Hydrocarbons and turbidity in the Lower Little Susitna River

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List of Abbreviations and Acronyms

ADEC. Alaska Department of Environmental Conservation

ADNR. Department of Natural Resources

BTEX. Benzene, Toluene, Ethyl-benzene, Xylenes

cfs. cubic feet per second

g. grams

gal. gallon

HCl. Hydrochloric acid

km. kilometer

mg/s. milligrams per second

ml. milliliter

NTU. Nephelometric turbidity units

PUF. Public Use Facility and boat launch

PUFDN. Sampling site 3.5 km downstream from the PUF boat launch

PUFUP. Sampling site 9 km upstream from the PUF boat launch

TAH. Total Aromatic Hydrocarbons (sum of BTEX compounds)

VOC. Volatile Organic Carbons

μg/L. micrograms (10^{-6}) per liter

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Summary

Water sampling was conducted on the Lower Little Susitna River near the Little Susitna River Public Use Facility (PUF) to evaluate the influence of recreational use on water quality. Weekly water samples were collected from seven sampling locations distributed from 1 km upstream to 4 km downstream from the PUF boat launch. More frequent sampling (every 3 hours) was conducted at the boat launch during peak use periods one weekend in August of 2009 and June of 2010. Water samples were collected and analyzed for total aromatic hydrocarbons, turbidity, pH, and specific conductivity. Turbidity was measured hourly at a reference site near Houston and at two locations below the PUF boat launch with Hydrolab probes and data loggers. Surveys of boat use by motor type (2-cycle, 4-cycle) were conducted concurrent with water sampling. The effects of changing water quality on the biotic community were evaluated by testing for differences in macroinvertebrate drift and juvenile fish relative abundance above and below the PUF.

Hydrocarbon concentrations varied with changes in discharge and boat use. Concentrations of hydrocarbons, corrected by differences in flow, increased with increasing boat use. TAH concentrations exceeded state water quality standards (10 µg/L) for aquatic life at one or more of the sampling sites on 3 of the 15 weekly sampling dates. Average concentrations of TAH from sites downstream of the boat launch exceeded state standards on 1 of the 15 sampling dates. Concentrations of hydrocarbons from one or more samples at the boat launch during more frequent daily sampling exceeded water quality standard on all three of the days during August of 2009 but not during June 2010. During periods of high use, concentrations of hydrocarbons increased from the boat launch to sampling locations 16 km downstream. Relationships between boat use and flow-corrected hydrocarbons were statistically significant for total boats, boats with 4-cycle motors, and boats with 2-cycle motors that were operating during the sampling period. The total number of boats, regardless of motor type, explained the greatest variation in flow-corrected hydrocarbon concentrations. There was no difference in hydrocarbon discharge per boat when comparing days with high and low percent 2-cycle motor use.

The relationships between total boat count at the entrance booth and flow-corrected hydrocarbon concentrations, and the relationship between stream flow at the PUF and flow 3 days prior at the gauge station in Hatcher Pass gives managers a tool that can be used to avoid exceedances of water quality standards. The maximum number of boats per day that can pass the entrance booth which will not likely result in TAH concentrations greater than 10 µg/L can be estimated from the following equation.

$$B_t = 0.08\, Q_{H-3} + 12.6$$

Where B_t is the total number of boats passing the entrance booth, and Q_{H-3} is stream flow at the USGS gauging station three days before in cubic feet per second.

Turbidity from weekly grab samples was higher than reference values at sampling sites near the PUF. At sites located 1.0 and 0.5 km upstream of the boat launch, turbidity from grab samples was 5 or more NTU above background on 2 of the 15 sampling dates. However, 4 km downstream from the launch, turbidity was greater than 5 NTU above background on 11 of the 15 sampling dates and 10 NTU above

background on 4 of the 15 sampling dates. In 2009, average daily turbidity from hourly measures was more than 5 NTU above background on 71% of the days between May 24 and September 6, and 10 NTU greater on 47% of the days. In 2010, turbidity was 5 NTU greater than background on 85% of the days between May 15 and June 26, and 10 NTU greater on 55% of the days. Regression relationships between measures of boat use and turbidity were significant.

Measures of the macroinvertebrate and fish communities were consistent with previous years. The abundance of drifting macroinvertebrates was significantly higher at the reference site compared to the site downstream from the PUF in August but not in June. Coho juvenile salmon and total salmonid catch per trap was greater upstream in August. Catch per trap of Chinook juvenile salmon was greater upstream in June.

Introduction

The Little Susitna River is located within Southcentral Alaska and flows from the Talkeetna Mountains adjacent to the communities of Wasilla and Houston (Figure 1). The river travels over 161 km (100 miles) from the Mint Glacier to Cook Inlet. The river flows through the Hatcher Pass State Recreation Area, the Nancy Lake State Recreation Area and the Susitna Flats State Game Refuge. The Little Susitna River is one of the rivers managed under the Susitna Area Recreational Rivers Management Plan (ADNR 1991). The river supports a highly popular salmon and trout fishery as well as recreational non-motorized and motorized boating. Most of the residential development is located between Edgerton Park Road and Schrock Road, adjacent to the cities of Wasilla and Houston, resulting in bank and riparian modifications (Davis and Davis 2007).

Primary use of the Lower Little Susitna River, from its mouth upstream to the Parks Highway, is related to the salmon sport fishery. Access is limited to undeveloped boat launches near Houston (River Mile 62) and at the PUF (River Mile 25). There are no known boat access points between these two locations. In 2007, over 11,000 anglers accessed the Little Susitna River at the PUF during the Chinook and coho salmon sport fisheries. The high amount of boat-accessed fishing, particularly near the PUF, has the potential to cause negative effects to water quality. The apparent increase in lower river stream water during the sport fishery was confirmed by sampling conducted in 2006 and 2007 (Davis and Davis 2007). Similarly, intensive boat use on the Kenai River and within Big Lake has resulted in concentrations of hydrocarbons within the water column that exceed state water quality standards (18 AAC 70) (Oasis 2006, Oasis 2008).

Initial water quality sampling was conducted from July 2007 through June 2008 to determine the location and extent of potential hydrocarbon and turbidity contamination of the Little Susitna River. Sampling was conducted weekly through the fall coho fishery (July through mid-September 2007) and the spring Chinook fishery (May and June 2008) above and below the city of Houston and above and below the PUF. Results indicate that total aromatic hydrocarbon concentrations exceeded state water quality standards above and below the PUF boat launch during the coho and Chinook fisheries. Stream water turbidity increased above background levels and periodically exceeded state standards (Davis and Davis 2008). In the fall of 2008 and spring of 2009, more intensive sampling was conducted at sites ranging from 1.0 km above the PUF to 4 km below the PUF. Water samples were collected weekly during the fall coho and spring Chinook fisheries. Surveys of boat use by motor type were conducted concurrently with water sampling (Davis et al. 2009).

The concentration of TAH and turbidity exceeded the state water quality standard of 10 μg/L on multiple occasions through the fall 2008 and spring 2009 sampling periods. Including all dates and sites, 24 samples out of 105 (23%) had TAH concentrations greater than or equal to 10 μg/L. Concentrations exceeded state standards more often during August of 2008 when the number of boats was high and discharge was between 390 and 425 cfs. Stream water turbidity at the PUF was greater than 5 NTU above background measures on most sampling dates. There was more than a 5 NTU difference on 10 of 15 days (67%) based upon weekly grab samples.

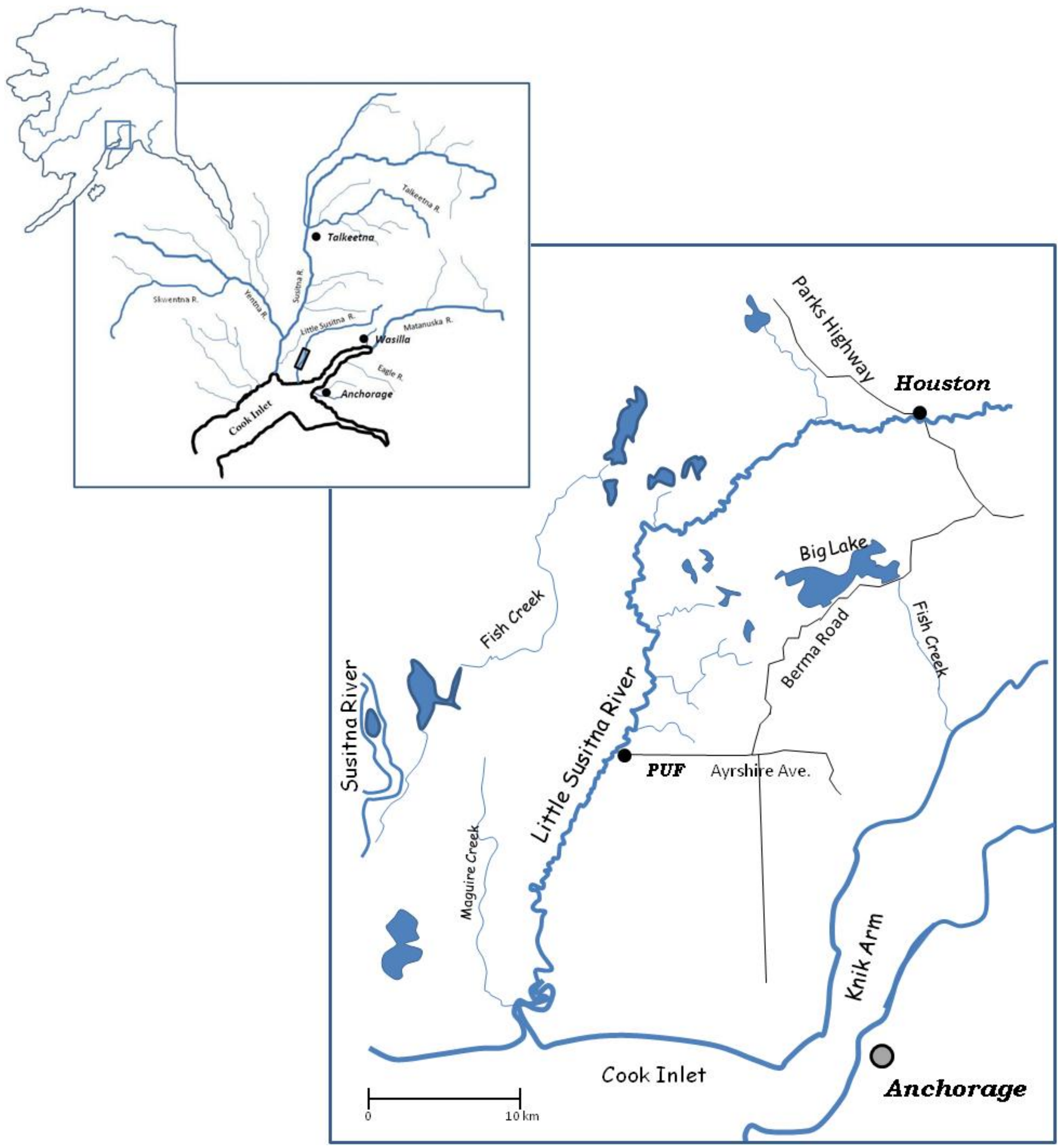


Figure 1. Location of the Little Susitna River within Southcentral Alaska with rectangle showing approximate study location.

Average daily turbidity from the hourly measures were more than 5 NTU above background measurements collected near Houston, on 26 of 50 days (52%) in 2008, and 21 of 34 days (62%) during spring 2009. Turbidity at the reference sites and the PUF increase during spring runoff and storm events; however, high flows explain only a portion of the increase in turbidity.

Continued water sampling was implemented in the fall of 2009 and spring of 2010. Sampling was conducted to provide additional data points to improve regression relationships and to monitor annual variability. Specific objectives for the FY10 study are as follows.

Objectives

1. Determine whether state water quality standards for total aromatic hydrocarbon (TAH) (18 AAC 70.020(b)(5)) are exceeded in the Little Susitna River adjacent to the Public Use Facility.
2. Measure the change in TAH concentrations upstream and downstream from the boat launch to determine changes due to evaporative loss.
3. Measure daily changes in TAH concentrations to determine the portion of a day water quality standards are exceeded.
4. Test the hypothesis that 2-cycle motors are the predominant cause of TAH discharge to receiving waters.
5. Measure the relationship between motor boats and TAH concentrations and use this relationship to estimate the number of days water quality standards are exceeded.
6. Determine whether state water quality standards for turbidity (18 AAC 70.020(b)(12)) are exceeded in the Little Susitna River adjacent to the Public Use Facility.
7. Test for differences in macroinvertebrate drift and juvenile salmon abundance between low and high motorboat use areas.

Methods

Detailed description of sampling design, collection, analyses, and interpretation are provided in the ADEC Quality Assurance Project Plan (Appendix D).

Total Aromatic Hydrocarbon Concentrations

<u>Objectives 1 and 2. Evaluation of state standards and evaporative loss.</u>

Water samples were collected weekly on weekends from July 19 to September 5, 2009 and from May 15 to June 27, 2010. Sundays were selected to consistently sample high-use days. Water samples were collected between 12:00 and 16:00. In order to measure evaporative loss or downstream accumulation, water samples were collected from sites located 1.0 km, 0.5 km upstream, at the boat launch, and 0.5 km, 1.0 km, 2.0 km and 4 km downstream of the boat launch (Table 1). On August 9, 2009, sampling was extended to 8 km, 16 km, and 32 km below the boat launch and on June 20, 2010, sampling was extended to 8 km and 16 km downstream from the boat launch. The latitude and longitude of each sampling site was recorded using a GPS receiver and the same locations were sampled on each date.

