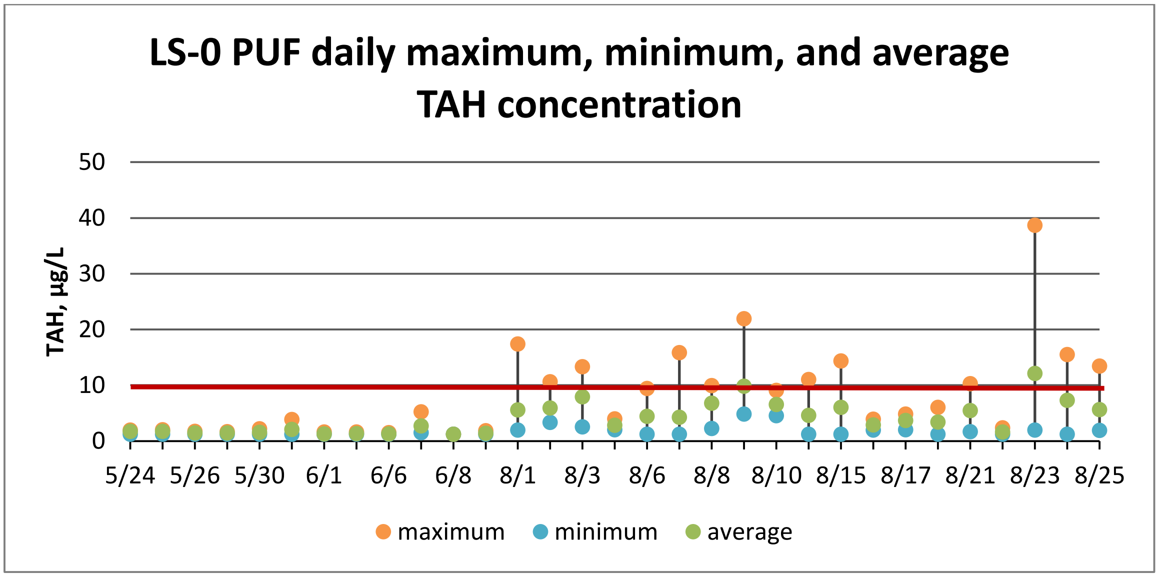


Figure 2. Daily maximum, minimum, and average TAH concentrations at site LS-0 PUF. Red line indicates the state WQC.

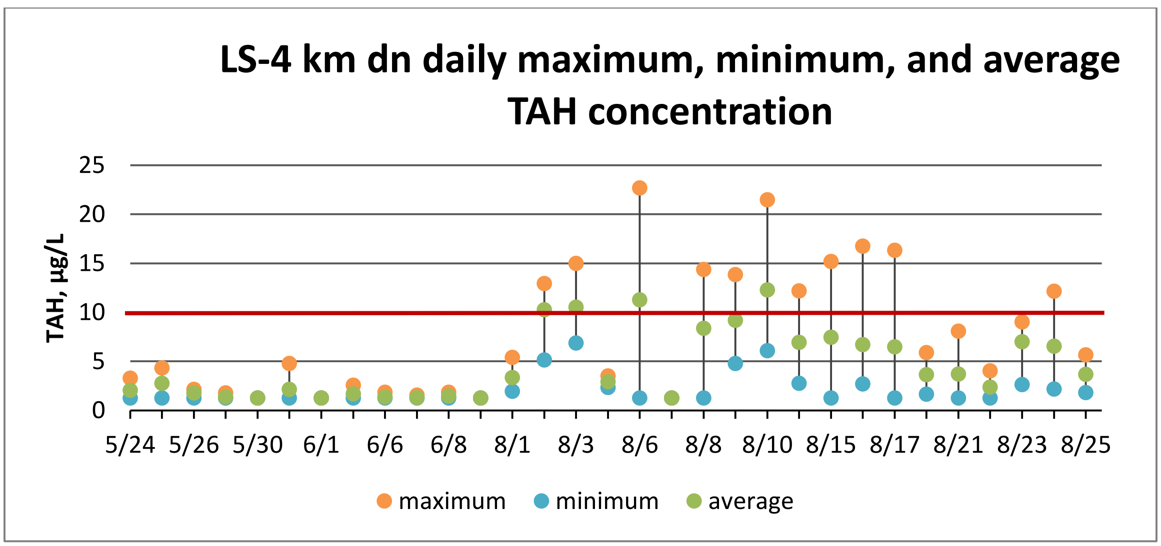


Figure 3. Daily maximum, minimum, and average TAH concentrations at site LS-4 km dn. Red line indicates the state WQC.

Daily WQC exceedances occurred at all sites, with the exception of the upstream sites LS-4 km up and LS-1 km up. Daily water sampling results for all non-intensive sites are provided in Table 7 and shown in Figures 4-8.

Table 7. Daily water sampling results for all non-intensive sites. For non-detect samples, a value of 0.5 x DL shown in this table was used to calculate TAH concentration.

Date	LS-4 km up	LS-1 km up	LS-1 km dn	LS-8 km dn	LS-12 km dn
5/24/2014	1.67	2.01	1.88	1.25	2.24
5/25/2014	1.61	1.96	4.43	3.98	3.71
5/26/2014	1.25	1.25	1.25	1.55	1.25
5/27/2014	1.25	1.25	1.67	1.25	1.25
5/30/2014	1.25	1.25	1.53	1.94	2.02
5/31/2014	1.25	1.25	1.25	2.45	2.46
6/1/2014	1.25	1.25	1.25	1.25	1.56
6/2/2014	1.25	1.50	2.08	1.25	2.33
6/6/2014	1.25	1.25	1.25	1.25	1.25
6/7/2014	1.25	1.25	1.25	1.25	1.25
6/8/2014	1.25	1.25	1.25	1.51	1.54
6/9/2014	1.25	1.51	1.50	1.25	1.25
8/1/2014	2.11	6.67	9.91	4.24	3.76
8/2/2014	2.36	2.53	10.19	11.42	13.10
8/3/2014	2.03	8.31	11.83	8.83	7.90
8/4/2014	1.25	3.48	3.87	4.29	6.46
8/6/2014	2.08	6.28	4.18	1.25	1.25
8/7/2014	1.83	1.97	1.92	1.25	1.25
8/8/2014	3.40	8.27	8.92	15.69	12.39
8/9/2014	5.33	5.29	9.92	11.21	10.85
8/10/2014	3.12	7.82	10.02	21.38	17.39
8/14/2014	4.16	4.15	14.70	10.98	10.72
8/15/2014	1.25	2.85	3.45	9.66	10.17
8/16/2014	1.25	1.63	4.27	9.70	13.30
8/17/2014	1.55	2.60	14.65	6.27	7.68
8/18/2014	1.25	4.40	8.98	6.18	2.28
8/21/2014	3.72	6.24	8.00	3.94	2.91
8/22/2014	1.25	1.25	1.25	2.38	2.47
8/23/2014	4.11	6.46	9.36	5.69	6.80
8/24/2014	3.47	4.59	6.71	2.26	5.47
8/25/2014	1.53	4.86	7.15	5.20	5.94

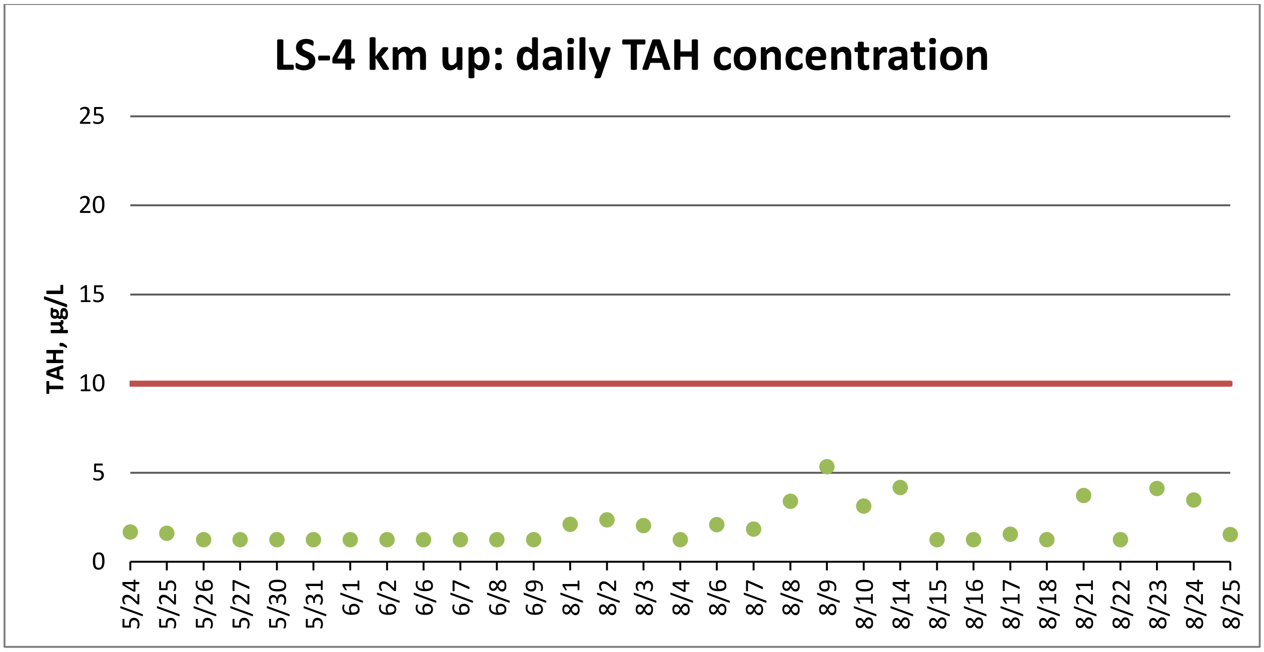


Figure 4. Daily concentration of TAH at site LS-4 km up. Red line depicts the WQC of 10 µg/L.

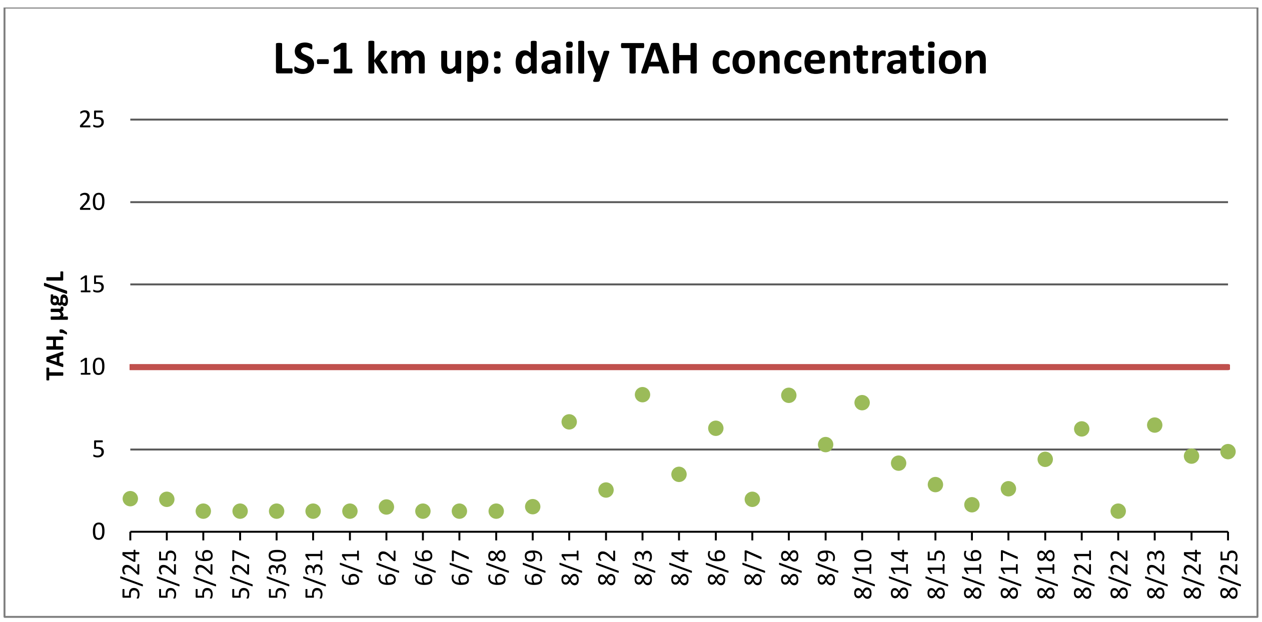


Figure 5. Daily concentration of TAH at site LS-1 km up. Red line depicts the WQC of 10 µg/L