Water samples were collected in a VOC sampler developed by the U.S. Geological Survey and constructed by Wildco, Incorporated (Shelton 1997). Samples were collected adjacent to the stream thalweg at mid depth off of the bow of the boat and at least 5 minutes after the motor had been turned off. Samples were collected in clean 40 ml amber bottles with Teflon caps. Duplicate samples were collected at each site. Samples were preserved with 2 drops of HCl and placed within a cooler with a frozen gel pak to keep samples at a temperature below 10° Celsius. The sampler was rinsed three times with stream water at each sampling location prior to sample collection. A field blank was collected using the sampler and well water available adjacent to the boat launch following stream sampling. A trip blank made of commercial drinking water was transported in the cooler with the water samples. Water samples were shipped overnight by Federal Express to AM Test, Incorporated (Kirkland, Washington) for analyses. Samples were analyzed for benzene, toluene, ethyl-benzene and total xylene (BTEX) by EPA method 624. TAH was calculated as the sum of the concentrations of these constituents (μg/L). TAH concentrations were evaluated relative to the state numeric standard for aquatic life of 10 μg/L (ADEC 2006, 18 AAC 70).

Stream discharge was measured on each sampling date at LS-1 (1.15 km upstream from the boat launch). Water velocity was measured at 0.6 x stream depth with a Swoffer 3000 velocity meter and top-set rod (Swoffer Instruments Inc.). Water velocity, depth, and distance were measured approximately every 2 meters with more frequent measures collected within the thalweg. Discharge was calculated as the sum of component measures (Rantz et al. 1982).

Objective 3. Daily variability in TAH concentrations.

Intensive sampling was conducted during the peak coho and Chinook fisheries. On August 8, 9, and 10, 2009, and June 19 and 20, 2010 samples were collected every three hours from 06:00 to 21:00 (06:00 to 15:00 on August 10). Early morning sampling was designed to occur prior to the majority of boat activity, and at 21:00 as boat activity decreased. Samples were collected downstream from the PUF boat launch (LS-3) and accessed by foot. Otherwise, sample collection, preservation, handling and analyses were conducted as described previously. Concentrations were plotted over time to determine daily change. Daily change in concentration was compared to boat use (see boat use surveys below) between sampling periods.

Table 1. Water quality sampling locations.

Name	Sample Collection	Distance from PUF Launch km/mi*	Latitude	Longitude
LS-1	Water Sampling Station, Discharge Transect	1.15/0.71	61.44245	-150.15931
LS-2	Water Sampling Station	0.44/0.27	61.44236	-150.16751
LS-3	Water Sampling Station	0.00	61.43783	-150.17386
LS-4	Water Sampling Station	-0.51/-0.32	61.43520	-150.17470
LS-5	Water Sampling Station	-1.35/-0.84	61.43345	-150.17239
LS-6	Water Sampling Station	-2.01/-1.25	61.43076	-150.18345
LS-7	Water Sampling Station	-3.87/-2.40	61.42389	-150.18958
LS-8km	Water Sampling Station during intensive sampling and location of Hydrolab	-8/-4.97	61.41125	-150.20590
LS-16km	Water Sampling Station during intensive sampling	-16/-9.94	61.38027	-150.24300
LS-32 km	Water Sampling Station during intensive sampling in 2009 and 2010	-32/-19.89	61.342820	-150.27598
Millers Reach	Reference Turbidity 2008 and 2009, Continuous Turbidity Monitoring 2009	60.48/37.8	62.62180	-149.84939
PUFUP	Continuous Turbidity 2008, Invertebrate Drift, Juvenile Salmon	9.62/5.98	61.46311	-150.14569
PUFDN	Continuous Turbidity 2008 and 2009, Invertebrate Drift, Juvenile Salmon	-3.50/-2.17	61.42787	-150.18953

* Positive values are upstream and negative values are downstream from the PUF.

Objective 4. Relationship between boat use by motor type and TAH concentrations.
Observations of boat use were conducted at the PUF boat launch on each sampling date. This boat launch is the only access point for the Lower Little Susitna River so any boat operating within the sampling reach must enter the river from this location. Observations by ARRI began upon arrival, generally between 12:00 and 14:00. The observer recorded the time that a boat entered the water from the launch or approached the launch from the water. Boats were not counted more than once if they made short trips upstream or downstream after launching, but were counted twice if trips were separated by more than one hour. The observer recorded the size (horsepower), make, and type of motor (2-cycle, 2-cycle direct injection, or 4-cycle). Boat operators were interviewed in order to obtain motor type or size information when this information was not visible on the motor cowling. Time of operation within the launch area was recorded along with route of departure and activity. Observations ended upon completion of water sample collection, generally after 2 or 3 hours except during intensive sampling events. Boat observations provided an index of boat activity within the sampling reach and not a precise measure of total boat operation within the sampling reach. Boats launching prior to initiating surveys operated within the sampling reach but were not counted, and hydrocarbons discharged from boats counted near the end of the survey would not contribute to sample concentrations. We also did not record total time each boat operated within or upstream of the sampling reach.

Regression and correlation analyses were used to evaluate the relationship between boat use by motor type and TAH concentrations. Boat observations during sampling were divided by observation time to get values for total boats; 4-cycle, 2-cycle direct injection, and 2-cycle motors/hr. TAH concentrations were multiplied by stream discharge to obtain flow-corrected values in mg/s or TAH flux. This eliminated the variability in concentrations due to dilution by stream flows. Linear and multiple linear regressions were used to investigate flow-corrected TAH concentrations as a function of boat use per hour by motor type. We also used correlation to test relationships independent of scale. TAH and boat observation data collected from July 2008 to present were used in the regressions. Flow-corrected TAH values were 3 to 4 times higher than all other dates on August 2 and August 10, 2008 and were considered outliers. Data from these two dates were excluded from analyses providing 28 points for comparison. Multiple linear regressions used 4-cycle boats followed by 2-cycle boats/hour. The changes in flow-corrected TAH as a function of motorboat counts by motor type were modeled using second-order Akaike's information criterion (AIC) for small samples (Burnham and Anderson 2002). AIC analyses were conducted by Dr. Rinella (University of Alaska Anchorage, Environment and Natural Resources Institute).

Further tests of the effects of 2-cycle motors were conducted by testing for a significant regression relationship between the portion to boats using 2-cycle motors and TAH discharge as gallons/boat. These tests differed from regression analyses described above by using the portion of 2 cycles rather than the number of boats with 2-cycle motors launching per hour, thereby reducing the influence of other boats. Testing this hypothesis addresses the question of whether the reduction in 2-cycle motors would reduce fuel discharge per boat. Fuel discharge as gallons/boat was calculated by multiplying TAH times discharge (mg/s) by 2.71 (Oasis 2007) to obtain gasoline discharge (g/s). Gasoline discharge was divided by the density of gasoline (737,000 mg/L) to obtain gasoline discharge in L/s. Gasoline discharge in L/s was converted to gallons/hr, and divided by boat observations/hr to obtain discharge in gallons of gasoline/boat.

Gasoline Discharge per Boat (gal/boat)	=	TAH (mg/L)	X	Stream Flow (L/s)	X	2.71 (Ratio of Gas to TAH)	/	Density of Gas (737,000 mg/L)	X	0.2642 (Liters to Gallons)	X	3600 (seconds to hours)	/	Boats/hr

Objective 5. Estimate total number of days TAH concentrations exceeded water quality standards.
Regression equations between total boat counts/hour and flow-corrected TAH concentrations were used to estimate the number of days TAH concentrations exceeded state standards. We estimated boat counts/hour for days when surveys were not conducted through regressions between boat observations during sampling and boat counts obtained at the launch entrance booth. Entrance booth counts were available for most days from May through September of 2008 and 2009.

Turbidity

Objective 6. Determine whether state water quality standards for turbidity were exceeded.
State water quality standards for "Turbidity, For Fresh Water Uses" (18 AAC 70) are relative to "natural condition" values. The most stringent standard, (A)(i) water supply drinking, culinary, and food processing, requires that turbidity "may not exceed 5 nephelometric turbidity units (NTU) above natural conditions when the natural turbidity is 50 NTU or less, . . ." Similar relative standards apply to other designated uses. For secondary contact recreation, turbidity cannot exceed 10 NTU above natural conditions, and for aquaculture or the growth and propogation of fish, turbidity cannot exceed 25 NTU above natural conditions. "Natural Condition means any physical, chemical, biological, or radiological condition existing in a waterbody before any human-caused influence on, discharge to, or addition of material to, the waterbody." The Alaska Department of Environmental Conservation has developed guidance and statistical tools used to define the natural condition (ADEC 2006, ADEC 2010a). Further guidance is provided by ADEC for evaluation of potentially impaired waters in the "Integrated Water Quality Monitoring and Assessment Report." Continuous data from upstream and downstream reference and treatment sites is preferred. If more than 10% of the samples exceed the turbidity criteria, the waterbody is considered for assignment to Category 5 (ADEC 2011).

Turbidity was measured from grab samples collected concurrent with TAH sampling and from measures using Hydrolab MS5 probes. Reference grab samples for turbidity were collected below Houston at Millers Reach access road. Grab samples were collected at each sampling location (LS-1 through LS-7) on each sampling date. In addition, during intensive sampling, grab samples for turbidity were collected at 4 locations nearshore to mid channel.

Turbidity from grab samples were analyzed using samples collected from July 2008 through June 2010. Paired t-tests were used to test for significant differences between the reference site and the 7 sampling locations. Grab samples were collected at the reference site in Houston on the same day as the sampling locations near the PUF, so resulting turbidity could not be offset by the flow times between reference and sampling stations. We counted the total number of days turbidity differed from the reference site by 5 NTU and 10 NTU. T-tests were used to test for differences in turbidity between low and high boat use periods.

In 2008, Hydrolab MS5 multiprobes were deployed for hourly turbidity monitoring at stations approximately 9 km upstream (PUFUP) from the PUF boat launch and 3.5 km downstream (PUFDN). The PUFUP site was selected in 2008 as a reference turbidity location; however, due to occasional boat activity from the PUF at this location, the site was relocated in 2009 to upstream of Millers Reach and below Houston and the Parks Highway Bridge. In August of 2009 and in May 2010 a third Hydrolab was placed at 8 km downstream from the PUF. There are no major tributaries or natural sources of turbidity between the reference site and the potentially impacted site. Loggers were calibrated prior to deployment and set to record water temperature hourly. Loggers were suspended vertically within the water column with the probe at approximately 0.66 times water depth. Loggers were deployed in the middle to end of May, removed the end of June, redeployed in the middle of July and removed in early September. Loggers were checked approximately every 3 weeks, cleared of any debris, downloaded, and batteries changed. We deleted all data points from both sites when turbidity was greater than 1000 NTU. These data points were not associated with any consistent increase in turbidity and were believed to be due to debris accumulating on the probe. Values over 1000 NTU were less than 0.1% of total recorded measures. The data also were analyzed after removing all data points greater than 300 NTU. There were 15 data points greater than 300 or 0.03%.

Hourly turbidity data from the reference location were loaded into the "Alaska Statistical Spreadsheet Tool for Natural Conditions Evaluation version 2" (ADEC 2010). Data were submitted for the *W* test for normality but did not require trimming to meet statistical assumptions. Data were corrected for serial correlation. Turbidity met the minimum data requirement of two years. Data also were analyzed for two seasons, June and August, corresponding to boat use during the Chinook and coho fisheries. Natural condition values were used to evaluate compliance with state water quality standards from turbidity data collected downstream from the PUF boat launch. Turbidity was collected using the same equipment and methods as at the reference location. Data management was the same with all data points over 1000 NTU removed, and then an adjusted data set with all values over 300 NTU removed. The percentage of samples were counted at the site 4 km below the boat launch that were 5, 10, and 25 NTU above natural conditions.

In addition, paired t-tests were used to test ($\alpha = 0.05$) for differences in average daily turbidity between the reference site and the site located 4 km below the PUF for 2009 and 2010 independently. Comparisons were offset by one day (calculated from distance and average velocity) to account for flow time between the two locations. The total numbers of days were counted when the difference in turbidity between the reference site and the site located 4 km below the PUF was greater than 5 NTU and 10 NTU. Regression analyses were used to test for significant relationships between boat counts at the entrance booth and differences in average daily turbidity.

Biotic Assessment

Objective 7. Test for differences in macroinvertebrate drift and juvenile salmon abundance between high and low boat use areas

Macroinvertebrates were sampled on August 8, 2009 and June 18, 2010 in drift nets (283 μm mesh, 45.7 x 30.5 cm opening) at PUFUP and PUFDN. Drift sampling was conducted following the methods described in Davis et al. 2001. A series of three nets were deployed across the channel 10 to 20 cm below the water surface. Water flow into the nets was measured with a General Oceanics flow meter centered in the net opening. Nets remained in the water until there was a visible decrease in flow due to accumulated biomass on the mesh. All material within the nets was transferred to 500-ml Nalgene bottles and preserved with ethyl-alcohol. Samples were sorted and identified to genus. One tailed T-tests (alpha 0.05) were used to test for differences in drift abundance (organisms/m3) between samples collected at PUFUP and PUFDN (n = 3). Paired T-tests (alpha 0.05) were used to test for differences in drift using average values from spring and fall samples collected from August 2008 through June 2010 (n = 4).

Juvenile salmon were sampled concurrent with macroinvertebrate drift. Ten baited (salmon roe) minnow traps were placed in low velocity areas near or under cover along an outside bend. Each trap was approximately 5 meters from the next nearest trap. Traps remained for 20 to 21 hours. Fish traps were emptied into plastic buckets with stream water and fish anesthetized with MS222. All fish were identified to species, and all salmonids measured to fork length. Catches from each trap were recorded individually to provide catch per unit trap (CPUT) values. One tailed T-tests (alpha 0.05) were used to test for significant differences in average CPUT between traps placed 9.6 km above the boat launch (PUFUP) and 3.5 km below the boat launch (PUFDN) (n = 10). Paired T-tests (alpha 0.05) were used to test for differences in average upstream and downstream CPUT for 4 sampling dates, fall and spring from August 2008 through June 2010 (n = 4).

Results

Total Aromatic Hydrocarbon Concentrations

Objectives 1 and 2. Evaluation of state standards and evaporative loss.

Concentrations of TAH for state fiscal years FY 09 and FY10 for the 7 sampling locations are shown in Table 2 and Figure 2. In the fall of 2008 and spring of 2009 (FY09), 24 of 105 samples collected (23%) exceeded the state standard of 10 μg/L. The total number of exceedances during fall 2009 and spring 2010 sampling (FY10) decreased to 7 of 91 samples collected (8%). In FY09, TAH concentrations exceeded 10 μg/L on 3 or 4 of the 15 sampling dates, depending on the sampling site; however, using the average of site LS-3 to LS-7 (sampling locations below the boat launch), average TAH concentrations exceeded state standards on 5 sampling dates. In FY10, TAH concentrations exceeded 10 μg/L on 0 to 3 of the 15 sampling dates (20%), depending on the site; however, average TAH concentrations (average of the 5 sampling locations below the launch) exceed state standards for petroleum hydrocarbons on 1 of the 15 sampling dates (7%). This was on June 13, 2010, during the peak of the Chinook salmon fishery. Samples also were collected every 3 hours from 06:00 to 21:00 on August 8 and 9 and from

06:00 to 15:00 on August 10. At least one sample on each of these dates also exceeded standards. The average of all daily measures exceeded standards on August 8 but not August 9 or 10 (see Figure 4).

Table 2. TAH concentrations (µg/L) for all FY09 and FY10 sampling dates and sites, with exceedances for each year. 'Average' is the average value for sampling locations LS-3 through LS-7 (including LS-7 duplicate), downstream from the boat launch. 'Flow' is discharge measured at LS-1 and in cubic feet per second.

Date	LS-1	LS-2	LS-3	LS-4	LS-5	LS-6	LS-7	LS-7D	Average	Flow
7/27/2008	2.8	3.6	2.5	2.1	2.0	2.4	3.6	6.8	3.2	482
8/02/2008	17.2	16.1	18.1	12.4	23.9	18.3	17.6	17.7	18.0	318
8/10/2008	13.2	16.1	23.5	30.8	26.1	28.3	27.7	28.1	27.4	401
8/13/2008	4.3	4.2	6.2	5.2	11.1	16.5	10.7	13.7	10.6	378
8/17/2008	26.2	27.1	27.9	22.3	2.5	0.0	4.8	7.3	10.8	311
8/24/2008	6.9	6.8	6.8	10.4	8.4	7.5	9.3	9.3	8.6	520
8/30/2008	ND	ND	ND	ND	ND	ND	ND	0.0	0.0	414
9/06/2008	ND	ND	ND	ND	ND	2.9	ND	5.6	1.4	344
5/17/2009	ND	ND	ND	1.0	ND	ND	ND	0.0	0.2	315
5/24/2009	3.1	4.2	8.3	6.8	5.0	9.2	6.9	4.5	6.8	361
5/31/2009	ND	ND	3.7	ND	ND	1.4	3.6	3.2	2.0	713
6/07/2009	ND	3.2	10.4	9.1	9.7	9.3	12.7	9.6	10.1	497
6/14/2009	1.9	2.2	5.3	5.4	4.5	5.8	2.9	6.0	5.0	335
6/21/2009	3.3	1.9	1.2	1.8	3.0	3.9	3.1	3.4	2.7	314
6/28/2009	1.8	1.8	2.3	5.4	4.6	4.6	5.2	4.8	4.5	375
7/19/2009	1.4	ND	14.1	6.5	4.9	4.6	2.6	4.1	6.1	482
7/26/2009	2.2	2.7	3.8	4.4	15.7	7.1	10.1	11.5	8.8	318
8/02/2009	ND	3.6	5.0	1.8	5.6	2.0	5.3	6.0	4.3	401
8/09/2009	5.4	4.5	5.0	5.3	7.4	9.0	8.3	14.1	8.2	378
8/16/2009	2.2	2.3	4.7	6.7	5.4	5.3	5.5	5.6	5.5	311
8/23/2009	1.3	1.5	1.6	1.7	1.3	2.1	5.6	2.8	2.5	520
8/30/2009	3.4	3.1	1.6	3.6	3.3	3.8	1.8		2.8	414
9/05/2009	1.3		1.0				4.1		2.6	344
5/15/2010	ND	ND	ND		8.8	4.9	2.8	2.9	3.9	315
5/23/2010	ND	1.3	5.6		11.7	3.0	3.4	3.0	5.4	361
5/30/2010	4.2	4.2	4.9		2.6	2.2	4.7	7.9	4.5	713
6/06/2010	2.6	4.6	5.5		6.0	9.4	9.5	8.4	7.8	497
6/13/2010	8.7	6.2	15.8		13.9	13.7	8.5	8.1	12.0	335
6/20/2010	2.0	2.1	2.5		2.8	4.2	6.3		3.9	314
6/27/2010	2.7		3.1				2.3		2.7	375
Number	30	29	30	22	29	29	30	26	30	30
FY09 >10	3	3	4	4	3	3	4	3	5	
FY10 >10	0	0	2	0	3	1	1	2	1	
Combined	3	3	6	4	6	4	5	5	6	

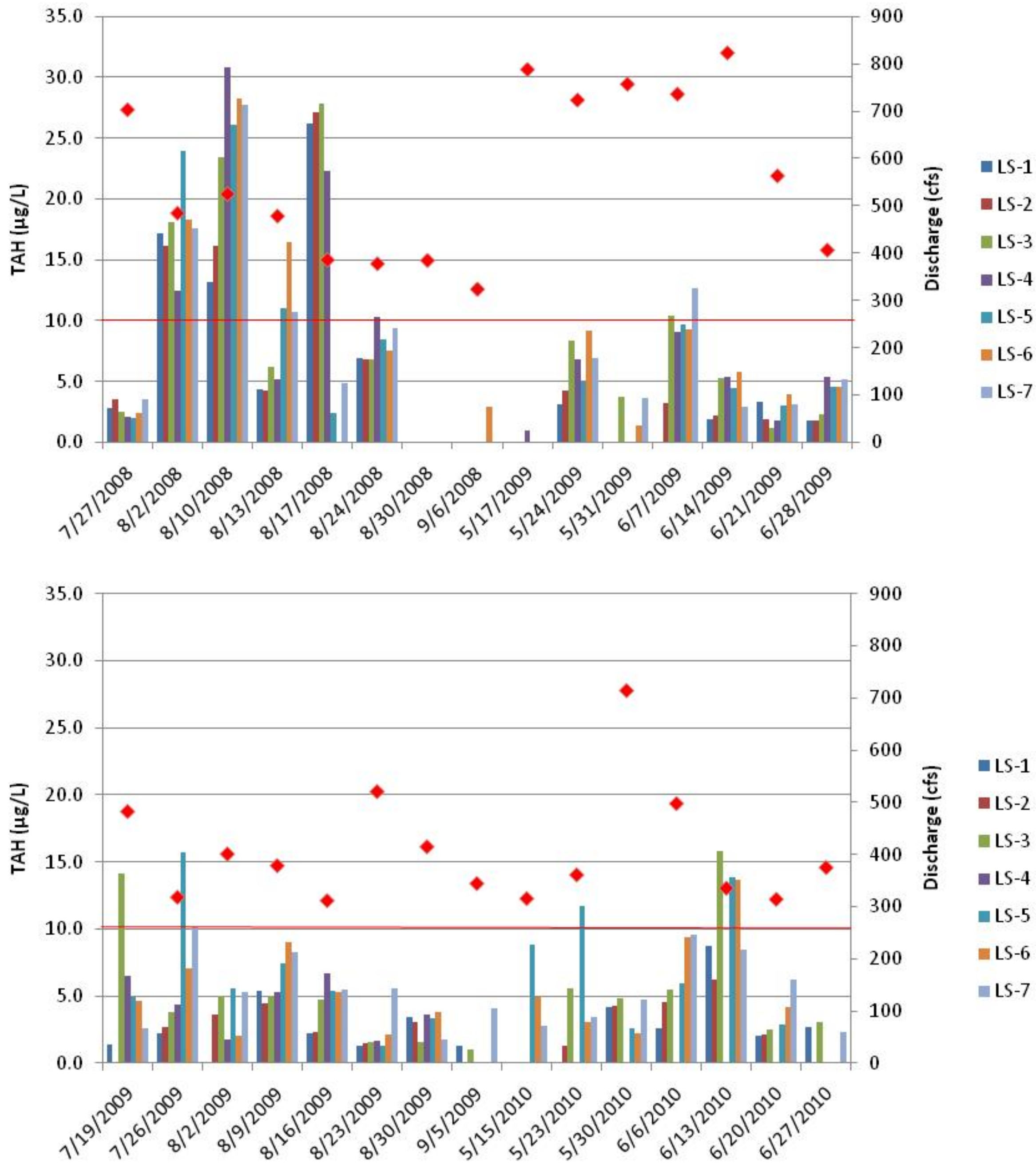


Figure 2. TAH concentrations for the sampling locations for all sampling dates in FY09 (top) and FY10 (bottom). Red line denotes state water quality standard for aquatic life at 10 µg/L. Red diamonds are LS-1 discharge.

There is no consistent change in concentrations of TAH from the boat launch at the PUF to the sampling location 4 km downstream. Paired t-tests were used to test for differences in TAH concentrations between the boat launch and the furthest downstream sampling location (LS-7, 4 km downstream) using all measures from July 2008 through June 2010 (N=30). There was no significant difference in TAH concentrations between these two sampling sites (p = 0.90). During peak use periods on August 9, 2009 and June 6, 2010, concentrations tended to increase when sampling was extended downstream 16 km below the PUF (Figure 3).

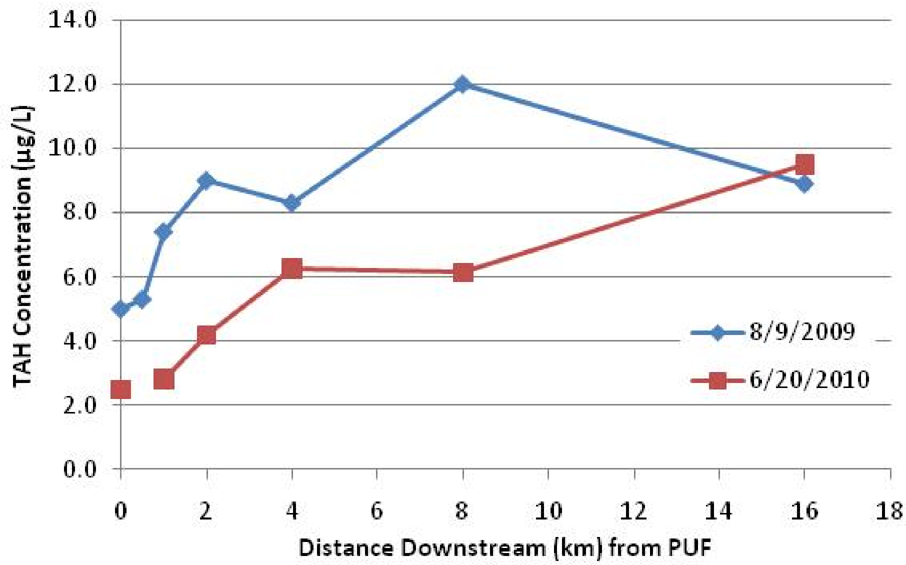
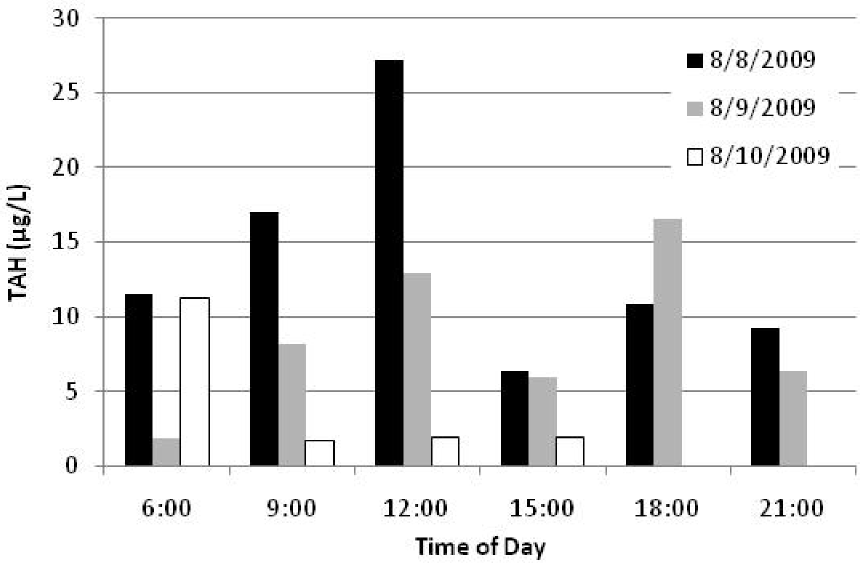


Figure 3. TAH concentrations downstream from the PUF boat launch during peak use periods.