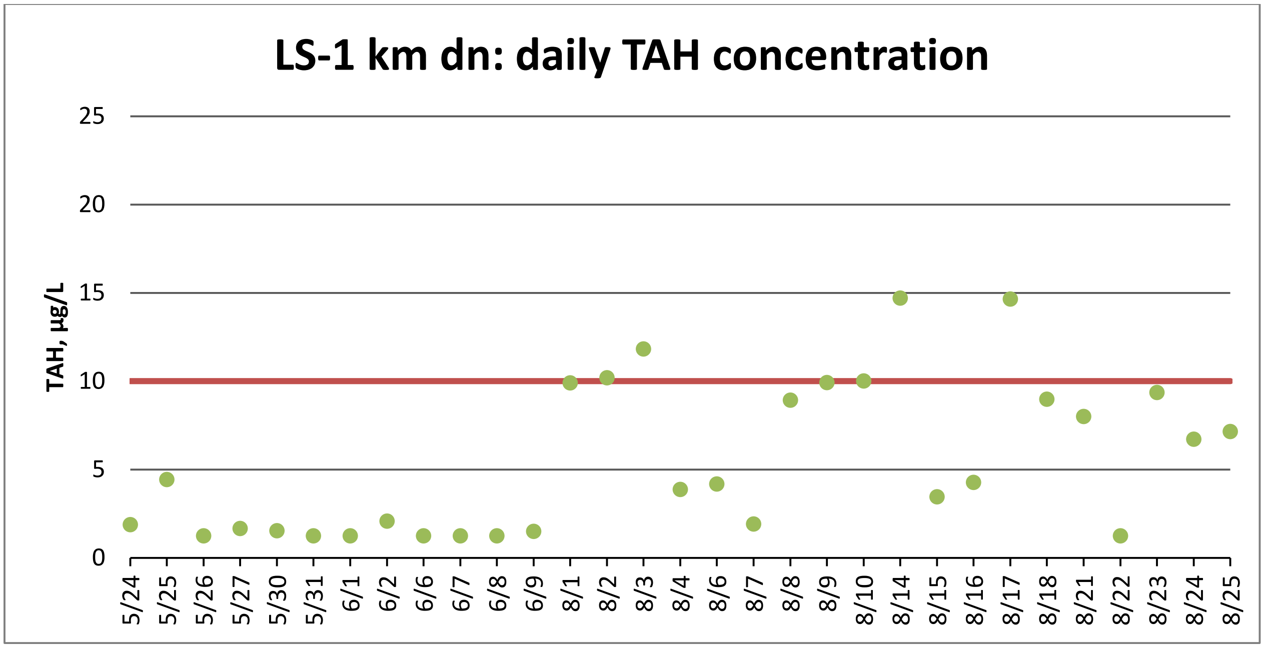


Figure 6. Daily concentration of TAH at site LS-1 km dn. Red line depicts the WQC of 10 µg/L.

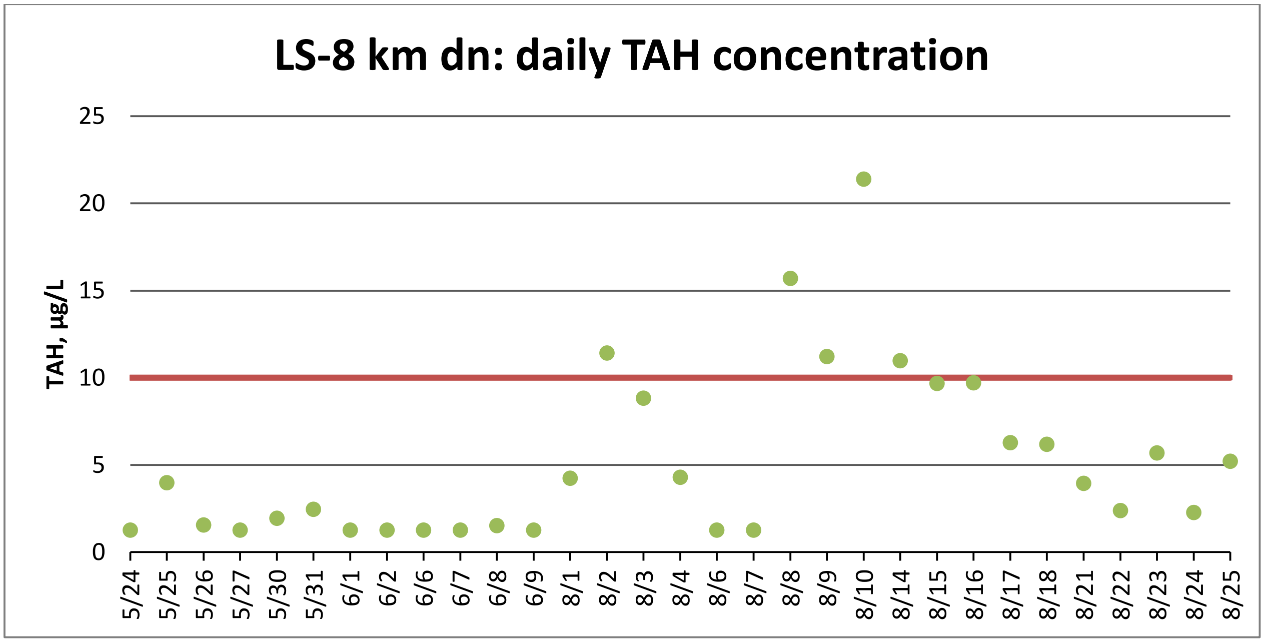


Figure 7. Daily concentration of TAH at site LS-8 km dn. Red line depicts the WQC of 10 µg/L.

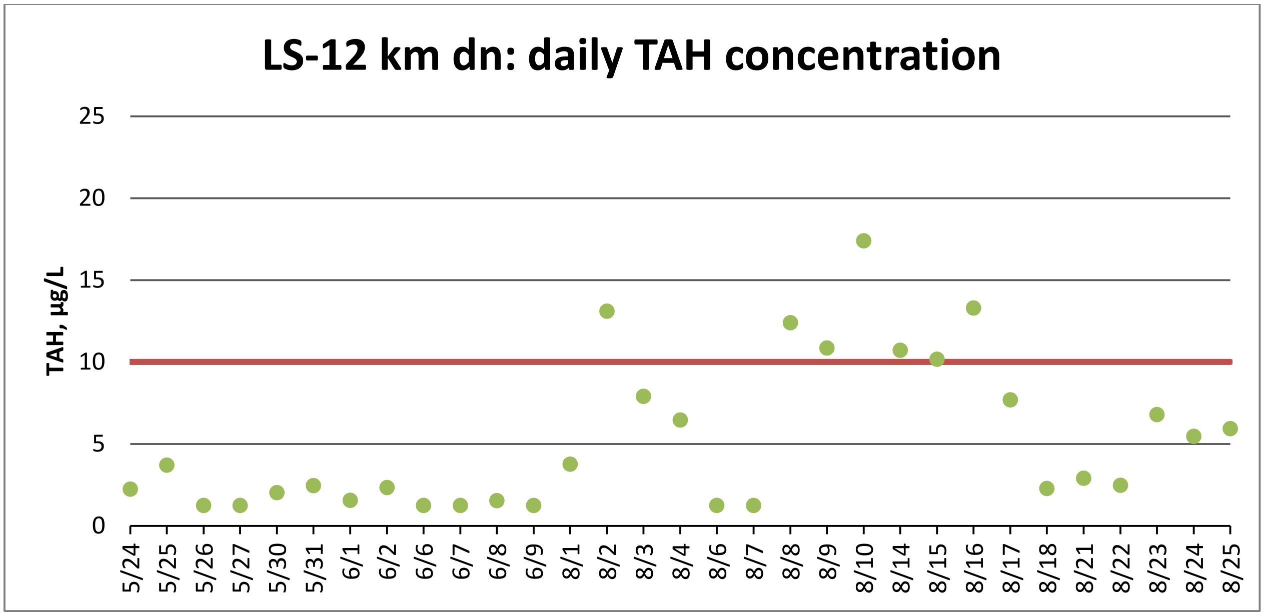


Figure 8. Daily concentration of TAH at site LS-12 km dn. Red line depicts the WQC of 10 µg/L.

4.2.2 Average 96-hour TAH concentrations: LS-0 PUF and LS-4 km dn

Average 96-hour TAH concentrations did not exceed the state WQC of 10 µg/L during any sampling event during the Chinook or the coho salmon fishery.

The maximum 96-hour TAH concentration was 7.78 µg/L sampled at the site 4 km (2.5 miles) downstream of the PUF boat launch (LS-4 km dn) during the sampling period August 7-August 10. Average 96-hour TAH concentrations at sites LS-0 PUF and LS-4 km dn are provided in Table 8.

Table 8. The 96-hour average TAH concentrations by site and sampling period. For 120-hour sampling events, TAH concentrations were calculated for the first 96-hours and for the second 96-hours, in order to provide consistent averages over time.

	Dates	LS -0 PUF	LS-4 km dn
Chinook salmon fishery	5/24-5/27	1.61	1.98
	5/30-6/2	1.61	1.58
	6/6-6/9	1.68	1.34
Coho salmon fishery	8/1-8/4	5.58	6.76
	8/6-8/9	6.35	7.52
	8/7-8/10	6.88	7.78
	8/14-8/17	4.34	6.89
	8/15-8/18	4.03	6.07
	8/21-8/24	6.66	4.90
	8/22-8/25	6.69	4.89

4.3 Spatial extent of TAH Concentrations

In order to determine the longitudinal extent of TAH presence along the river corridor, single sample TAH concentrations were evaluated from the August 10, 2014 sampling date (Figure 9). This date was selected because it was part of the 96-hour sampling period that returned the highest TAH concentrations at intensive sampling sites PUF boat launch (LS-0 PUF) and 4 km (2.5 miles) downstream of the PUF boat launch (LS-4 km dn).

TAH concentrations did not decline longitudinally with flushing; in contrast, TAH concentrations increased downstream ($p=0.0048$) with the maximum value being recorded at 8 km (5 miles) downstream of the PUF boat launch (LS-8 km dn). Water sampling was not conducted farther downstream than 12 km below the PUF boat launch (LS-12 km dn). Daily TAH concentrations > 10 µg/L occurred at all downstream sites. Maximum TAH concentrations for all sampling dates are shown in Figure 10. Maximum TAH concentrations did not exceed 10 µg/L at the sampling sites upstream of the PUF boat launch. Maximum TAH concentrations at the PUF boat launch (LS-0 PUF), and at sample sites downstream were greater than 10 µg/L.