<u>Objective 3. Daily variability in TAH concentrations.</u>

Concentrations of TAH at the boat launch varied throughout the day but not in a consistent pattern (Figure 4). On 4 of the 5 sampling dates TAH concentrations were above detection limits at 06:00 hours. On August 8 and August 9 (intensive sampling weekend) concentrations tended to increase until 12:00 noon, decline by 15:00 and peak again at 18:00. A similar trend was observed on June 20 (Sunday), with a morning (09:00) and late afternoon (18:00) peaks in daily TAH concentrations. This trend did not repeat on August 10 (Monday) or June 19, 2010 (Saturday).

Correlation and regression analyses were used to evaluate the relationships between TAH at the boat launch, boat use by motor type, and direction of travel using all data collected during intensive sampling events. Short-term changes in flow-corrected TAH at the boat launch were correlated closest with the number of boats with two-cycle motors launching between sampling events. Pearson correlation coefficients were 0.6, 0.2 and 0.5 for boats with 2-cycle, 4-cycle, and total boats, respectively. The regression relationship between flow-corrected TAH and boats using 2-cycle motors was significant (p = 0.003, N=23); however, the relationship explained only a small portion of the variability (R^2 = 0.35).



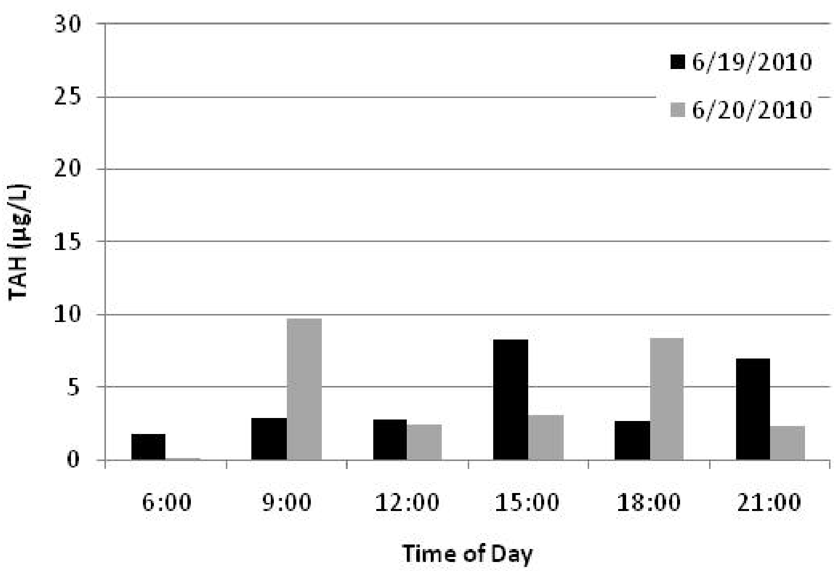


Figure 4. Daily variability in TAH concentration at LS-3 during intensive sampling in August 2009 and June 2010.

<u>Objective 4. Relationship between boat use by motor type and TAH concentrations.</u>

The number of boats counted launching at the PUF by motor type during fall 2009 and spring 2010 sampling are shown in Table 3. Total counts per hour during this time period ranged from 6.3/hr to 20.5/hr with an average of 12.2/hr. This is within the range of previous surveys conducted at the boat launch during sampling. Considering all sample dates from fall 2008 through spring 2010, the total number of boats operating at the PUF boat launch during TAH sampling has ranged from 3.3/hr to 23.6/hr with an average of 11.4/hr. Peak boat use occurred in early June and early August. The portion of boats using 2-cycle motors averages 40% and has ranged from 10% to 60% of the total. There has been no consistent annual change in the percent 2-cycle over time with boats using these motors accounting for 33%, 38%, and 40% for 2008, 2009, and 2010 (partial year), respectively.

Concentrations of TAH increased with boat use during sampling periods. Regression relationships between flow-corrected TAH concentrations and boat use were significant for total boats, and those using both 4-cycle and 2-cycle motors ($p < 0.05$) (Figures 5, 6, and 7). The total number of boats counted per hour during sampling explained 67 percent of variability in TAH. The number of boats using 4-cycle (including 2-cycle DI), and 2-cycle motors accounted for 57 and 54 percent of the variability in TAH. The inclusion of both 2-cylce and 4-cycle motors is supported by AIC modeling, but not the use of 2 or 4-cycle motor counts individually. Based upon the model beta values, or slopes, of 8.9 and 6.2 for 2 and 4-cycle motors, respectively, 2-cylce motors discharge approximately 1.3 times more than 4-cycle motors. A similar result is obtained by comparing regression slopes between 2 and 4-cycle motor counts shown in Figures 6 and 7.

Table 3. Total boats counted at the PUF during sampling events by motor type and direction of travel.

Date	Day	Total Count	2-Cycle	4-Cycle and 2-Cycle DI	Non Motorized	Operates Upstream	Operates Downstream	Percent 2-Cycle	Percent of Total Boat Count operating Upstream	Most Common Horse Power (mode)
7/19/2009	Sunday	28	13	11	4	12	14	46%	43%	65
7/26/2009	Sunday	31	17	12	2	14	13	55%	45%	65
8/02/2009	Sunday	36	18	17	0	11	20	50%	31%	40
8/08/2009	Saturday	59	30	28	0	22	31	51%	37%	80
8/09/2009	Sunday	51	18	32	0	14	37	35%	27%	65
8/10/2009	Monday	55	30	21	2	17	33	55%	31%	65
8/16/2009	Sunday	36	13	22	1	17	15	36%	47%	65
8/23/2009	Sunday	22	10	12	0	11	9	45%	50%	65
8/30/2009	Sunday	20	6	12	1	5	14	30%	25%	65
9/05/2009	Saturday	11	3	4	2	4	6	27%	36%	65
5/15/2010	Saturday	12	5	7	0	6	5	42%	55%	65
5/23/2010	Sunday	26	16	9	1	18	7	62%	72%	65
5/30/2010	Sunday	30	7	18	5	9	17	23%	35%	65
6/06/2010	Sunday	44	16	27	1	17	18	36%	49%	65
6/13/2010	Sunday	38	13	20	5	16	23	34%	41%	65
6/20/2010	Sunday	19	9	10	0	7	13	47%	35%	65

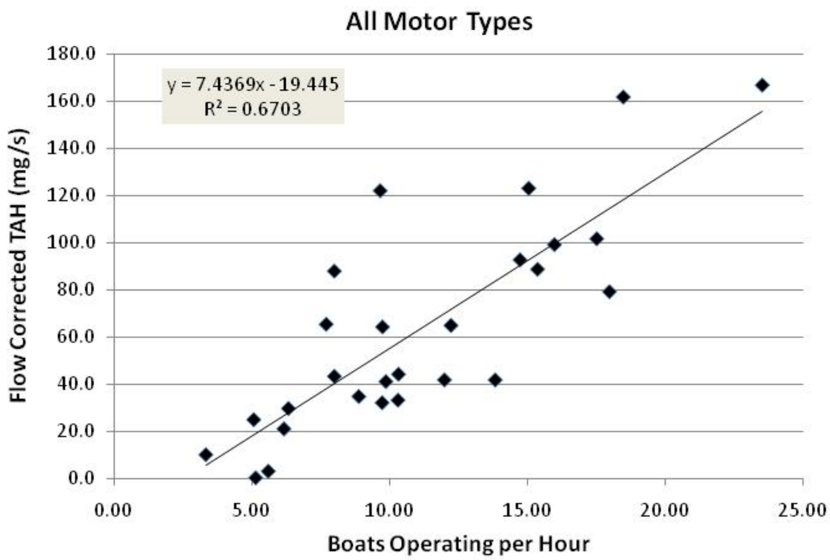


Figure 5. Regression relationship between total boats operating per hour during sampling and average (LS-1 through LS-7) flow-corrected TAH.

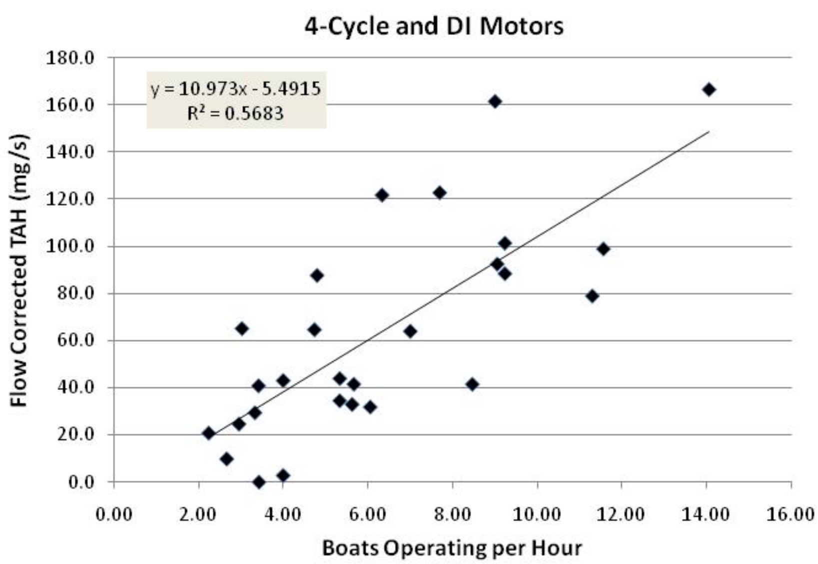


Figure 6. Regression relationship between total 4-cycle and direct inject 2-cycle boats counted per hour during sampling and average flow-corrected TAH.

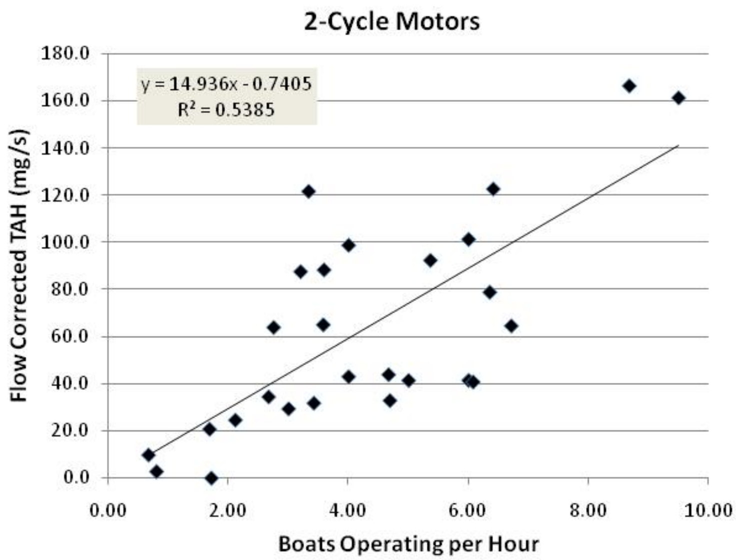


Figure 7. Regression relationship between boats with 2-cycle motors operating per hour during sampling and flow-corrected TAH.

Total TAH loading to the Lower Little Susitna River is shown in Table 4. TAH concentration was converted to volume using a density of 0.737 g/ml and TAH volumes were converted to gasoline using the ratio 0.376 (Oasis 2007). Average TAH loading is 2.0 gal/day or an estimated 5 gal/day of gasoline. TAH discharge per boat has ranged from 0.001 to 0.016 gal/boat/hr with an average of 0.007 gal/boat/hr. TAH discharge in gal/boat/hr was very similar to values estimated by Oasis (2007), which were 0.0068 gal/hr for a 4-cycle motor at half throttle. However, multiplying our 2-cycle motors/hr by the Oasis estimate for discharge from these motor types (0.0685 gal/hr average at half throttle) yielded values an order of magnitude higher than our measured TAH discharge in gal/boat/hr.

The regression relationship between percent 2-cycle motors and discharge per boat was not statistically significant ($p = 0.31$). Therefore, reducing the number of 2-cycle motors relative to the total number of boats launching is not expected to reduce fuel discharge per boat.

Objective 5. Estimate total number of days TAH concentrations exceeded water quality standards. Daily TAH concentrations were obtained using the regression relationship between total boats during observations and flow-corrected concentrations (see Figure 4). Daily boats operating per hour was estimated from the total number of boats counted at the entrance booth (Appendix B). Total boats per day entering the entrance booth were converted to boats operating per hour ($y = 0.29 + 4.27$). Total boats operating per hour was used to estimate flow corrected TAH (mg/s) ($y = 7.97 – 17.74$). TAH in µg/L were estimated by dividing by discharge at the PUF (LS-1). Daily discharge at the PUF was estimated using a regression relationship with discharge measured at LS-1 and recorded at the USGS gauge in Hatcher Pass (Figure 8). Estimated TAH concentrations for 2008 and 2009 are shown in Figure 9. Based on the model, TAH concentrations would have exceeded state standards on 2 days in 2008 and 5 days in 2009. The model was tested by comparing predicted with observed values. Modeled values underestimated measured values on August 2 and August 10, 2008, by 13 and 17 µg/L, respectively. However, these were the extreme high values that were not used in developing the regression equation. Excluding these two dates, there were 17 comparisons. The maximum absolute difference was 7 µg/L, the average difference was 2.23 µg/L, with a 95% confidence interval of 1.04 µg/L.

Table 4. TAH loading to the Lower Little Susitna River per boat operating during sampling events.