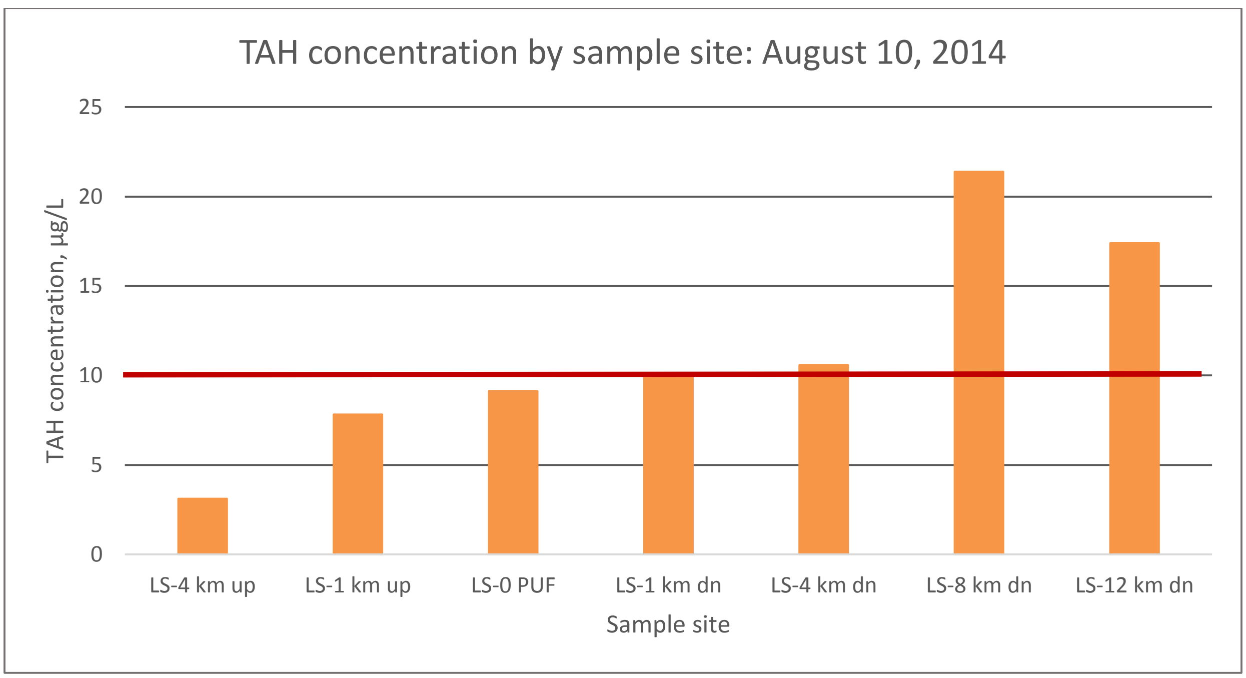


Figure 9. Longitudinal extent of TAH concentration. Red line depicts WQC at 10 µg/L.

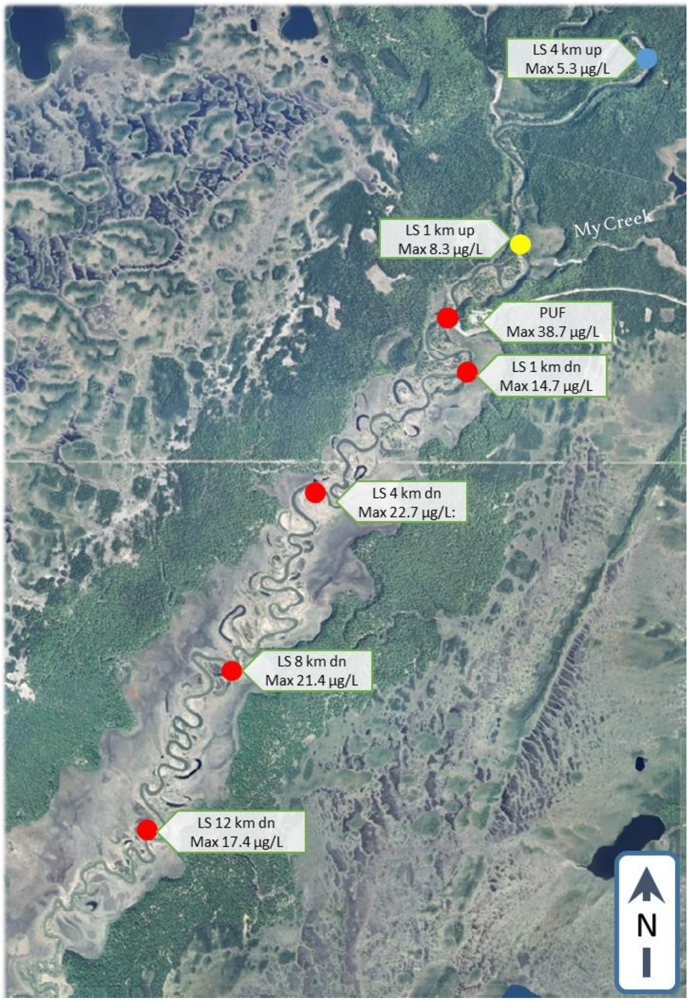


Figure 10. Maximum TAH concentrations at all sampling locations. Blue dot represents maximum TAH concentration below WQC of 10 µg/L, yellow dot represents a maximum TAH value approaching the WQC, and red dots represent maximum TAH concentrations over the WQC of 10 µg/L.

4.4 Water physical and chemical characteristics

In May and June, water temperature ranged from 8.5 to 17.2°C. In August, water temperature ranged from 11.8 to 18.0°C. Average daily water temperature measured at three sample sites (LS-0 PUF, LS-4 km dn, LS-8 km dn) from May through August is shown in Figure 11.

Little Susitna River discharge measurements recorded a maximum of 625.82 cfs in June and a minimum of 278.96 cfs in August. My Creek discharge measurements, taken directly above its confluence with the Little Susitna River at 1 km (0.7 miles) upstream of the PUF boat launch (LS-1 km up), recorded a maximum of 9.05 cfs in May and a minimum of 5.19 cfs in August. All discharge data for the Little Susitna River and My Creek are provided in Table 9. Daily discharge measurements recorded on the Little Susitna River at 1 km (0.7 miles) upstream of the PUF boat launch (LS-1 km up) are shown in Figure 12.

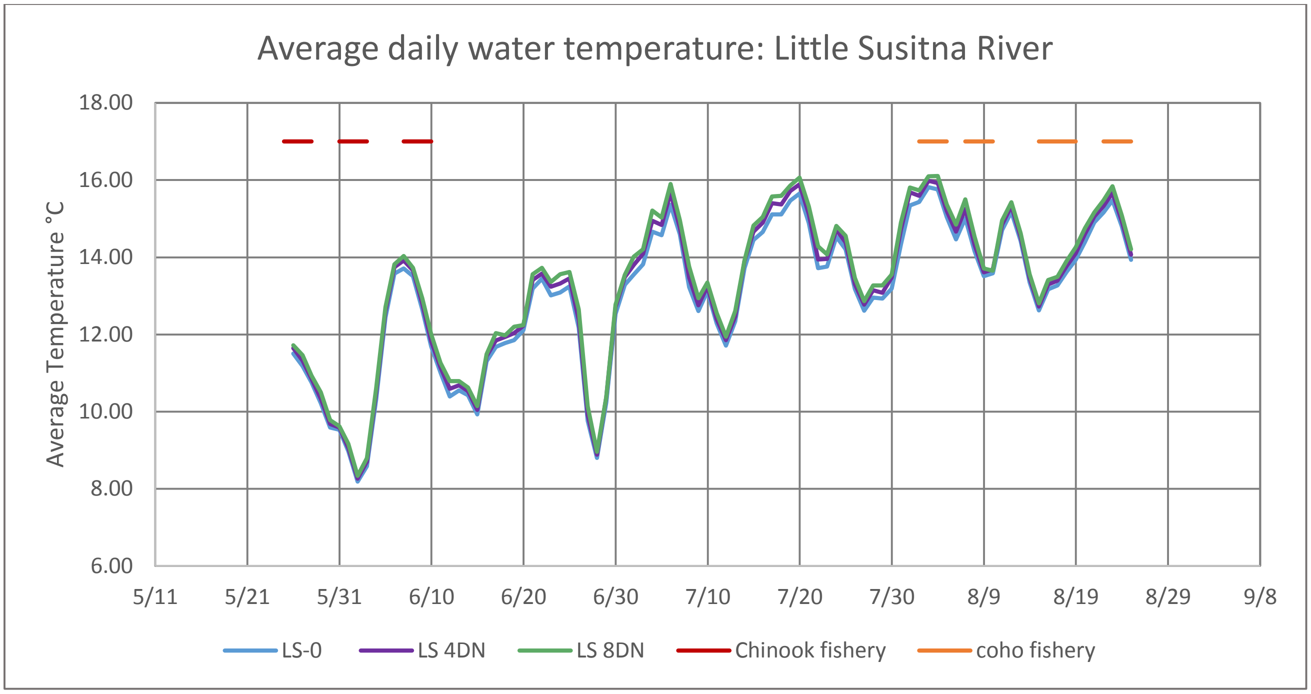


Figure 11. Average daily water temperature at three sites on the Little Susitna River, May-August. Red lines along the top represent sampling periods during the Chinook salmon fishery. Orange lines along the top represent sampling periods during the coho salmon fishery.

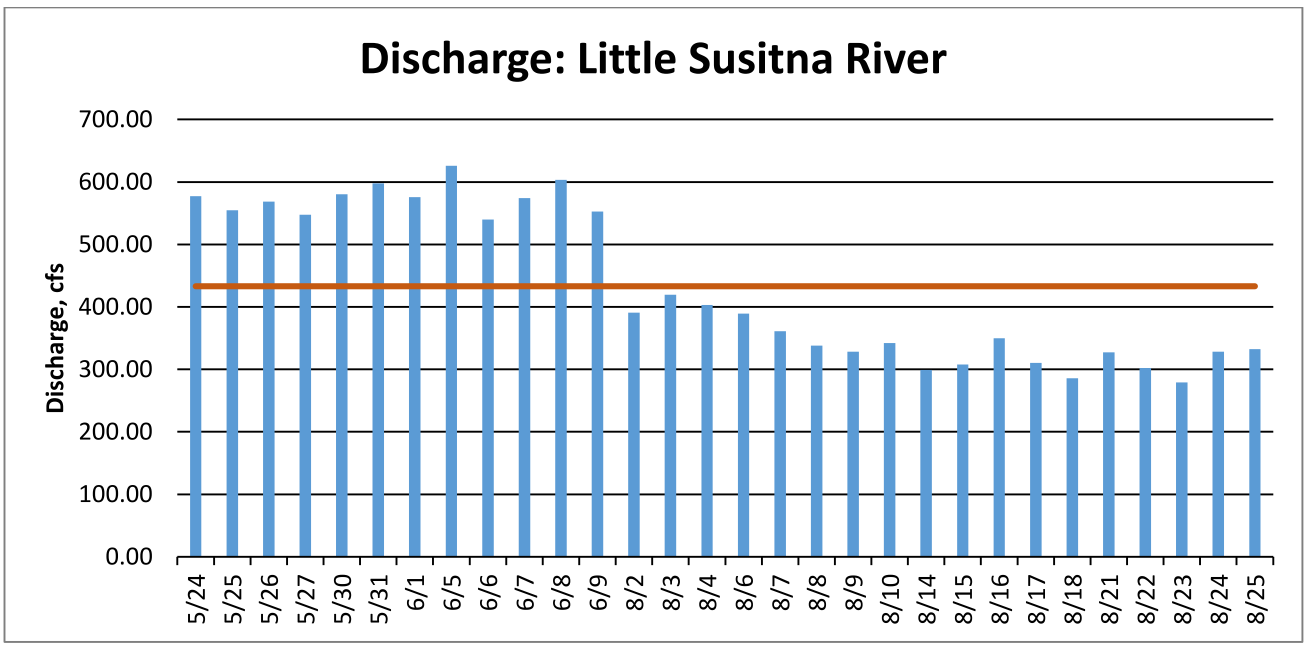


Figure 12. Daily discharge of the Little Susitna River measured at LS-1 km up. The orange line depicts the average (433.04 cfs) over the entire project period May-end of August. The average discharge during the Chinook salmon fishery was 574.85 cfs. The average discharge during the coho salmon fishery was 338.50 cfs.

Table 9. Discharge (cfs) measurements for the Little Susitna River and My Creek.