Date	TAH (mg/s)	TAH (gal/hr)	TAH (gal/day)	Gasoline (gal/hr)	Gasoline (gal/day)	Total Boats /hr	TAH (gal/Boat)	Portion 2-Cycle
7/27/2008	64.00	0.083	1.982	0.220	5.27	9.8	0.008	0.28
8/13/2008	121.78	0.157	3.772	0.418	10.03	9.7	0.016	0.34
8/17/2008	161.50	0.208	5.002	0.554	13.30	18.5	0.011	0.51
8/24/2008	87.67	0.113	2.716	0.301	7.22	8.0	0.014	0.40
9/06/2008	9.82	0.013	0.304	0.034	0.81	3.3	0.004	0.20
5/17/2009	2.79	0.004	0.086	0.010	0.23	5.6	0.001	0.14
5/24/2009	122.80	0.158	3.803	0.421	10.12	15.1	0.011	0.43
5/31/2009	31.85	0.041	0.987	0.109	2.62	9.7	0.004	0.35
6/07/2009	166.56	0.215	5.159	0.572	13.72	23.6	0.009	0.37
6/14/2009	98.92	0.128	3.064	0.340	8.15	16.0	0.008	0.25
6/21/2009	43.06	0.056	1.334	0.148	3.55	8.0	0.007	0.50
6/28/2009	43.93	0.057	1.361	0.151	3.62	10.3	0.005	0.45
7/19/2009	65.15	0.084	2.018	0.224	5.37	7.7	0.011	0.46
7/26/2009	64.65	0.083	2.002	0.222	5.33	12.2	0.007	0.55
8/02/2009	41.52	0.054	1.286	0.143	3.42	12.0	0.004	0.50
8/09/2009	78.95	0.102	2.445	0.271	6.50	18.0	0.006	0.35
8/16/2009	41.51	0.054	1.286	0.142	3.42	13.8	0.004	0.36
8/23/2009	32.94	0.043	1.020	0.113	2.71	10.3	0.004	0.45
8/30/2009	34.51	0.045	1.069	0.118	2.84	8.9	0.005	0.30
9/05/2009	20.78	0.027	0.643	0.071	1.71	6.2	0.004	0.27
5/15/2010	24.65	0.032	0.764	0.085	2.03	5.1	0.006	0.42
5/23/2010	40.86	0.053	1.266	0.140	3.37	9.9	0.005	0.62
5/30/2010	88.44	0.114	2.739	0.304	7.28	15.4	0.007	0.23
6/06/2010	92.47	0.119	2.864	0.317	7.62	14.7	0.008	0.36
6/13/2010	101.39	0.131	3.140	0.348	8.35	17.5	0.007	0.34
6/20/2010	29.43	0.038	0.911	0.101	2.42	6.3	0.006	0.47
Max	166.56	0.215	5.159	0.572	13.72	23.6	0.016	0.62
Min	2.79	0.004	0.086	0.010	0.23	3.3	0.001	0.14
Ave	65.84	0.085	2.039	0.226	5.42	11.4	0.007	0.38

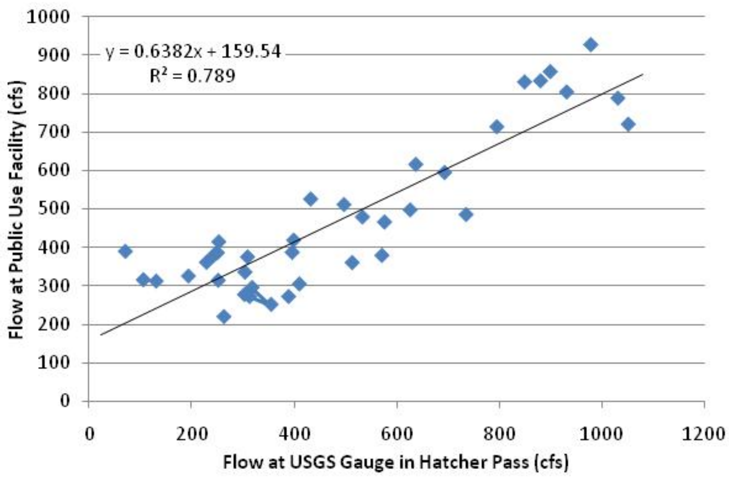


Figure 8. Regression relationship between Hatcher Pass flow and flow at the PUF 3-days later.

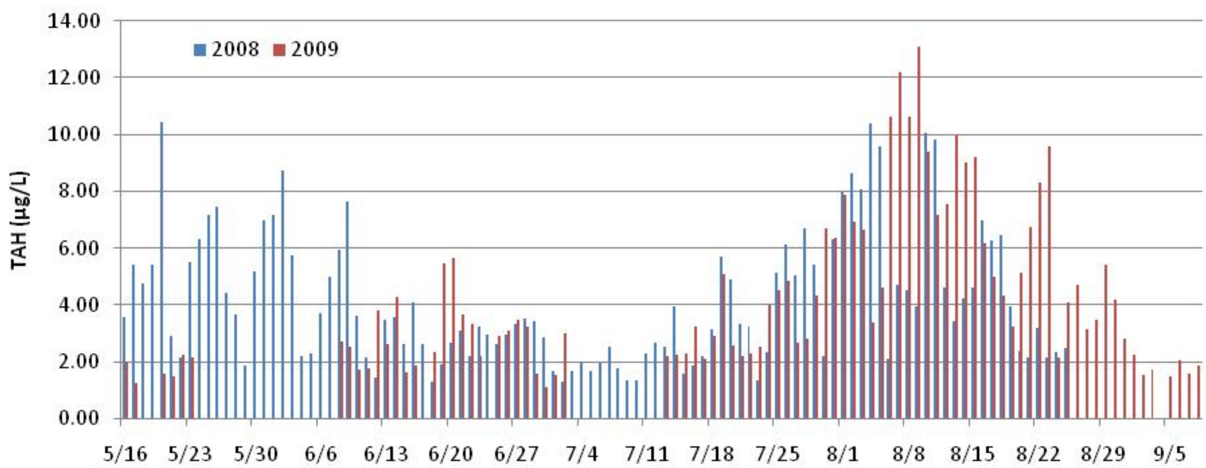


Figure 9. Estimated daily TAH concentrations in the Lower Little Susitna River for 2008 and 2009 based upon the number of boats entering the launch and river flows. Missing values are on days when counts were not conducted by ADNR staff at the entrance booth (see Appendix B).

Turbidity

Objective 6. Determine whether state water quality standards for turbidity were exceeded.

Turbidity from grab samples collected at the reference site ranged from 1.1 to 8.1 NTU and averaged 4.1 NTU during weekly sampling in the fall of 2009 and spring of 2010. Average turbidity at LS-3 and LS-7 for these same sampling dates averaged 8.4, and 10.7 NTU, respectively. Stream water turbidity from grab samples was significantly greater at sampling sites LS-1 through LS-7 compared to the reference site near Houston ($p < 0.05$). The difference in turbidity (site value minus reference value) for the fall 2009 and spring 2010 samples are shown in Figures 10 and 11. The number of days turbidity exceeded 5 NTU above reference values was greater for sites located further downstream from the PUF. At sites located 1.0 and 0.5 km upstream of the boat launch, turbidity was 5 or more NTU above background on 2 of the 15 sampling dates. However, at site LS-7, 4 km downstream from the launch, turbidity was greater than 5 NTU above background on 11 of the 15 sampling dates and 10 NTU above background on 4 of the 15 sampling dates. Using all samples from July 2008 through the end of June 2010 (N = 30), turbidity was significantly higher (paired t-test, $p < 0.001$) at all of the sampling sites near the PUF when compared to the reference site. Average reference turbidity was 3.7 NTU. Average turbidity at the boat launch (LS-3) was 8.8 NTU, and average turbidity was 10.7 NTU 4 km below the launch. Differences, again, were greater at the sites located further downstream. Turbidity was greater than 5 NTU above background on 6 of the 30 sampling dates at LS-1, 1 km upstream of the launch, and on 22 of the 30 dates at LS-7, 4 km downstream from the launch. The maximum difference between reference site turbidity and turbidity at LS-7 from grab samples including all sampling dates was 17.4 NTU.

Differences in turbidity were related to boat use measured at the PUF during sampling periods. The regression relationship between boat use and turbidity difference from grab samples was significant ($p = 0.02$), but explained only a small portion of the variability (Figure 12).

Turbidity was slightly higher near shore when compared to mid-channel samples. There was no significant difference in turbidity using ANOVA among samples collected from 4 locations extending from near shore to mid channel. However, there was a significant difference in turbidity between the near shore and mid-channel samples using paired t-tests. The average difference in turbidity between these two locations was 0.87 NTU.

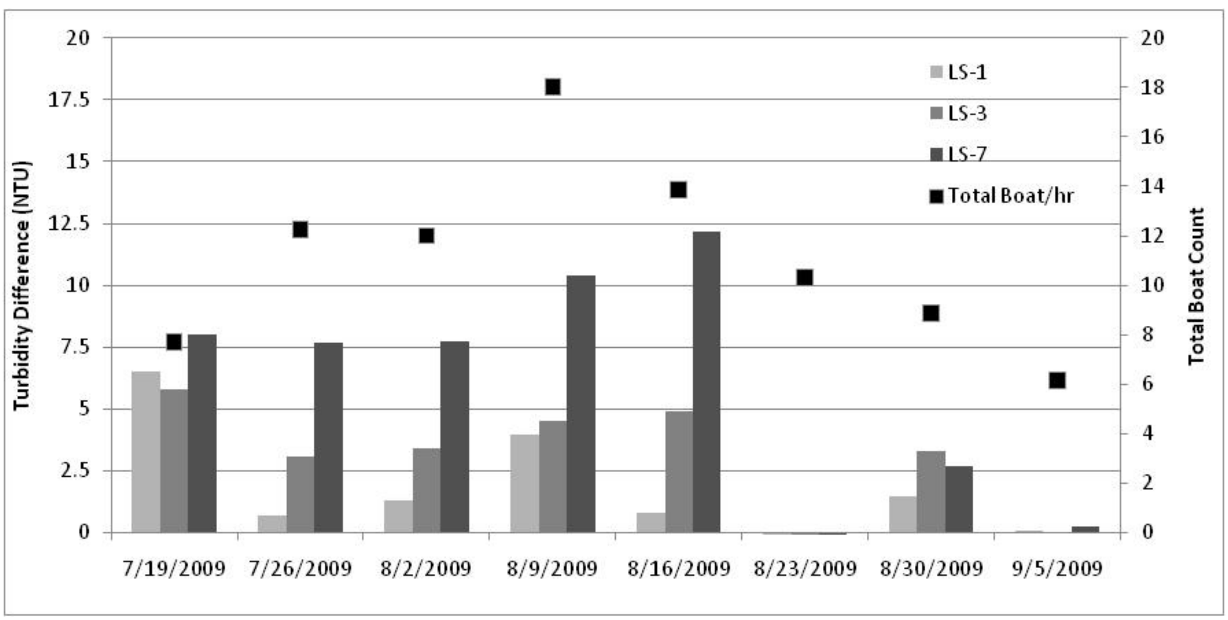


Figure 10. Differences in turbidity (site value minus reference value) between reference (Houston) and sampling sites, and total boat count per hour during fall sampling.

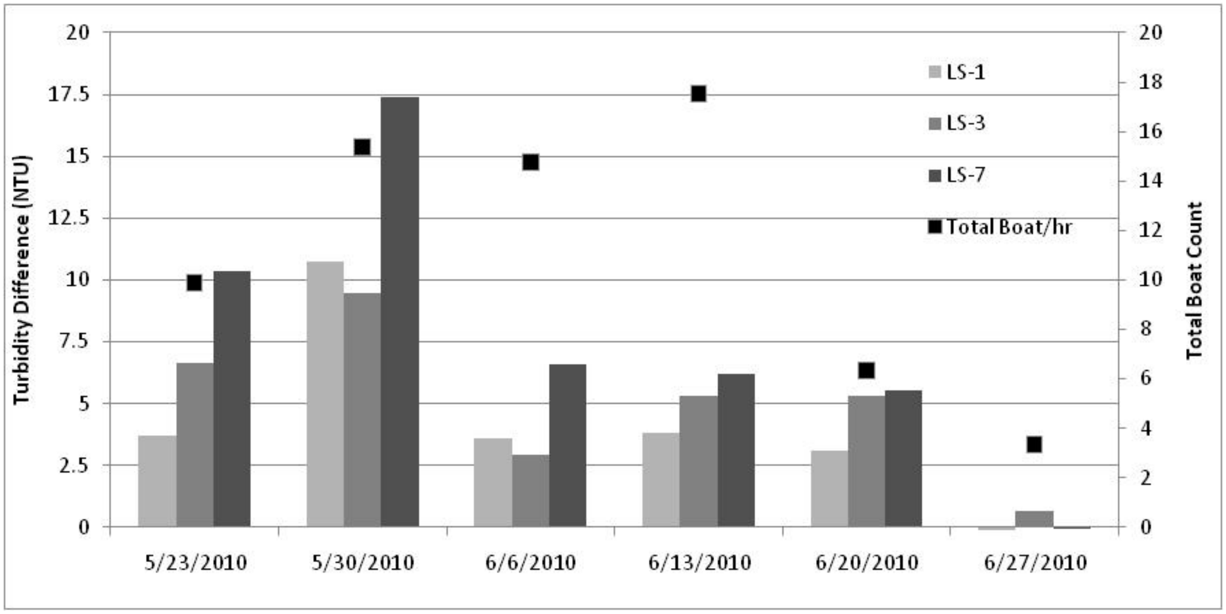


Figure 11. Difference in turbidity (site value minus reference value) between reference (Houston) and sampling sites, and total boat count per hour during spring sampling.

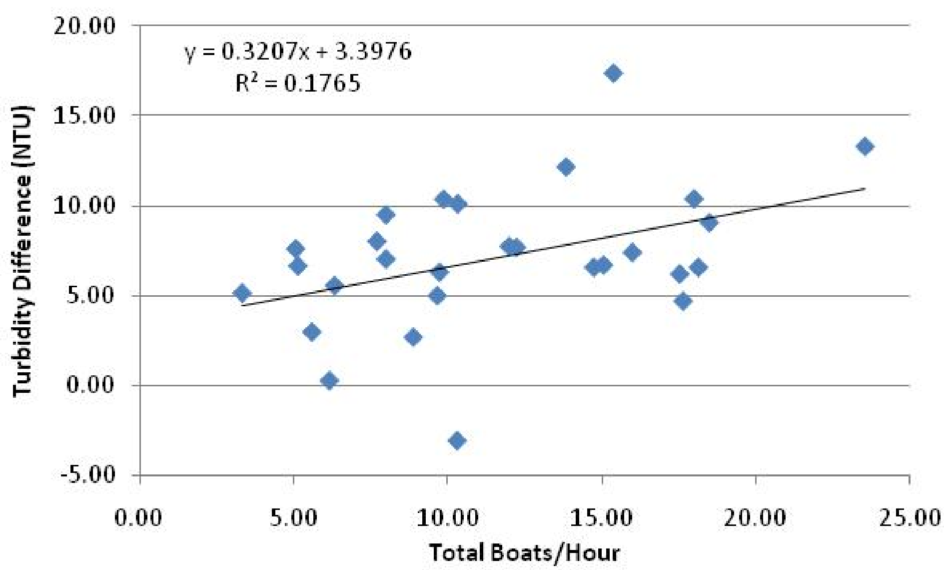


Figure 12. Regression relationship between total boats operating per hour and the difference in turbidity between the reference and the sampling site located 4 km below the launch from grab samples collected from July 2008 through June 2010.

The results of the Natural Condition analyses for the Little Susitna River reference site including all 4,609 data points from 2008 and 2009 are shown in Table 5. The natural conditions tool displays the lower 95% confidence interval of the 90^{th} percentile of the distribution as the basis for impairment determinations. The 90^{th} percentile of the distribution, using the entire data set (May 24 through September 7), is 15.7 NTU and the lower 95% confidence interval is 14.9 NTU. Results of the Natural Condition analyses for the restricted data (values > 300 NTU removed) also is shown in Table 5. Using this restricted data set, the 90^{th} percentile of the distribution is 15.4 NTU, and the lower 95% confidence interval is 14.6 NTU.

Based upon the natural condition established by this point in the distribution, state water quality standards would be exceeded (5 NTU above natural condition) when turbidity exceeds 19.9 NTU using the entire data set, or 19.6 based on adjusted data set. Natural condition analyses also were conducted for two seasons, the month of June and the month of August. These months correspond with the Chinook and coho salmon fisheries, respectively. Natural condition values (lower 95% CI for 90^{th} percentile) were lower for these two seasons at 13.8 and 13.1 NTU, respectively.

Approximately 29% of the turbidity measures 4 km below the PUF were 5 NTU above natural conditions using the entire or adjusted data sets (Table 5). This increased to approximately 39% when using data collected during peak use periods in June or August. The less restrictive standard for aquaculture or growth and propagation of fish, was exceeded over 170 times, and accounted for approximately 4% of the total values. The percentage of values that exceeded 25 NTU above natural conditions increased to 5% when using the August data set.

Since Category 5 listing is based upon the percentage of values exceeding water quality criteria, inclusion of data beyond times when impacts are expected could reduce the portion of values above state standards. To see if this influenced our results, we evaluated different portions of the data set. Turbidity below the PUF facility increases due to boat use during the sport fisheries. Most boat use is occurs from Saturday through Monday between 06:00 to 23:00. Therefore, the August data set was restricted to values collected during these time periods (Table 6). The percentage of values that exceeded the water quality criteria (5 NTU above natural conditions) increased from 40% to 47%, when using values during this restricted time period. The less restrictive criteria for growth and propagation of fish increased from 5% to 8% of the values.

Table 5. Natural condition analyses results for the Little Susitna River reference site and evaluation of water quality standard exceedances of the turbidity standard.

	Entire Data Set (values >1000 removed)	Adjusted Data Set (values >300 NTU removed)	June	August
Reference				
Total Number of Values	4,609	4,594	1,324	1,817
90% of Distribution	15.7	15.4	14.3	14.2
Natural Conditions Value	14.9	14.6	13.8	13.1
5 NTU above NC	19.9	19.6	18.8	18.1
10 NTU above NC	24.9	24.6	23.8	23.1
25 NTU above NC	39.9	39.6	38.8	38.1
4 km Below PUF				
Total Number of Values	4,280	4,257	1,324	1,486
Values 5 NTU above NC	1,228	1,252	519	589
% of Total Values	28.7%	29.4%	39.2%	39.6%
Values 10 NTU above NC	645	646	169	345
% of Total Values	15.1%	15.2%	12.8%	23.2%
Values 25 NTU above NC	174	158	19	77
% of Total Values	4.1%	3.7%	1.4%	5.2%

Table 6. Comparison of the number of values above water quality criteria for the August (2009 and 2010) data set restricted to the time periods when boat activity is greatest.

	Aug (2009 and 2010)	Aug (2009 and 2010) 0600 to 2300	Aug (2009 and 2010) 0600 to 2300 Fri, Sat, Sun, Mon
Total Number of Values	1,486	1,114	666
Values 5 NTU above NC	589	499	311
% of Total Values	39.6%	44.8%	46.7%
Values 10 NTU above NC	345	300	192
% of Total Values	23.2%	26.9%	28.8%
Values 25 NTU above NC	77	70	55
% of Total Values	5.2%	6.3%	8.3%

The cumulative frequency distribution (Figure 13) demonstrates the differences in turbidity between the reference site and the site downstream from the PUF. For example, at the reference site turbidity is less than 2 NTU 47.8% of the time; however, below the PUF turbidity is less than 2 NTU only 1.89% of the time. Another way to evaluate the distribution would be to calculate the portion of the distribution where differences in turbidity exceed a given value. For example, primary productivity is reduced by approximately 50% when turbidity is greater than 10 NTU (Lloyd et al 1987; Washington DEQ 2010). At the reference site, turbidity was less than 10 NTU 80% of the time, while at the site 4 km below the PUF boat launch turbidity was less than 10 NTU only 34% of the time. In August, turbidity was less than 10 NTU 80% of the time at the reference site, but only 25% of the time below the PUF.

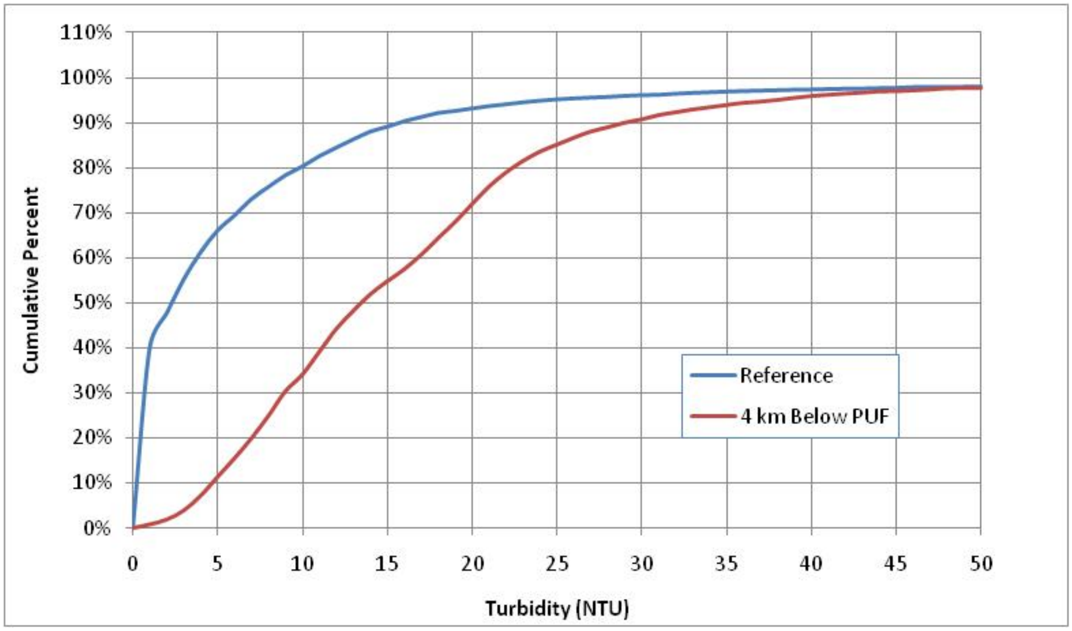


Figure 13. Cumulative turbidity frequency distributions for the reference site and the sampling location 4 km below the PUF.

Average daily turbidity at the reference site and the site located downstream from the PUF are shown in Figures 14 and 15. Average daily turbidity at the monitoring site located 4 km downstream from the PUF was significantly higher than background during 2009 and 2010 ($p < 0.001$). In 2009, average daily turbidity was more than 5 NTU above background on 71% of the days between May 24 and September 6 and 10 NTU greater on 47% of the days. In 2010, turbidity was 5 NTU greater than background on 85% of the days between May 15 and June 26, and 10 NTU greater on 55% of the days.

The increase in turbidity relative to boat use was investigated by comparing low and high boat use days and regression analyses. Boat counts at the entrance booth were used as a measure of boat activity. Differences in turbidity were compared between days with high boat use (greater than 20 boats entering the PUF) and low boat use (< 20 boats entering the booth). The average difference in turbidity between the reference site and the Hydrolab at 4 km below the launch was 13.3 NTU during high boat use and 7.7 NTU during low boat use. These means were significantly different ($p=0.0003$). During high boat use days turbidity was 5 NTU above background on 85% of the days and 10 NTU above background on 68% of the days. During low boat use days, these percentages dropped to 78% and 35% for 5 and 10 NTU, respectively.

A regression analysis was used to further evaluate the influence of boats on turbidity. The regression between total boats per day and change in average daily turbidity was significant ($p<0.001$) (Figure 16). Boat counts at the entrance booth only explained 23% of the variability in turbidity difference. This increased only slightly to 25% when discharge was added using multiple linear regression.

The daily change in turbidity was much higher downstream from the PUF compared to the reference site. Hourly turbidity measures for high use periods during intensive sampling are shown in Figure 16.

In both August of 2009 and June of 2010 turbidity downstream from the PUF decreased consistently from approximately 23:00 to 06:00 and then increased and was highly variable throughout the day. In comparison, this daily variation in turbidity was not apparent at the reference location.

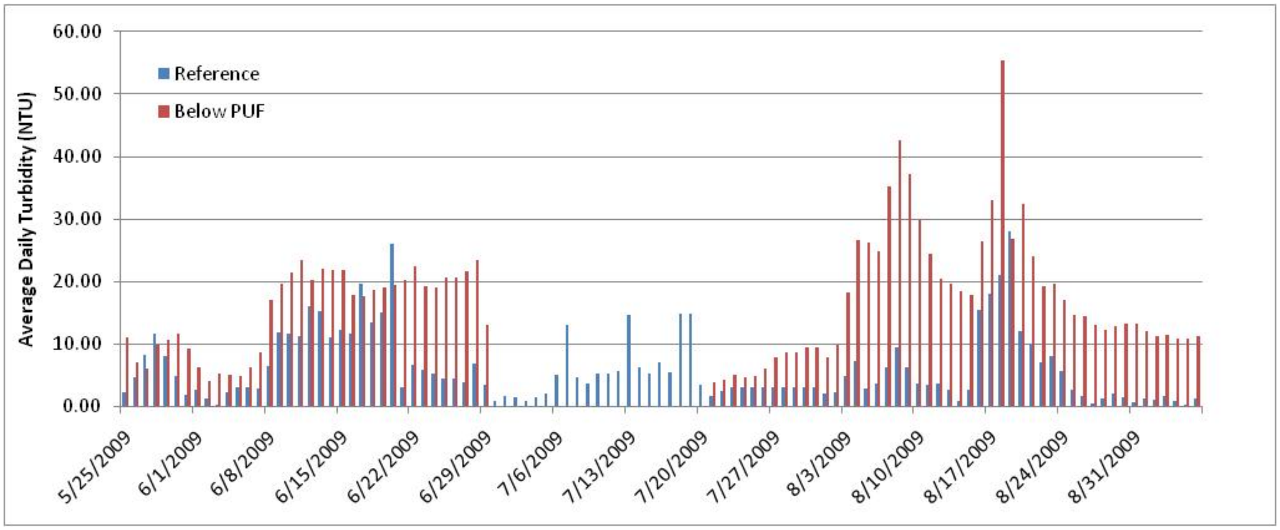


Figure 14. Average daily turbidity from hourly Hydrolab measures in 2009 at the reference site near Houston and sampling site 4 km (LS-7) below the PUF. Turbidity was not measured below the PUF from June 29 through July 20.