Date	LS-1 km up	My Creek
5/24/2014	577.44	
5/25/2014	554.80	
5/26/2014	568.51	
5/27/2014	547.38	7.37
5/30/2014	580.24	8.57
5/31/2014	597.91	9.05
6/1/2014	575.94	
6/5/2014	625.82	
6/6/2014	540.10	7.19
6/7/2014	573.95	
6/8/2014	603.42	
6/9/2014	552.71	
8/2/2014	390.62	
8/3/2014	419.24	5.27
8/4/2014	403.27	
8/6/2014	389.22	
8/7/2014	361.01	6.61
8/8/2014	338.18	
8/9/2014	328.22	
8/10/2014	341.85	
8/14/2014	298.81	
8/15/2014	307.72	
8/16/2014	349.93	
8/17/2014	310.13	5.19
8/18/2014	285.55	
8/21/2014	327.20	
8/22/2014	302.37	
8/23/2014	278.96	
8/24/2014	328.35	5.73
8/25/2014	332.33	

4.5 Boat use on the lower Little Susitna River

4.5.1 Boat use counts

Boat use data were collected from both the PUF entrance booth and stop-action photography. Only boat use data recorded by stop-action photography was used for analysis, due to inconsistencies in the booth count data collection. Also, consistent stop-action photography is a better tool for documenting real-time boat activity throughout the day. Stop-action photographs were reviewed and boat use counts were obtained by recording the number of boats operating in each photograph for each day. Motor-type (2-stroke/4-stroke) was not distinguishable from photography.

Boat use data from stop-action photography indicated more motorized boat activity during the coho salmon fishery in August than the Chinook salmon fishery in May and June. The cumulative number of boats active over 96-hours during the coho salmon fishery were almost twice that of the Chinook salmon fishery. The maximum number of boats observed in one 96-hour sampling period was a cumulative 142 boats, August 7-August 10. Boat count data from both the stop-action photography and the PUF entrance booth are provided in Tables 10 and 11.

4.5.2 Relationship between water quality and boat use

TAH concentrations (96-hour averages and daily averages) were statistically correlated to boat counts obtained through stop-action photography, but not with boat counts from the PUF entrance booth. Boat counts at the entrance booth were inconsistent, often missing many critical time periods and were not a good measure of boat activity on the river. Correlations between boat activity and 96-hour TAH concentrations were improved slightly when differences in discharge (water volume) were accounted for. Daily discharge had a significant negative correlation with average daily TAH at site LS-0 PUF ($p=0.005$). As discharge decreases, dilution decreases and TAH concentrations increase. There was no measurable effect of temperature on TAH concentrations.

TAH concentration had a significant positive correlation with 96-hour boat counts at intensive sites LS-0 PUF ($p=0.0335$) and LS-4 km dn ($p=0.0001$). Figures 13 and 14 show TAH concentration as a function of boat activity.

Table 10. Boat use recorded during the Chinook salmon fishery. NR indicates data were not recorded.

	Stop-action photo		DNR booth	
Date	Daily boats	# of boats during 96-hour sampling period	Daily boats	% 2-stroke
5/24/2014	17	68*	4	0.00
5/25/2014	18		10	20.00
5/26/2014	NR		14	14.29
5/27/2014	NR		2	50.00
5/30/2014	7	50	3	0.00
5/31/2014	15		18	11.11
6/1/2014	17		10	20.00
6/2/2014	11		10	10.00
6/6/2014	7	59	NR	NR
6/7/2014	16		12	33.33
6/8/2014	19		14	35.71
6/9/2014	17		12	16.67

* Sum includes estimated number of boats on days when not recorded due to camera failure. Estimate obtained from relationship between stop-action photography and entrance booth counts.

Table 11. Boat use recorded during the coho salmon fishery. NR indicates data were not recorded. In the case of 120-hour sampling periods, the first number indicates the cumulative daily boats during the first 96-hours and the second number indicates the cumulative daily boats during the second 96-hours of one sampling period.

	Stop-action photo		DNR booth	
Date	Daily boats	# of boats during 96-hour sampling period	Daily boats	% 2-stroke
8/1/2014	26	109	12	25.00
8/2/2014	39		16	12.50
8/3/2014	25		22	22.73
8/4/2014	19		18	11.11
8/6/2014	35	138 (Aug 6 – 9)	38	31.58
8/7/2014	29		17	35.29
8/8/2014	29		16	50.00
8/9/2014	45	142 (Aug 7 – 10)	12	16.67
8/10/2014	39		3	33.33
8/14/2014	25	109 (Aug 14 – 17)	10	0.00
8/15/2014	33		8	37.50
8/16/2014	26		17	23.53
8/17/2014	25	102* (Aug 15 – 18)	10	30.00
8/18/2014	NR		4	25.00
8/21/2014	20	81 (Aug 21-24)	12	33.33
8/22/2014	13		1	0.00
8/23/2014	29		6	0.00
8/24/2014	19	72 (Aug 22-25)	5	0.00
8/25/2014	11		3	0.00

* Sum includes estimated number of boats on days when not recorded due to camera failure. Estimate obtained from relationship between stop-action photography and DNR booth counts.

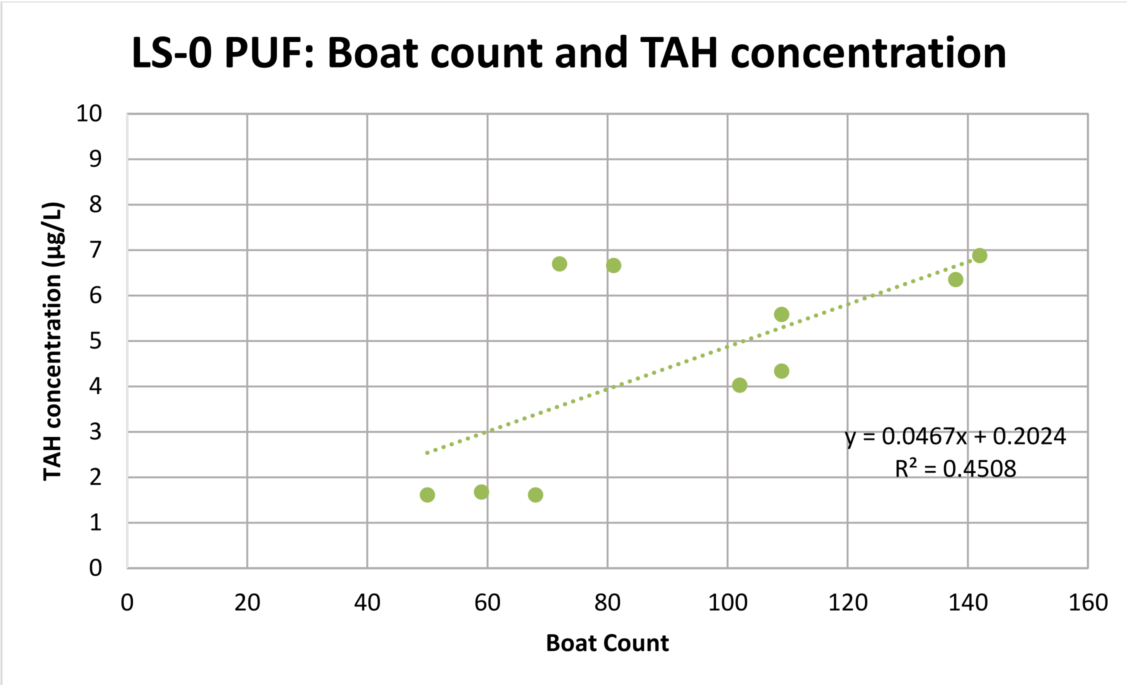


Figure 13. 96-hour average TAH concentration as a function of boat count at site LS-0 PUF.

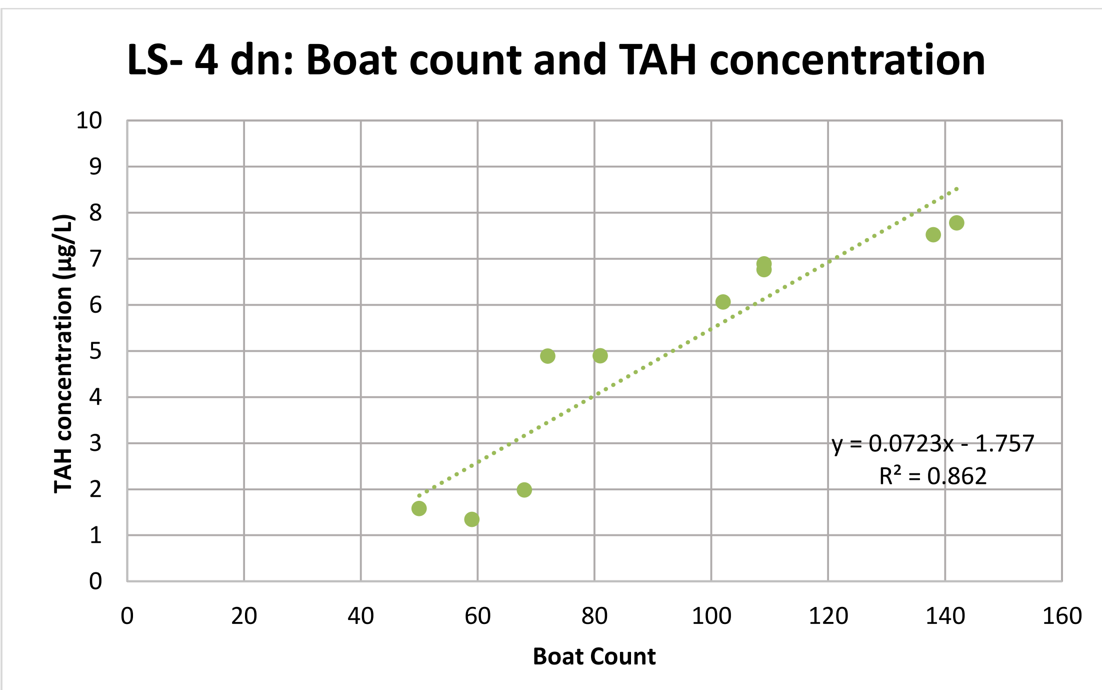


Figure 14. 96-hour average TAH concentration as a function of boat count at site LS-4 km dn.

5.0 Discussion

Daily maximum and daily average TAH concentrations frequently exceeded the WQC of 10 µg/L during the coho salmon fishery. Average 96-hour TAH concentrations did not exceed the state WQC of 10 µg/L during any sampling period in May, June, or August 2014. Study results show that TAH concentrations do not remain above WQC over multiple days; however, daily TAH concentrations do exceed WQC during heavy motorized-use periods. Daily WQC TAH concentration >10 µg/L occurred at five sample sites, from the PUF boat launch (site LS-0 PUF) downstream 12 km (7.5 miles) to site LS-12 km dn.

The maximum TAH concentration recorded during both the Chinook and coho salmon fisheries was 38.7 µg/L at site LS-0 PUF on August 23. Site LS-0 PUF reflects a combination of upstream TAH inputs and TAH inputs directly at the boat launch (LS-0 PUF). Motor inefficiencies (fuel discharged/fuel burned) are higher when motors are idling. Even though fuel use rates are low during idling, high inefficiencies and direct inputs from fueling and boat ramp runoff from bilge pumping/draining, resulting in high TAH loading at this location. The average amount of TAH being discharged to the river over a 96-hour period ranged from approximately 0.3 to 1.0 L/hr (0.07 to 0.26 gallons/hr) depending on the number of boats. As TAH is only a component of gasoline the amount of gasoline being discharged to the river is approximately 2.6 L (0.21 to 0.72 gallons) of gasoline/hr (based on a gasoline/TAH ratio of 2.71 estimated by Oasis 2007).

Results from this study are consistent with previous work that documented the direct correlation between motor boat activity and TAH concentrations in the Little Susitna River (Davis et al. 2011, Davis and Davis 2013). Motor boat activity on the lower Little Susitna River degrades water quality through the discharge of gasoline. TAH concentrations were lowest when boat activity was low (May and June) and highest when boat activity was high (August), during the coho salmon sport fishery.

TAH concentrations did not decline longitudinally with flushing; in contrast, TAH concentrations appear to increase downstream, specifically on days of high motorized boat use. The longitudinal extent of TAH exceedances was not determined past 12 km (7.5 miles) downstream. Daily TAH concentration > 10 µg/L occurred at all downstream sites. The concentration of TAH is likely higher downstream of the boat launch due to the compounded effects of high boat traffic throughout the river and downstream transport of TAH in the water column from boat use upstream.

The increase in TAH concentrations is directly correlated with boat use during the Chinook and coho salmon sport fisheries. Chinook salmon fishing was allowed throughout the May and June sampling periods; however, harvest was restricted to Saturday, Sunday, and Monday. This may have reduced the number of boats operating during the Chinook salmon fishery. The coho salmon fishery was not restricted during the August sampling events. Fishing with bait was allowed beginning on August 6 and on August 15, the harvest limit was increased from two to three fish.

TAH concentrations (96-hour averages and daily averages) were correlated to boat counts obtained through stop action photography, but not with boat counts from the PUF entrance booth. When entrance booth count data was compared with stop-action photography, the photography proved to be a more accurate method of recording actual boat use on the river. Boat counts at the entrance booth were inconsistent, missing many critical time periods, and did not collect boater information in a systematic manner. Also, entrance booth counts do not represent actual boat activity on the river, as it cannot record where and when boats are operating. Stop action photography was an effective method for documenting real-time boat activity at the boat launch throughout the day.

Daily maximum, minimum, and average values at intensive sample sites LS-0 PUF and LS-4 km dn show the variability of TAH concentrations each day. Maximum TAH concentrations typically occurred in samples taken between 13:00 and 20:00, corresponding with the peak in boating activity. In August, 55% of daily maximum TAH concentrations at site LS-4 km dn were above water quality criterion. Similarly, 61% of daily maximum TAH concentrations at Site LS-0 PUF were above water quality criterion in August.

River discharge also had a significant effect on TAH concentrations alone and as a function of boat use. The flushing effect of higher daily discharge dilutes the concentration of hydrocarbons, potentially dropping concentrations below water quality standards. Higher spring flows (May and June) may mediate the effects of boat use, however, boat use in this study was significantly higher during August when discharge is lower and TAH concentrations were higher.

When considering TAH concentration as a function of cumulative boats and discharge, predictions of daily average TAH concentrations can be developed for a given number of boats, at a specific flow level, modeled at LS-4 km dn. The equation representing this relationship is: $y = 2.482 + 0.245x - 0.007z$, where x is the daily cumulative boats operating at the boat launch, z is the daily discharge (cfs), and y is the average daily TAH concentration. Using this equation, average daily TAH concentrations will exceed 10 µg/L when 34 (200 cfs) to 48 (600 cfs) boats are operating at the boat launch.

5.0 Conclusions

The results of this study found that:

- The 96-hour average concentration of TAH did not exceed the water quality criteria (WQC) for TAH of 10 µg/L at neither the PUF boat launch nor the 4 km (2.5 miles) downstream site;
- Daily TAH concentrations greater than 10 µg/L were recorded at sites from the PUF boat launch to 12 km (7.5 miles) downstream during the coho salmon fishery;
- The maximum TAH concentration recorded was 38.7 µg/L at the PUF boat launch (site LS-0 PUF) on August 23;
- TAH concentrations were positively related to boat use during the sampling periods, which is consistent with previous results; and,
- An estimated daily total of 34 to 48 boats (depending on river discharge) counted operating at the boat launch will result in an average daily TAH concentration of 10 µg/L.

7.0 References

Alaska Department of Environmental Conservation. 2012. 18 AAC 70, Water Quality Standards. Juneau, Alaska.

Davis, J.C., G.A. Davis, and L. Eldred. 2011. Hydrocarbons and Turbidity on the Lower Little Susitna River. Final Report for the Alaska Department of Environmental Conservation. ACWA 10-03. Talkeetna, AK.

Davis, J.C., and G.A. Davis. 2013. Water Quality in the Lower Little Susitna River. Cumulative Final Report for the Alaska Department of Environmental Conservation. ACWA 18-6002-12. Talkeetna, AK.

Oasis Environmental Incorporated. 2007. Amended Final Report and Additional Scenario—Lower Kenai River petroleum hydrocarbon estimate. Submitted to the Alaska Department of Environmental Conservation.

8.0 Appendices

8.1 Appendix A. Site photographs

Photograph A1. LS-4 km up looking downstream (8/9/14).

Photograph A2. LS-1 km up looking downstream (8/9/14).

Photograph A3. PUF boat launch (8/9/14). Stop-action camera was located on buildings in upper right of photo.

Photograph A4. LS-0 Looking upstream at PUF boat launch (8/9/14).

Photograph A5. LS-1 km dn looking downstream (8/9/14).

Photograph A6. LS-4 km dn looking downstream (8/9/14).

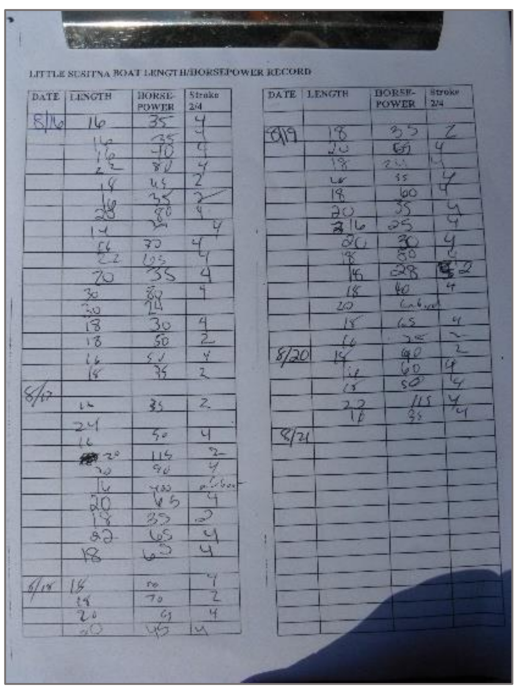
Photograph A7. LS-8 km dn looking upstream (8/9/14.)

Photograph A8. LS-8 km dn looking downstream.

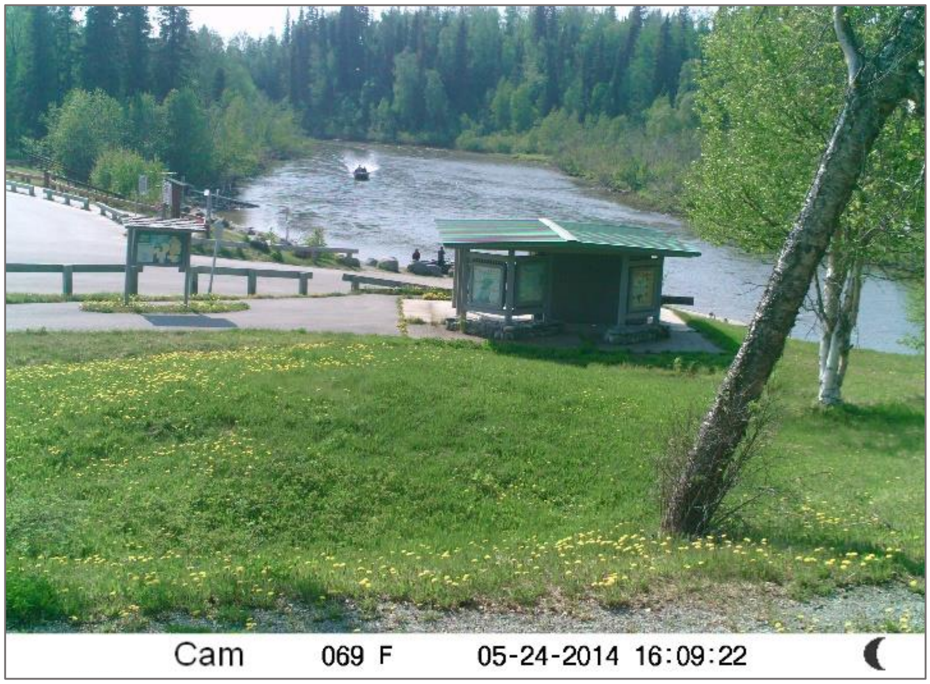
Photograph A9. LS-12 km dn looking downstream (8/9/14).

Photograph A10. Measuring discharge in My Creek (8/3/14).

Photograph A11. Removing sample bottles from VOC sampler (8/3/14).



Photograph A12. Entrance booth boat counts.



Photograph A13. Image captured by stop-action camera at PUF boat launch.

8.2 Appendix B. Water sampling results.

Site	Date	Time	Measurement	Result	Units
LS 0 PUF	5/24/2014	7:00	BTEX	1.25	µg/L
LS 0 PUF	5/24/2014	10:00	BTEX	1.94	µg/L
LS 0 PUF	5/24/2014	13:09	BTEX	1.73	µg/L
LS 0 PUF	5/24/2014	16:00	BTEX	1.94	µg/L
LS 0 PUF	5/24/2014	20:00	BTEX	2.01	µg/L
LS 0 PUF	5/25/2014	7:13	BTEX	1.25	µg/L
LS 0 PUF	5/25/2014	10:07	BTEX	1.91	µg/L
LS 0 PUF	5/25/2014	13:05	BTEX	2.03	µg/L
LS 0 PUF	5/25/2014	16:09	BTEX	1.85	µg/L
LS 0 PUF	5/25/2014	20:00	BTEX	1.63	µg/L
LS 0 PUF	5/26/2014	7:00	BTEX	1.25	µg/L
LS 0 PUF	5/26/2014	10:20	BTEX	1.25	µg/L
LS 0 PUF	5/26/2014	13:05	BTEX	1.75	µg/L
LS 0 PUF	5/26/2014	15:41	BTEX	1.25	µg/L
LS 0 PUF	5/26/2014	20:10	BTEX	1.79	µg/L
LS 0 PUF	5/27/2014	7:05	BTEX	1.25	µg/L
LS 0 PUF	5/27/2014	10:05	BTEX	1.69	µg/L
LS 0 PUF	5/27/2014	13:15	BTEX	1.58	µg/L
LS 0 PUF	5/27/2014	15:38	BTEX	1.67	µg/L
LS 0 PUF	5/27/2014	20:00	BTEX	1.25	µg/L
LS 0 PUF	5/30/2014	7:22	BTEX	1.25	µg/L
LS 0 PUF	5/30/2014	10:01	BTEX	1.25	µg/L
LS 0 PUF	5/30/2014	13:05	BTEX	1.25	µg/L
LS 0 PUF	5/30/2014	16:18	BTEX	2	µg/L
LS 0 PUF	5/30/2014	20:00	BTEX	2.21	µg/L
LS 0 PUF	5/31/2014	7:02	BTEX	1.72	µg/L
LS 0 PUF	5/31/2014	10:02	BTEX	3.88	µg/L
LS 0 PUF	5/31/2014	13:08	BTEX	1.72	µg/L
LS 0 PUF	5/31/2014	15:26	BTEX	1.25	µg/L
LS 0 PUF	5/31/2014	19:51	BTEX	2.05	µg/L
LS 0 PUF	6/1/2014	7:00	BTEX	1.63	µg/L
LS 0 PUF	6/1/2014	10:15	BTEX	1.25	µg/L
LS 0 PUF	6/1/2014	13:05	BTEX	1.25	µg/L
LS 0 PUF	6/1/2014	14:55	BTEX	1.25	µg/L
LS 0 PUF	6/1/2014	20:07	BTEX	1.25	µg/L
LS 0 PUF	6/2/2014	7:12	BTEX	1.25	µg/L
LS 0 PUF	6/2/2014	10:03	BTEX	1.53	µg/L
LS 0 PUF	6/2/2014	12:53	BTEX	1.25	µg/L