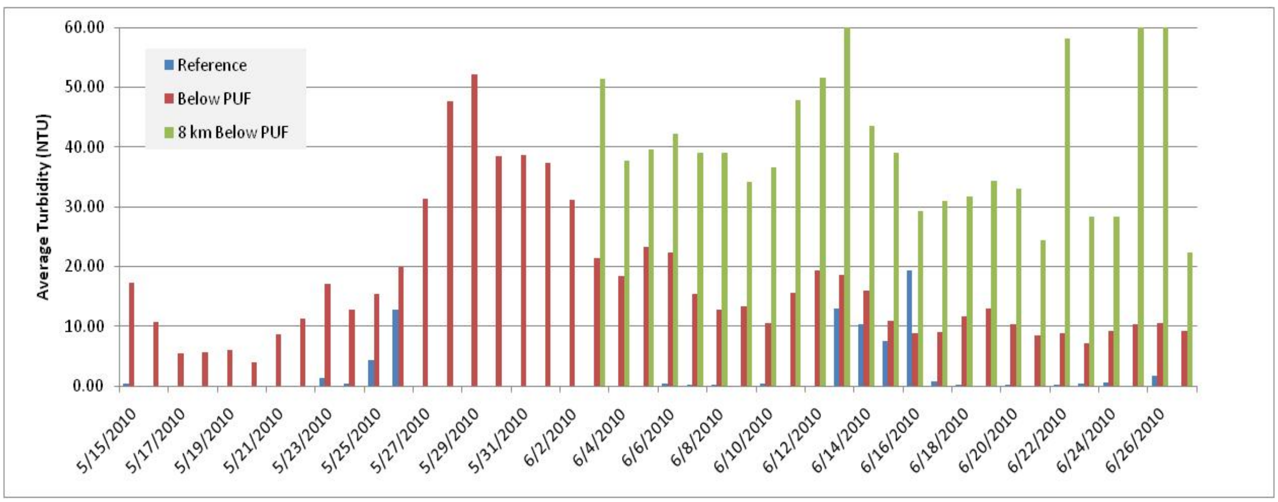


Figure 15. Average daily turbidity from hourly Hydrolab measures in 2010 at the reference site near Houston, and the sampling locations 4 km (LS-7) and 8 km (LS-8km, installed on June 3) below the PUF.

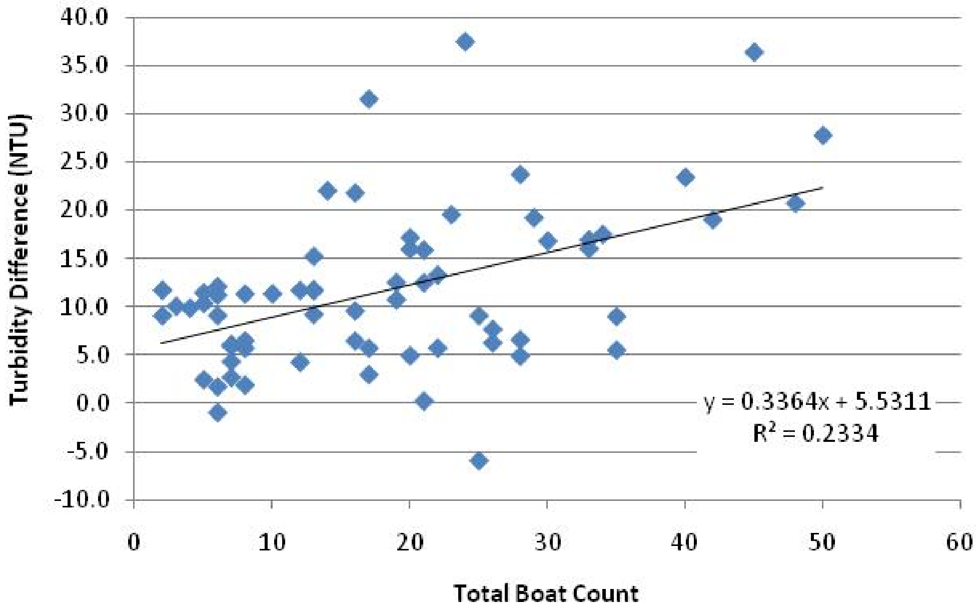


Figure 16. Regression relationship between the total boat count at the entrance booth and the difference in turbidity between the reference site at Houston and 4 km (LS-7) below the launch 2 days later.

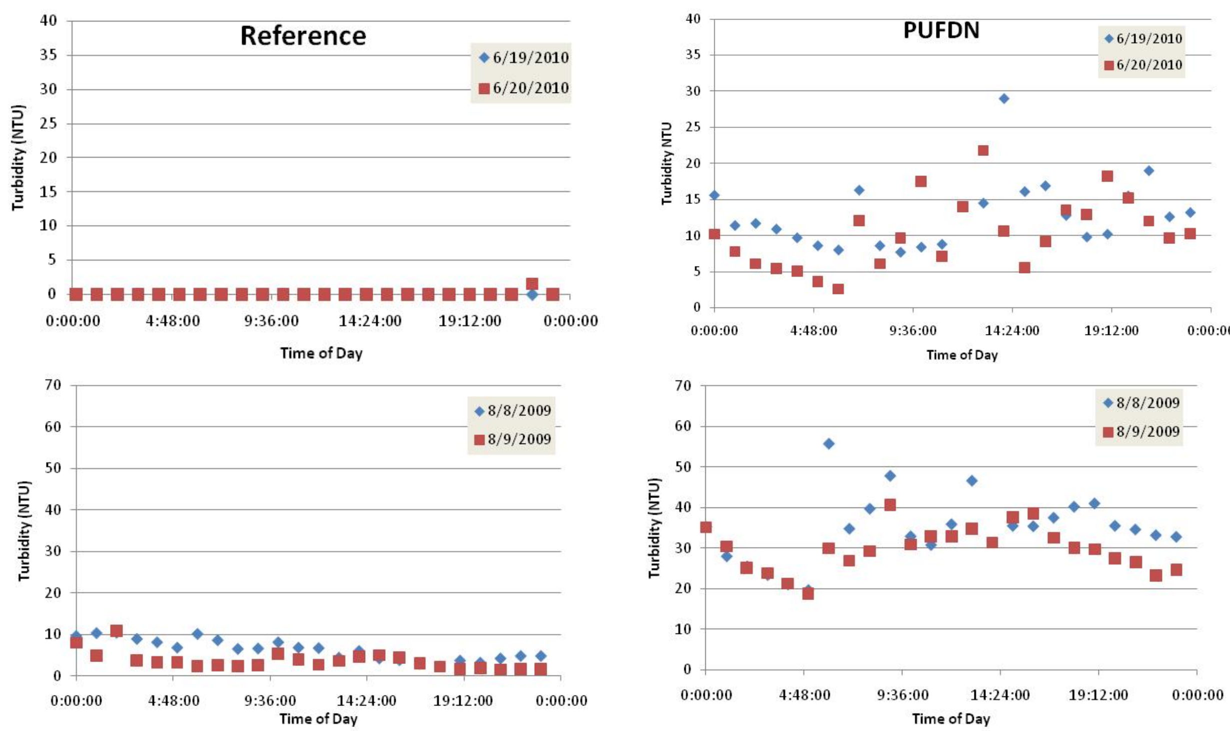


Figure 17. Hourly turbidity measures at the reference site and 4 km (LS-7) below the PUF during peak boat use in the fall of 2009 and spring of 2010, showing a linear decrease in turbidity below the PUF from approximately 23:00 to 06:00.

Biotic Assessment

Objective 7. Test for differences in macroinvertebrate drift and juvenile salmon abundance between high and low boat use areas

The abundance of invertebrates in the drift is higher 9 km upstream of the launch relative to 4 km downstream from the launch (Figure 18). Average drift is from 5 to 8 organisms per m^3 upstream and from 3 to 6 organisms per m^3 downstream. There were no differences in the relative abundance of insect orders within the drift comparing upstream with downstream. Drift abundance was significantly higher in August of 2009 ($p = 0.03$) but not in June of 2010 ($p = 0.22$). Drift abundance is significantly higher upstream ($p = 0.01$) than downstream based on paired T-tests using all sampling dates from the fall of 2008 through the spring of 2010.

The relative abundance of coho and Chinook salmon based on catch per trap, have been consistently higher upstream relative to downstream from the boat launch (Figure 19). Looking at each individual sampling date, average CPUT (n = 10) was significantly higher upstream for coho, Chinook, and total salmonids, with the exception of Chinook salmon in the fall of 2009 and coho salmon in the spring of 2010. These differences have been statistically significant for both species in the fall of 2008 and spring of 2009. Using all sampling dates (n = 4) average CPUT was not significantly higher upstream for coho ($p = 0.09$), but was for Chinook ($p = 0.04$), and total salmonids ($p = 0.04$).

Catch per trap is higher during August with an average of 25 to 45 coho per trap compared to approximately 5 during the spring. Chinook salmon show a similar trend with 5 to 10 per trap in the spring compared to 10 to 20 per trap in August.

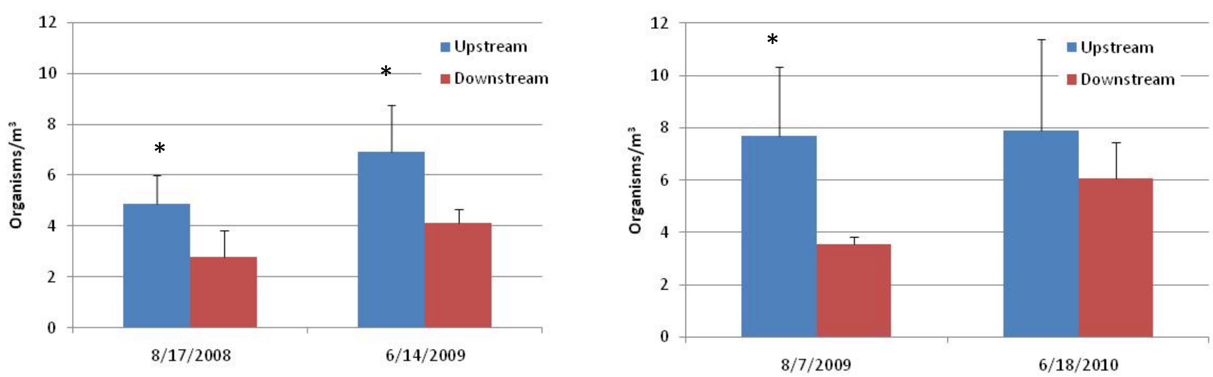


Figure 18. Average abundance of drift organisms from samples collected 9 km upstream and 4 km downstream from the PUF boat launch. Asterisks denote significant differences. Error bars are one standard deviation.

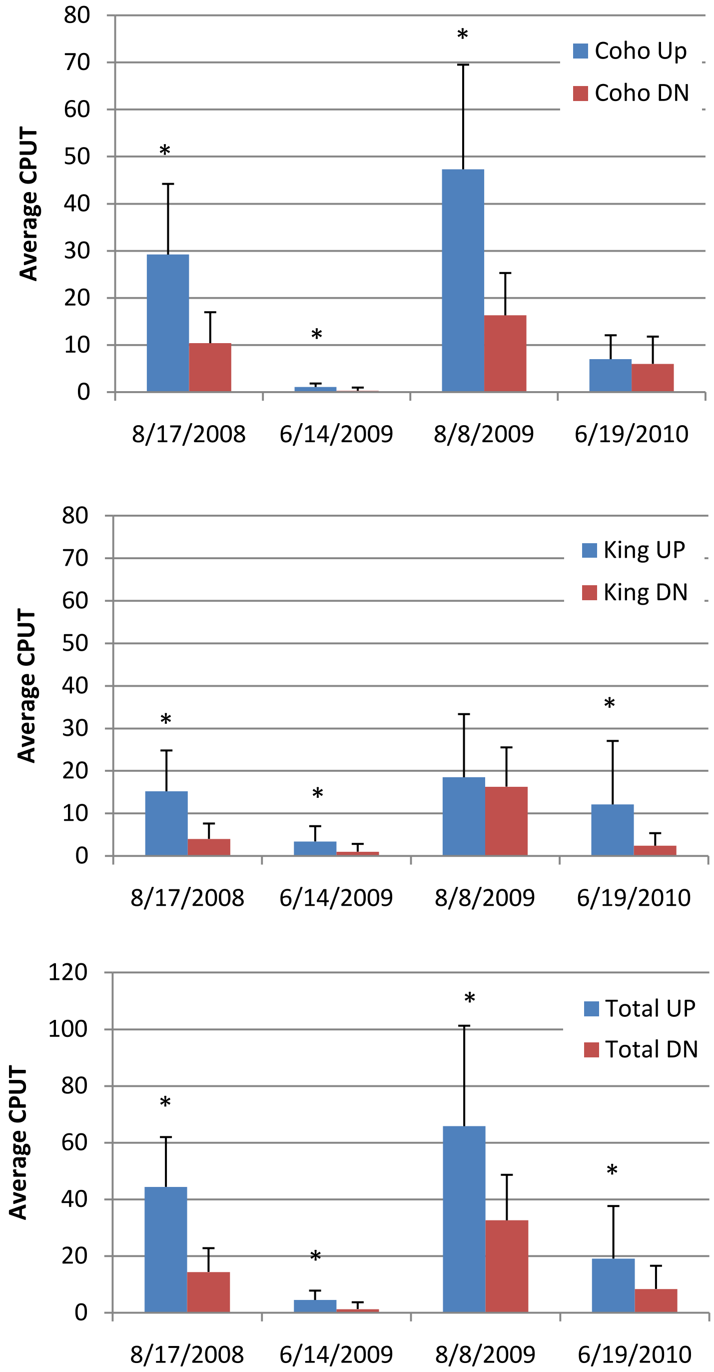


Figure 19. Average coho, Chinook (King), and total salmon CPUT(n=10) on 4 sampling dates 9.6 km upstream and 3.5 km downstream from the boat launch. Asterisks denote significant differences. Error bars are one standard deviation.