LS 0 PUF	6/2/2014	15:00	BTEX	1.66	µg/L
LS 0 PUF	6/2/2014	19:50	BTEX	1.25	µg/L
LS 0 PUF	6/6/2014	6:55	BTEX	1.25	µg/L
LS 0 PUF	6/6/2014	9:50	BTEX	1.25	µg/L
LS 0 PUF	6/6/2014	12:52	BTEX	1.25	µg/L
LS 0 PUF	6/6/2014	15:12	BTEX	1.25	µg/L
LS 0 PUF	6/6/2014	20:04	BTEX	1.55	µg/L
LS 0 PUF	6/7/2014	7:05	BTEX	2.47	µg/L
LS 0 PUF	6/7/2014	9:55	BTEX	1.93	µg/L
LS 0 PUF	6/7/2014	13:00	BTEX	2.41	µg/L
LS 0 PUF	6/7/2014	15:07	BTEX	1.51	µg/L
LS 0 PUF	6/7/2014	20:00	BTEX	5.29	µg/L
LS 0 PUF	6/8/2014	7:09	BTEX	1.25	µg/L
LS 0 PUF	6/8/2014	10:11	BTEX	1.25	µg/L
LS 0 PUF	6/8/2014	13:05	BTEX	1.25	µg/L
LS 0 PUF	6/8/2014	15:41	BTEX	1.25	µg/L
LS 0 PUF	6/8/2014	20:45	BTEX	1.25	µg/L
LS 0 PUF	6/9/2014	7:04	BTEX	1.25	µg/L
LS 0 PUF	6/9/2014	9:57	BTEX	1.25	µg/L
LS 0 PUF	6/9/2014	13:04	BTEX	1.25	µg/L
LS 0 PUF	6/9/2014	15:16	BTEX	1.52	µg/L
LS 0 PUF	6/9/2014	19:50	BTEX	1.85	µg/L
LS 0 PUF	8/1/2014	7:08	BTEX	1.98	µg/L
LS 0 PUF	8/1/2014	10:05	BTEX	3.53	µg/L
LS 0 PUF	8/1/2014	13:07	BTEX	2.46	µg/L
LS 0 PUF	8/1/2014	15:25	BTEX	17.44	µg/L
LS 0 PUF	8/1/2014	20:10	BTEX	2.59	µg/L
LS 0 PUF	8/2/2014	7:07	BTEX	3.39	µg/L
LS 0 PUF	8/2/2014	10:08	BTEX	4.2	µg/L
LS 0 PUF	8/2/2014	13:08	BTEX	10.67	µg/L
LS 0 PUF	8/2/2014	15:12	BTEX	7.43	µg/L
LS 0 PUF	8/2/2014	20:08	BTEX	4.08	µg/L
LS 0 PUF	8/3/2014	7:05	BTEX	4.55	µg/L
LS 0 PUF	8/3/2014	10:02	BTEX	13.35	µg/L
LS 0 PUF	8/3/2014	13:03	BTEX	11.66	µg/L
LS 0 PUF	8/3/2014	15:40	BTEX	7.53	µg/L
LS 0 PUF	8/3/2014	20:10	BTEX	2.59	µg/L
LS 0 PUF	8/4/2014	7:00	BTEX	2.09	µg/L
LS 0 PUF	8/4/2014	10:03	BTEX	3.05	µg/L
LS 0 PUF	8/4/2014	13:05	BTEX	2.05	µg/L
LS 0 PUF	8/4/2014	15:15	BTEX	3.98	µg/L

LS 0 PUF	8/4/2014	20:00	BTEX	3.01	µg/L
LS 0 PUF	8/6/2014	7:05	BTEX	3.36	µg/L
LS 0 PUF	8/6/2014	10:08	BTEX	5.17	µg/L
LS 0 PUF	8/6/2014	13:05	BTEX	1.25	µg/L
LS 0 PUF	8/6/2014	15:50	BTEX	3.05	µg/L
LS 0 PUF	8/6/2014	20:00	BTEX	9.45	µg/L
LS 0 PUF	8/7/2014	7:08	BTEX	1.25	µg/L
LS 0 PUF	8/7/2014	10:09	BTEX	1.25	µg/L
LS 0 PUF	8/7/2014	13:02	BTEX	1.25	µg/L
LS 0 PUF	8/7/2014	15:35	BTEX	15.87	µg/L
LS 0 PUF	8/7/2014	20:10	BTEX	1.86	µg/L
LS 0 PUF	8/8/2014	7:08	BTEX	2.74	µg/L
LS 0 PUF	8/8/2014	10:10	BTEX	2.29	µg/L
LS 0 PUF	8/8/2014	13:05	BTEX	9.96	µg/L
LS 0 PUF	8/8/2014	16:13	BTEX	9.54	µg/L
LS 0 PUF	8/8/2014	20:05	BTEX	9.6	µg/L
LS 0 PUF	8/9/2014	7:00	BTEX	5.74	µg/L
LS 0 PUF	8/9/2014	10:05	BTEX	4.88	µg/L
LS 0 PUF	8/9/2014	13:15	BTEX	7.79	µg/L
LS 0 PUF	8/9/2014	15:17	BTEX	21.97	µg/L
LS 0 PUF	8/9/2014	19:56	BTEX	8.76	µg/L
LS 0 PUF	8/10/2014	7:00	BTEX	4.56	µg/L
LS 0 PUF	8/10/2014	10:00	BTEX	4.8	µg/L
LS 0 PUF	8/10/2014	12:58	BTEX	8.05	µg/L
LS 0 PUF	8/10/2014	14:50	BTEX	9.12	µg/L
LS 0 PUF	8/10/2014	19:50	BTEX	6.27	µg/L
LS 0 PUF	8/14/2014	7:05	BTEX	1.25	µg/L
LS 0 PUF	8/14/2014	10:07	BTEX	2.58	µg/L
LS 0 PUF	8/14/2014	13:08	BTEX	4.94	µg/L
LS 0 PUF	8/14/2014	15:25	BTEX	11.04	µg/L
LS 0 PUF	8/14/2014	20:15	BTEX	3.42	µg/L
LS 0 PUF	8/15/2014	7:03	BTEX	1.25	µg/L
LS 0 PUF	8/15/2014	10:07	BTEX	5.46	µg/L
LS 0 PUF	8/15/2014	13:13	BTEX	7.89	µg/L
LS 0 PUF	8/15/2014	15:35	BTEX	1.25	µg/L
LS 0 PUF	8/15/2014	20:08	BTEX	14.4	µg/L
LS 0 PUF	8/16/2014	7:10	BTEX	2.02	µg/L
LS 0 PUF	8/16/2014	10:10	BTEX	3.894	µg/L
LS 0 PUF	8/16/2014	13:35	BTEX	3.95	µg/L
LS 0 PUF	8/16/2014	16:10	BTEX	2	µg/L
LS 0 PUF	8/16/2014	20:10	BTEX	2.82	µg/L

LS 0 PUF	8/17/2014	7:05	BTEX	2.27	µg/L
LS 0 PUF	8/17/2014	10:05	BTEX	2.04	µg/L
LS 0 PUF	8/17/2014	13:25	BTEX	4.64	µg/L
LS 0 PUF	8/17/2014	15:49	BTEX	4.87	µg/L
LS 0 PUF	8/17/2014	20:03	BTEX	4.8	µg/L
LS 0 PUF	8/18/2014	7:04	BTEX	1.25	µg/L
LS 0 PUF	8/18/2014	10:00	BTEX	6.08	µg/L
LS 0 PUF	8/18/2014	13:20	BTEX	4.89	µg/L
LS 0 PUF	8/18/2014	15:55	BTEX	2.36	µg/L
LS 0 PUF	8/18/2014	19:50	BTEX	2.42	µg/L
LS 0 PUF	8/21/2014	7:07	BTEX	2.6	µg/L
LS 0 PUF	8/21/2014	10:06	BTEX	1.69	µg/L
LS 0 PUF	8/21/2014	13:32	BTEX	6.86	µg/L
LS 0 PUF	8/21/2014	16:25	BTEX	6.03	µg/L
LS 0 PUF	8/21/2014	20:10	BTEX	10.33	µg/L
LS 0 PUF	8/22/2014	7:00	BTEX	1.25	µg/L
LS 0 PUF	8/22/2014	10:02	BTEX	1.25	µg/L
LS 0 PUF	8/22/2014	13:25	BTEX	1.25	µg/L
LS 0 PUF	8/22/2014	16:25	BTEX	2.12	µg/L
LS 0 PUF	8/22/2014	20:00	BTEX	2.39	µg/L
LS 0 PUF	8/23/2014	7:00	BTEX	4.01	µg/L
LS 0 PUF	8/23/2014	10:10	BTEX	3.05	µg/L
LS 0 PUF	8/23/2014	13:33	BTEX	38.72	µg/L
LS 0 PUF	8/23/2014	16:20	BTEX	12.95	µg/L
LS 0 PUF	8/23/2014	19:55	BTEX	2	µg/L
LS 0 PUF	8/24/2014	7:03	BTEX	1.25	µg/L
LS 0 PUF	8/24/2014	9:57	BTEX	2.02	µg/L
LS 0 PUF	8/24/2014	13:05	BTEX	6.56	µg/L
LS 0 PUF	8/24/2014	16:15	BTEX	15.54	µg/L
LS 0 PUF	8/24/2014	20:02	BTEX	11.28	µg/L
LS 0 PUF	8/25/2014	7:05	BTEX	1.91	µg/L
LS 0 PUF	8/25/2014	10:00	BTEX	2.82	µg/L
LS 0 PUF	8/25/2014	13:00	BTEX	6.64	µg/L
LS 0 PUF	8/25/2014	15:55	BTEX	13.49	µg/L
LS 0 PUF	8/25/2014	19:58	BTEX	3.33	µg/L
LS 4 km dn	5/24/2014	7:29	BTEX	1.25	µg/L
LS 4 km dn	5/24/2014	10:36	BTEX	1.65	µg/L
LS 4 km dn	5/24/2014	13:38	BTEX	1.86	µg/L
LS 4 km dn	5/24/2014	16:38	BTEX	2.1	µg/L
LS 4 km dn	5/24/2014	20:13	BTEX	3.29	µg/L
LS 4 km dn	5/25/2014	7:47	BTEX	1.25	µg/L

LS 4 km dn	5/25/2014	10:30	BTEX	1.75	µg/L
LS 4 km dn	5/25/2014	13:30	BTEX	4.08	µg/L
LS 4 km dn	5/25/2014	16:45	BTEX	4.32	µg/L
LS 4 km dn	5/25/2014	20:20	BTEX	2.42	µg/L
LS 4 km dn	5/26/2014	7:51	BTEX	2.14	µg/L
LS 4 km dn	5/26/2014	10:40	BTEX	1.98	µg/L
LS 4 km dn	5/26/2014	13:30	BTEX	1.75	µg/L
LS 4 km dn	5/26/2014	16:21	BTEX	1.82	µg/L
LS 4 km dn	5/26/2014	20:30	BTEX	1.25	µg/L
LS 4 km dn	5/27/2014	7:30	BTEX	1.25	µg/L
LS 4 km dn	5/27/2014	10:25	BTEX	1.25	µg/L
LS 4 km dn	5/27/2014	13:40	BTEX	1.25	µg/L
LS 4 km dn	5/27/2014	16:20	BTEX	1.77	µg/L
LS 4 km dn	5/27/2014	20:18	BTEX	1.25	µg/L
LS 4 km dn	5/30/2014	7:45	BTEX	1.25	µg/L
LS 4 km dn	5/30/2014	10:25	BTEX	1.25	µg/L
LS 4 km dn	5/30/2014	13:30	BTEX	1.25	µg/L
LS 4 km dn	5/30/2014	17:01	BTEX	1.25	µg/L
LS 4 km dn	5/30/2014	20:22	BTEX	1.25	µg/L
LS 4 km dn	5/31/2014	7:25	BTEX	4.79	µg/L
LS 4 km dn	5/31/2014	10:24	BTEX	1.61	µg/L
LS 4 km dn	5/31/2014	13:27	BTEX	1.72	µg/L
LS 4 km dn	5/31/2014	16:08	BTEX	1.25	µg/L
LS 4 km dn	5/31/2014	20:10	BTEX	1.25	µg/L
LS 4 km dn	6/1/2014	7:15	BTEX	1.25	µg/L
LS 4 km dn	6/1/2014	10:30	BTEX	1.25	µg/L
LS 4 km dn	6/1/2014	13:25	BTEX	1.25	µg/L
LS 4 km dn	6/1/2014	15:30	BTEX	1.25	µg/L
LS 4 km dn	6/1/2014	20:27	BTEX	1.25	µg/L
LS 4 km dn	6/2/2014	7:36	BTEX	2.57	µg/L
LS 4 km dn	6/2/2014	10:25	BTEX	1.25	µg/L
LS 4 km dn	6/2/2014	13:11	BTEX	1.25	µg/L
LS 4 km dn	6/2/2014	15:40	BTEX	2.18	µg/L
LS 4 km dn	6/2/2014	20:15	BTEX	1.25	µg/L
LS 4 km dn	6/6/2014	7:16	BTEX	1.25	µg/L
LS 4 km dn	6/6/2014	10:10	BTEX	1.25	µg/L
LS 4 km dn	6/6/2014	13:12	BTEX	1.25	µg/L
LS 4 km dn	6/6/2014	15:46	BTEX	1.25	µg/L
LS 4 km dn	6/6/2014	20:25	BTEX	1.85	µg/L
LS 4 km dn	6/7/2014	7:27	BTEX	1.25	µg/L
LS 4 km dn	6/7/2014	10:15	BTEX	1.25	µg/L

LS 4 km dn	6/7/2014	13:20	BTEX	1.54	µg/L
LS 4 km dn	6/7/2014	15:48	BTEX	1.25	µg/L
LS 4 km dn	6/7/2014	20:20	BTEX	1.25	µg/L
LS 4 km dn	6/8/2014	7:38	BTEX	1.6	µg/L
LS 4 km dn	6/8/2014	10:37	BTEX	1.25	µg/L
LS 4 km dn	6/8/2014	13:33	BTEX	1.86	µg/L
LS 4 km dn	6/8/2014	16:32	BTEX	1.25	µg/L
LS 4 km dn	6/8/2014	21:06	BTEX	1.25	µg/L
Ls 4 km dn	6/9/2014	7:25	BTEX	1.25	µg/L
LS 4 km dn	6/9/2014	10:20	BTEX	1.25	µg/L
LS 4 km dn	6/9/2014	13:26	BTEX	1.25	µg/L
LS 4 km dn	6/9/2014	16:05	BTEX	1.25	µg/L
LS 4 km dn	6/9/2014	20:12	BTEX	1.25	µg/L
LS 4 km dn	8/1/2014	7:34	BTEX	1.95	µg/L
LS 4 km dn	8/1/2014	10:30	BTEX	4.32	µg/L
LS 4 km dn	8/1/2014	13:35	BTEX	2.6	µg/L
LS 4 km dn	8/1/2014	16:03	BTEX	5.4	µg/L
LS 4 km dn	8/1/2014	20:28	BTEX	2.45	µg/L
LS 4 km dn	8/2/2014	7:30	BTEX	9.41	µg/L
LS 4 km dn	8/2/2014	10:35	BTEX	12.92	µg/L
LS 4 km dn	8/2/2014	13:28	BTEX	11.62	µg/L
LS 4 km dn	8/2/2014	16:05	BTEX	12.23	µg/L
LS 4 km dn	8/2/2014	20:27	BTEX	5.14	µg/L
LS 4 km dn	8/3/2014	7:32	BTEX	9.49	µg/L
LS 4 km dn	8/3/2014	10:25	BTEX	12.5	µg/L
LS 4 km dn	8/3/2014	13:25	BTEX	6.86	µg/L
LS 4 km dn	8/3/2014	16:15	BTEX	14.98	µg/L
LS 4 km dn	8/3/2014	20:40	BTEX	8.72	µg/L
LS 4 km dn	8/4/2014	7:23	BTEX	3	µg/L
LS 4 km dn	8/4/2014	10:22	BTEX	3.17	µg/L
LS 4 km dn	8/4/2014	13:35	BTEX	3.51	µg/L
LS 4 km dn	8/4/2014	15:45	BTEX	2.32	µg/L
LS 4 km dn	8/4/2014	20:20	BTEX	2.66	µg/L
LS 4 km dn	8/6/2014	7:25	BTEX	22.69	µg/L
LS 4 km dn	8/6/2014	10:30	BTEX	3.78	µg/L
LS 4 km dn	8/6/2014	13:23	BTEX	13.34	µg/L
LS 4 km dn	8/6/2014	16:22	BTEX	15.34	µg/L
LS 4 km dn	8/6/2014	20:19	BTEX	1.25	µg/L
LS 4 km dn	8/7/2014	7:25	BTEX	1.25	µg/L
LS 4 km dn	8/7/2014	10:30	BTEX	1.25	µg/L
LS 4 km dn	8/7/2014	13:20	BTEX	1.25	µg/L

LS 4 km dn	8/7/2014	16:05	BTEX	1.25	µg/L
LS 4 km dn	8/7/2014	20:30	BTEX	1.25	µg/L
LS 4 km dn	8/8/2014	7:48	BTEX	4.49	µg/L
LS 4 km dn	8/8/2014	10:30	BTEX	1.25	µg/L
LS 4 km dn	8/8/2014	13:25	BTEX	14.36	µg/L
LS 4 km dn	8/8/2014	16:45	BTEX	8.44	µg/L
LS 4 km dn	8/8/2014	20:30	BTEX	13.32	µg/L
LS 4 km dn	8/9/2014	7:20	BTEX	4.78	µg/L
LS 4 km dn	8/9/2014	10:27	BTEX	9.56	µg/L
LS 4 km dn	8/9/2014	13:35	BTEX	8.17	µg/L
LS 4 km dn	8/9/2014	15:50	BTEX	13.85	µg/L
LS 4 km dn	8/9/2014	20:15	BTEX	9.61	µg/L
LS 4 km dn	8/10/2014	7:21	BTEX	6.1	µg/L
LS 4 km dn	8/10/2014	10:24	BTEX	7.57	µg/L
LS 4 km dn	8/10/2014	13:19	BTEX	10.58	µg/L
LS 4 km dn	8/10/2014	15:21	BTEX	21.48	µg/L
LS 4 km dn	8/10/2014	20:05	BTEX	15.74	µg/L
LS 4 km dn	8/14/2014	7:25	BTEX	3.29	µg/L
LS 4 km dn	8/14/2014	10:27	BTEX	2.76	µg/L
LS 4 km dn	8/14/2014	13:28	BTEX	9.25	µg/L
LS 4 km dn	8/14/2014	16:00	BTEX	12.17	µg/L
LS 4 km dn	8/14/2014	20:34	BTEX	7.14	µg/L
LS 4 km dn	8/15/2014	7:20	BTEX	1.25	µg/L
LS 4 km dn	8/15/2014	10:25	BTEX	1.25	µg/L
LS 4 km dn	8/15/2014	13:30	BTEX	10.27	µg/L
LS 4 km dn	8/15/2014	16:05	BTEX	9.3	µg/L
LS 4 km dn	8/15/2014	20:25	BTEX	15.17	µg/L
LS 4 km dn	8/16/2014	7:35	BTEX	4.91	µg/L
LS 4 km dn	8/16/2014	10:32	BTEX	16.75	µg/L
LS 4 km dn	8/16/2014	14:00	BTEX	5.07	µg/L
LS 4 km dn	8/16/2014	15:40	BTEX	2.69	µg/L
LS 4 km dn	8/16/2014	20:25	BTEX	4.14	µg/L
LS 4 km dn	8/17/2014	7:21	BTEX	1.25	µg/L
LS 4 km dn	8/17/2014	10:26	BTEX	2.59	µg/L
LS 4 km dn	8/17/2014	13:54	BTEX	5.48	µg/L
LS 4 km dn	8/17/2014	15:35	BTEX	16.34	µg/L
LS 4 km dn	8/17/2014	20:20	BTEX	6.69	µg/L
LS 4 km dn	8/18/2014	7:22	BTEX	2.13	µg/L
LS 4 km dn	8/18/2014	10:17	BTEX	1.66	µg/L
LS 4 km dn	8/18/2014	13:52	BTEX	5.04	µg/L
LS 4 km dn	8/18/2014	15:35	BTEX	5.88	µg/L

LS 4 km dn	8/18/2014	20:10	BTEX	3.44	µg/L
LS 4 km dn	8/21/2014	7:25	BTEX	1.25	µg/L
LS 4 km dn	8/21/2014	10:32	BTEX	3.71	µg/L
LS 4 km dn	8/21/2014	14:04	BTEX	8.06	µg/L
LS 4 km dn	8/21/2014	16:05	BTEX	1.74	µg/L
LS 4 km dn	8/21/2014	20:23	BTEX	3.74	µg/L
LS 4 km dn	8/22/2014	7:19	BTEX	1.25	µg/L
LS 4 km dn	8/22/2014	10:22	BTEX	2	µg/L
LS 4 km dn	8/22/2014	13:55	BTEX	1.25	µg/L
LS 4 km dn	8/22/2014	15:57	BTEX	4.02	µg/L
LS 4 km dn	8/22/2014	20:16	BTEX	3.26	µg/L
LS 4 km dn	8/23/2014	7:30	BTEX	2.63	µg/L
LS 4 km dn	8/23/2014	10:30	BTEX	6.92	µg/L
LS 4 km dn	8/23/2014	14:10	BTEX	8.86	µg/L
LS 4 km dn	8/23/2014	15:55	BTEX	9.01	µg/L
LS 4 km dn	8/23/2014	20:15	BTEX	7.61	µg/L
LS 4 km dn	8/24/2014	7:20	BTEX	2.16	µg/L
LS 4 km dn	8/24/2014	10:15	BTEX	7.41	µg/L
LS 4 km dn	8/24/2014	13:23	BTEX	2.32	µg/L
LS 4 km dn	8/24/2014	15:55	BTEX	8.61	µg/L
LS 4 km dn	8/24/2014	20:21	BTEX	12.15	µg/L
LS 4 km dn	8/25/2014	7:25	BTEX	1.82	µg/L
LS 4 km dn	8/25/2014	10:15	BTEX	2.01	µg/L
LS 4 km dn	8/25/2014	13:19	BTEX	3.95	µg/L
LS 4 km dn	8/25/2014	15:35	BTEX	5.65	µg/L
LS 4 km dn	8/25/2014	20:17	BTEX	4.86	µg/L
LS 4 km up	5/24/2014	14:48	BTEX	1.67	µg/L
LS 4 km up	5/25/2014	14:48	BTEX	1.61	µg/L
LS 4 km up	5/26/2014	14:35	BTEX	1.25	µg/L
LS 4 km up	5/27/2014	14:40	BTEX	1.25	µg/L
LS 4 km up	5/30/2014	15:20	BTEX	1.25	µg/L
LS 4 km up	5/31/2014	14:25	BTEX	1.25	µg/L
LS 4 km up	6/1/2014	14:19	BTEX	1.25	µg/L
LS 4 km up	6/2/2014	14:20	BTEX	1.25	µg/L
LS 4 km up	6/6/2014	14:13	BTEX	1.25	µg/L
LS 4 km up	6/7/2014	14:13	BTEX	1.25	µg/L
LS 4 km up	6/8/2014	14:15	BTEX	1.25	µg/L
LS 4 km up	6/9/2014	14:52	BTEX	1.25	µg/L
LS 4 km up	8/1/2014	14:38	BTEX	2.11	µg/L
LS 4 km up	8/2/2014	14:40	BTEX	2.36	µg/L
LS 4 km up	8/3/2014	14:40	BTEX	2.03	µg/L

LS 4 km up	8/4/2014	14:25	BTEX	1.25	µg/L
LS 4 km up	8/6/2014	14:22	BTEX	2.08	µg/L
LS 4 km up	8/7/2014	14:18	BTEX	1.83	µg/L
LS 4 km up	8/8/2014	15:40	BTEX	3.4	µg/L
LS 4 km up	8/9/2014	14:40	BTEX	5.33	µg/L
LS 4 km up	8/10/2014	14:11	BTEX	3.12	µg/L
LS 4 km up	8/14/2014	14:25	BTEX	4.16	µg/L
LS 4 km up	8/15/2014	14:32	BTEX	1.25	µg/L
LS 4 km up	8/16/2014	12:50	BTEX	1.25	µg/L
LS 4 km up	8/17/2014	12:45	BTEX	1.55	µg/L
LS 4 km up	8/18/2014	12:48	BTEX	1.25	µg/L
LS 4 km up	8/21/2014	12:55	BTEX	3.72	µg/L
LS 4 km up	8/22/2014	12:48	BTEX	1.25	µg/L
LS 4 km up	8/23/2014	13:00	BTEX	4.11	µg/L
LS 4 km up	8/24/2014	13:50	BTEX	3.47	µg/L
LS 4 km up	8/25/2014	13:46	BTEX	1.53	µg/L
LS 1 km up	5/24/2014	15:15	BTEX	2.01	µg/L
LS 1 km up	5/25/2014	15:12	BTEX	1.96	µg/L
LS 1 km up	5/26/2014	14:55	BTEX	1.25	µg/L
LS 1 km up	5/27/2014	15:00	BTEX	1.25	µg/L
LS 1 km up	5/30/2014	15:42	BTEX	1.25	µg/L
LS 1 km up	5/31/2014	14:47	BTEX	1.25	µg/L
LS 1 km up	6/1/2014	14:45	BTEX	1.25	µg/L
LS 1 km up	6/2/2014	14:42	BTEX	1.5	µg/L
LS 1 km up	6/6/2014	14:35	BTEX	1.25	µg/L
LS 1 km up	6/7/2014	14:37	BTEX	1.25	µg/L
LS 1 km up	6/8/2014	15:17	BTEX	1.25	µg/L
LS 1 km up	6/9/2014	14:56	BTEX	1.51	µg/L
LS 1 km up	8/1/2014	15:00	BTEX	6.67	µg/L
LS 1 km up	8/2/2014	15:02	BTEX	2.53	µg/L
LS 1 km up	8/3/2014	15:04	BTEX	8.31	µg/L
LS 1 km up	8/4/2014	14:50	BTEX	3.48	µg/L
LS 1 km up	8/6/2014	14:35	BTEX	6.28	µg/L
LS 1 km up	8/7/2014	14:38	BTEX	1.97	µg/L
LS 1 km up	8/8/2014	16:00	BTEX	8.27	µg/L
LS 1 km up	8/9/2014	15:00	BTEX	5.29	µg/L
LS 1 km up	8/10/2014	14:28	BTEX	7.82	µg/L
LS 1 km up	8/14/2014	14:50	BTEX	4.15	µg/L
LS 1 km up	8/15/2014	14:50	BTEX	2.85	µg/L
LS 1 km up	8/16/2014	13:10	BTEX	1.63	µg/L
LS 1 km up	8/17/2014	13:05	BTEX	2.6	µg/L

LS 1 km up	8/18/2014	13:04	BTEX	4.4	µg/L
LS 1 km up	8/21/2014	13:14	BTEX	6.24	µg/L
LS 1 km up	8/22/2014	13:08	BTEX	1.25	µg/L
LS 1 km up	8/23/2014	13:15	BTEX	6.46	µg/L
LS 1 km up	8/24/2014	14:10	BTEX	4.59	µg/L
LS 1 km up	8/25/2014	14:04	BTEX	4.86	µg/L
LS 1 km dn	5/24/2014	16:17	BTEX	1.88	µg/L
LS 1 km dn	5/25/2014	15:45	BTEX	4.43	µg/L
LS 1 km dn	5/26/2014	16:00	BTEX	1.25	µg/L
LS 1 km dn	5/27/2014	15:55	BTEX	1.67	µg/L
LS 1 km dn	5/30/2014	16:41	BTEX	1.53	µg/L
LS 1 km dn	5/31/2014	15:41	BTEX	1.25	µg/L
LS 1 km dn	6/1/2014	15:12	BTEX	1.25	µg/L
LS 1 km dn	6/2/2014	15:20	BTEX	2.08	µg/L
LS 1 km dn	6/6/2014	15:28	BTEX	1.25	µg/L
LS 1 km dn	6/7/2014	15:25	BTEX	1.25	µg/L
LS 1 km dn	6/8/2014	16:08	BTEX	1.25	µg/L
LS 1 km dn	6/9/2014	15:36	BTEX	1.5	µg/L
LS 1 km dn	8/1/2014	15:36	BTEX	9.91	µg/L
LS 1 km dn	8/2/2014	15:45	BTEX	10.19	µg/L
LS 1 km dn	8/3/2014	15:57	BTEX	11.83	µg/L
LS 1 km dn	8/4/2014	15:29	BTEX	3.87	µg/L
LS 1 km dn	8/6/2014	16:05	BTEX	4.18	µg/L
LS 1 km dn	8/7/2014	15:50	BTEX	1.92	µg/L
LS 1 km dn	8/8/2014	16:28	BTEX	8.92	µg/L
LS 1 km dn	8/9/2014	15:33	BTEX	9.92	µg/L
LS 1 km dn	8/10/2014	15:05	BTEX	10.02	µg/L
LS 1 km dn	8/14/2014	15:42	BTEX	14.7	µg/L
LS 1 km dn	8/15/2014	15:50	BTEX	3.45	µg/L
LS 1 km dn	8/16/2014	16:25	BTEX	4.27	µg/L
LS 1 km dn	8/17/2014	13:36	BTEX	14.65	µg/L
LS 1 km dn	8/18/2014	13:35	BTEX	8.98	µg/L
LS 1 km dn	8/21/2014	13:47	BTEX	8	µg/L
LS 1 km dn	8/22/2014	13:38	BTEX	1.25	µg/L
LS 1 km dn	8/23/2014	13:50	BTEX	9.36	µg/L
LS 1 km dn	8/24/2014	14:48	BTEX	6.71	µg/L
LS 1 km dn	8/25/2014	14:21	BTEX	7.15	µg/L
LS 8 km dn	5/24/2014	17:08	BTEX	1.25	µg/L
LS 8 km dn	5/25/2014	17:19	BTEX	3.98	µg/L
LS 8 km dn	5/26/2014	16:50	BTEX	1.55	µg/L
LS 8 km dn	5/27/2014	16:50	BTEX	1.25	µg/L

LS 8 km dn	5/30/2014	17:26	BTEX	1.94	µg/L
LS 8 km dn	5/31/2014	18:00	BTEX	2.45	µg/L
LS 8 km dn	6/1/2014	15:55	BTEX	1.25	µg/L
LS 8 km dn	6/2/2014	16:07	BTEX	1.25	µg/L
LS 8 km dn	6/6/2014	16:09	BTEX	1.25	µg/L
LS 8 km dn	6/7/2014	16:15	BTEX	1.25	µg/L
LS 8 km dn	6/8/2014	16:56	BTEX	1.51	µg/L
LS 8 km dn	6/9/2014	16:34	BTEX	1.25	µg/L
LS 8 km dn	8/1/2014	16:23	BTEX	4.24	µg/L
LS 8 km dn	8/2/2014	16:26	BTEX	11.42	µg/L
LS 8 km dn	8/3/2014	16:37	BTEX	8.83	µg/L
LS 8 km dn	8/4/2014	16:08	BTEX	4.29	µg/L
LS 8 km dn	8/6/2014	16:40	BTEX	1.25	µg/L
LS 8 km dn	8/7/2014	16:25	BTEX	1.25	µg/L
LS 8 km dn	8/8/2014	17:07	BTEX	15.69	µg/L
LS 8 km dn	8/9/2014	16:09	BTEX	11.21	µg/L
LS 8 km dn	8/10/2014	15:45	BTEX	21.38	µg/L
LS 8 km dn	8/14/2014	16:15	BTEX	10.98	µg/L
LS 8 km dn	8/15/2014	16:25	BTEX	9.66	µg/L
LS 8 km dn	8/16/2014	14:20	BTEX	9.7	µg/L
LS 8 km dn	8/17/2014	14:14	BTEX	6.27	µg/L
LS 8 km dn	8/18/2014	14:10	BTEX	6.18	µg/L
LS 8 km dn	8/21/2014	14:25	BTEX	3.94	µg/L
LS 8 km dn	8/22/2014	14:14	BTEX	2.38	µg/L
LS 8 km dn	8/23/2014	14:30	BTEX	5.69	µg/L
LS 8 km dn	8/24/2014	15:10	BTEX	2.26	µg/L
LS 8 km dn	8/25/2014	14:46	BTEX	5.2	µg/L
LS 12 km dn	5/24/2014	17:35	BTEX	2.24	µg/L
LS 12 km dn	5/25/2014	17:50	BTEX	3.71	µg/L
LS 12 km dn	5/26/2014	17:19	BTEX	1.25	µg/L
LS 12 km dn	5/27/2014	17:15	BTEX	1.25	µg/L
LS 12 km dn	5/30/2014	17:52	BTEX	2.02	µg/L
LS 12 km dn	5/31/2014	18:30	BTEX	2.46	µg/L
LS 12 km dn	6/1/2014	16:24	BTEX	1.56	µg/L
LS 12 km dn	6/2/2014	16:24	BTEX	2.33	µg/L
LS 12 km dn	6/6/2014	16:32	BTEX	1.25	µg/L
LS 12 km dn	6/7/2014	16:35	BTEX	1.25	µg/L
LS 12 km dn	6/8/2014	17:26	BTEX	1.54	µg/L
LS 12 km dn	6/9/2014	17:01	BTEX	1.25	µg/L
LS 12 km dn	8/1/2014	16:50	BTEX	3.76	µg/L
LS 12 km dn	8/2/2014	16:50	BTEX	13.1	µg/L

LS 12 km dn	8/3/2014	16:58	BTEX	7.9	µg/L
LS 12 km dn	8/4/2014	16:30	BTEX	6.46	µg/L
LS 12 km dn	8/6/2014	17:00	BTEX	1.25	µg/L
LS 12 km dn	8/7/2014	16:40	BTEX	1.25	µg/L
LS 12 km dn	8/8/2014	17:26	BTEX	12.39	µg/L
LS 12 km dn	8/9/2014	16:29	BTEX	10.85	µg/L
LS 12 km dn	8/10/2014	16:03	BTEX	17.39	µg/L
LS 12 km dn	8/14/2014	16:38	BTEX	10.72	µg/L
LS 12 km dn	8/15/2014	16:49	BTEX	10.17	µg/L
LS 12 km dn	8/16/2014	14:40	BTEX	13.3	µg/L
LS 12 km dn	8/17/2014	14:34	BTEX	7.68	µg/L
LS 12 km dn	8/18/2014	14:29	BTEX	2.28	µg/L
LS 12 km dn	8/21/2014	14:46	BTEX	2.91	µg/L
LS 12 km dn	8/22/2014	14:33	BTEX	2.47	µg/L
LS 12 km dn	8/23/2014	14:55	BTEX	6.8	µg/L
LS 12 km dn	8/24/2014	15:27	BTEX	5.47	µg/L
LS 12 km dn	8/25/2014	15:07	BTEX	5.94	µg/L