Discussion

Motor boats operating on the Little Susitna River discharge hydrocarbons resulting in concentrations that can exceed state water quality standards. Concentrations will exceed state standards during periods of high boat use and low stream flows. Over the past two years, these conditions have resulted in average TAH concentrations higher than state standards on 6 of 30 sampling dates. Modeling TAH concentrations based on daily boat counts at the entrance booth did not increase the number of days water quality standards were exceeded. Based on more frequent sampling throughout the day, concentrations likely exceed state standards through only a portion of these days. Sampling was conducted between 12:00 and 16:00 and different results could have been obtained if sampling were conducted during different times of the day resulting in either higher or lower values. State water quality standards do not specify the duration of time or an average over time or days for exceedances to occur; however, average daily or maximum daily values would provide different results.

The collection of fall 2009 and spring 2010 hydrocarbon data modified the regression relationships developed previously. The slopes between boat use and hydrocarbon concentrations decreased for all motor types. Therefore, hydrocarbon concentrations do not increase as rapidly relative to boat use as previously predicted (Davis et al. 2009). This is because hydrocarbon concentrations on August 2 and August 10, 2008, were extremely high for the amount of boat use and were determined outliers when looking at the data set for two years. Hydrocarbon data for these dates were not used in the current regression equations or other analyses.

TAH concentrations above state standards are much less likely upstream of the boat launch because less than half the boats launching travel in this direction. However, concentrations tend to increase downstream, particularly during high use periods, and concentrations can continue to increase up to 16 km below the launch. This may be due to downstream transportation rates exceeding evaporation and dilution augmented by boats operating this far downstream.

Investigation of the variability in TAH concentrations relative to boat use over the past two years does not support the hypothesis that 2-cycle motors are the primary hydrocarbon source. Correlation coefficients, which are independent of scale, were highest between total boats operating per hour and TAH concentrations (0.82) and lower for boats with 2-cycle motors (0.73). Regression R^2 values also were highest for total boats followed by 4-cycle motors and then 2-cycle motors. Adding 2-cycle motors as a second variable along with total boats using multiple linear regressions did not increase the resulting R^2 value. Similarly, the best model based upon AIC_c values includes both 2 and 4-cycle motors. If 2-cycle motors discharged TAH at 10 times the rate of 4-cycle motors as hypothesized by Oasis (2007)(0.068 vs. 0.0068, gal/hr for 2 and 4-cycle , respectively) then resulting concentrations should be closely correlated with the number of 2-cycle motors operating. This is not the case as 4-cycle and 2-cycle motors were poorly correlated, and the portion of 2-cycle motors operating varied considerably among sampling dates. Multiplying 2-cycle motors operating per hour by the discharge rate of 0.068 gph yields an average TAH discharge of 0.30 gal/h. This is much higher than average measured TAH discharge of 0.08 gal/h and does not include any addition from 4-cycle motors. AIC model beta values suggest discharge from 2-cycle motors is approximately 1.3 times the discharge from 4-cycle motors.

Finally, the lack of a significant regression relationship in TAH loading per boat as a function of the portion of boats using 2-cycle motors ranging from 14% to 42%, shows that decreasing the number of 2-cycle motors will not likely result in reduced TAH loading.

The relationship between total boat count and flow-corrected hydrocarbon concentrations, and the relationship between stream flow at the PUF and flow 3 days prior at the gauge station in Hatcher Pass gives managers a tool that can be used to avoid exceedances of water quality standards. Since the PUF is the only boat launch on the lower river, the number of boats operating can be regulated. In addition, the three day flow time between Hatcher Pass and the PUF provides prior warning of low flow conditions. Low flow conditions along with high boat use likely will result in exceedances of water quality standards for TAH. The maximum number of boats that can pass the entrance booth and still maintain water quality standards can be estimated by combining regression equations that estimate TAH as a function of total boats and stream flow. The total number of boats entering the PUF is related to total boats operating per hour, which is used to estimate flow-corrected TAH. Discharge at the PUF is calculated from the relationship with flows at the USGS gauging station in Hatcher Pass. By combining these equations the maximum number of boats that can pass the entrance booth that will not result in an exceedance of the water quality standard for TAH can be estimated.

$$B_t = 0.08\, Q_{H-3} + 12.6$$

Where B_t is the total number of boats passing the entrance booth, and $Q_{H\text{-}3}$ is stream flow in cubic feet per second, at the USGS gauging station three days before.

Turbidity from grab samples or average daily values obtained from the Hydrolabs were consistently 5 NTU or more and often over 10 NTU higher, downstream from the PUF compared to the reference site. Regression analyses, daily changes in turbidity, and comparisons between low and high boat use periods all confirm that boat use causes an increase in stream water turbidity. Both regression slopes show that there will be a 5 NTU increase in turbidity with every 15 boats operating on the river. Hourly measures of turbidity show a 5 NTU to 15 NTU drop in turbidity from midnight to early morning clearly demonstrating boat influence. In addition, there was a significant relationship between the increase in turbidity relative to the reference site and boat counts at the entrance booth.

Regressions using either Hydrolab data or grab samples are significant but only explain a portion of the variability in turbidity differences. Including discharge did not improve the regression relationship. Turbidity increases with discharge at both the reference site and sites located near the PUF. In fact, during storms, turbidity is often higher at the upstream reference site, due to storm flows from small streams draining the Talkeetna Mountains. The largest differences in turbidity occurred during low flow (200 to 250 cfs) conditions, even though the water may appear clear because the bottom is visible. During low flow conditions jet motors are often drawing fine sediment, and boat waves are disturbing the stream bed resulting in a brown wake (personal observation) which could explain the higher differences in turbidity during low flows. The influence of boats on turbidity also could vary by boat type as hull configuration and boat weight have been shown to influence the size of boat waves. Increases in nearshore turbidity following boat-induced waves have been documented previously (Hill et al. 2002). The influence of an individual boat however, will depend upon wave size that varies with hull shape, boat size, speed, weight, bank types and water depths (Maynord 2001). The size of suspended particles will influence sedimentation rates and the length of time particles are in the water column. Suspended sediments are more likely to remain in the water column if the water is intermittently mixed due to jet intake or boat waves. This could explain the cumulative increase in turbidity with distance downstream from the PUF. These factors that alter the influence of boat use on turbidity should be further investigated so that managers can implement effective control measures.

Others have raised the hypothesis that cold turbid waters from Cook Inlet are entering the channel during high tides resulting in high turbidity. However, we did not record high turbidity that corresponded with high tides or rapid changes in temperature that would indicate tidal flow at the Hydrolab monitoring sites 4 km and 8 km downstream from the launch. Measures of specific conductivity from weekly grab samples also have not shown a large increase from other sampling locations, which would be expected if tidal waters were reaching the sampling sites. There are also no signs of fluctuating water levels or changes in riparian vegetation that would occur with tidal flow.

Measures of the biotic community continue to show differences between samples collected 9 km upstream and 4 km downstream from the launch. Average catch per trap for coho salmon, Chinook salmon, and total salmonid juveniles are consistently higher upstream. Similarly, the abundance of macroinvertebrates in the drift is higher upstream compared to downstream from the launch. We are unable to determine whether these changes are due to differences in water chemistry or turbidity, indirect habitat changes or other unmeasured causes. However, the influence of turbidity on stream biota is well established. For example, Lloyd et al. (1987) found that turbidity explained the greatest difference in macroinvertebrate density between mined and unmined streams. Increases in turbidity negatively affect fish metabolism, feeding ability, and behavior (Newcombe and Jensen 1996). Turbidity in the Little Susitna River has been shown to cause a decrease in stream productivity (Davis et al. 2009).

Operation of boats on the Little Susitna River causes changes to water quality. These changes include increases in hydrocarbon concentrations and turbidity. The abundance of macroinvertebrates and rearing juvenile salmon decreased as concentrations of hydrocarbons and turbidity increased. Concentrations of hydrocarbons and turbidity can exceed state water quality standards. Monitoring hydrocarbon concentrations and boat use should be continued to determine if further reductions in 2-cycle motor use result in lower TAH concentrations. Further work should be conducted to determine downstream changes in turbidity absent boat use and whether boat size reductions could reduce boat waves and limit changes to turbidity.

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Appendix A. Water Sampling Results

Date	Stream	Site	Measurement	Value	Units	Lab ID
7/19/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A011557
7/19/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A011557
7/19/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A011557
7/19/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A011557
7/19/2009	Little Su	LS-1	Toluene	1.4	µg/L	09-A011548
7/19/2009	Little Su	LS-1	Total Xylene	<1	µg/L	09-A011548
7/19/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A011548
7/19/2009	Little Su	LS-1	Benzene	<1	µg/L	09-A011548
7/19/2009	Little Su	LS-1	TAH	1.4	µg/L	
7/19/2009	Little Su	LS-2	Toluene	<1	µg/L	09-A011549
7/19/2009	Little Su	LS-2	Total Xylene	<1	µg/L	09-A011549
7/19/2009	Little Su	LS-2	Ethyl Benzene	<1	µg/L	09-A011549
7/19/2009	Little Su	LS-2	Benzene	<1	µg/L	09-A011549
7/19/2009	Little Su	LS-2	TAH	<1	µg/L	
7/19/2009	Little Su	LS-3	Toluene	5.9	µg/L	09-A011550
7/19/2009	Little Su	LS-3	Total Xylene	3.9	µg/L	09-A011550
7/19/2009	Little Su	LS-3	Ethyl Benzene	1.7	µg/L	09-A011550
7/19/2009	Little Su	LS-3	Benzene	2.6	µg/L	09-A011550
7/19/2009	Little Su	LS-3	TAH	14.1	µg/L	
7/19/2009	Little Su	LS-4	Toluene	2	µg/L	09-A011551
7/19/2009	Little Su	LS-4	Total Xylene	2.1	µg/L	09-A011551
7/19/2009	Little Su	LS-4	Ethyl Benzene	1	µg/L	09-A011551
7/19/2009	Little Su	LS-4	Benzene	1.4	µg/L	09-A011551
7/19/2009	Little Su	LS-4	TAH	6.5	µg/L	
7/19/2009	Little Su	LS-5	Toluene	1.7	µg/L	09-A011552
7/19/2009	Little Su	LS-5	Total Xylene	2	µg/L	09-A011552
7/19/2009	Little Su	LS-5	Ethyl Benzene	<1	µg/L	09-A011552
7/19/2009	Little Su	LS-5	Benzene	1.2	µg/L	09-A011552
7/19/2009	Little Su	LS-5	TAH	4.9	µg/L	
7/19/2009	Little Su	LS-6	Toluene	1.6	µg/L	09-A011553
7/19/2009	Little Su	LS-6	Total Xylene	2	µg/L	09-A011553
7/19/2009	Little Su	LS-6	Ethyl Benzene	<1	µg/L	09-A011553
7/19/2009	Little Su	LS-6	Benzene	1	µg/L	09-A011553
7/19/2009	Little Su	LS-6	TAH	4.6	µg/L	
7/19/2009	Little Su	LS-7	Toluene	1.3	µg/L	09-A011554
7/19/2009	Little Su	LS-7	Total Xylene	1.3	µg/L	09-A011554
7/19/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A011554
7/19/2009	Little Su	LS-7	Benzene	<1	µg/L	09-A011554
7/19/2009	Little Su	LS-7	TAH	2.6	µg/L	
7/19/2009	Little Su	LS-7x	Toluene	2.7	µg/L	09-A011555
7/19/2009	Little Su	LS-7x	Total Xylene	1.4	µg/L	09-A011555
7/19/2009	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	09-A011555
7/19/2009	Little Su	LS-7x	Benzene	<1	µg/L	09-A011555
7/19/2009	Little Su	LS-7x	TAH	4.1	µg/L	
7/19/2009	Little Su	Trip Blank	Toluene	<1	µg/L	09-A011556
7/19/2009	Little Su	Trip Blank	Total Xylene	<1	µg/L	09-A011556
7/19/2009	Little Su	Trip Blank	Ethyl Benzene	<1	µg/L	09-A011556

Date	Stream	Site	Measurement	Value	Units	Lab ID
7/19/2009	Little Su	Trip Blank	Benzene	<1	µg/L	09-A011556
7/26/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A012767
7/26/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A012767
7/26/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A012767
7/26/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A012767
7/26/2009	Little Su	LS-1	Toluene	2.2	µg/L	09-A012759
7/26/2009	Little Su	LS-1	Total Xylene	<1	µg/L	09-A012759
7/26/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A012759
7/26/2009	Little Su	LS-1	Benzene	<1	µg/L	09-A012759
7/26/2009	Little Su	LS-1	TAH	2.2	µg/L	
7/26/2009	Little Su	LS-2	Toluene	2.7	µg/L	09-A012760
7/26/2009	Little Su	LS-2	Total Xylene	<1	µg/L	09-A012760
7/26/2009	Little Su	LS-2	Ethyl Benzene	<1	µg/L	09-A012760
7/26/2009	Little Su	LS-2	Benzene	<1	µg/L	09-A012760
7/26/2009	Little Su	LS-2	TAH	2.7	µg/L	
7/26/2009	Little Su	LS-3	Toluene	3.8	µg/L	09-A012761
7/26/2009	Little Su	LS-3	Total Xylene	<1	µg/L	09-A012761
7/26/2009	Little Su	LS-3	Ethyl Benzene	<1	µg/L	09-A012761
7/26/2009	Little Su	LS-3	Benzene	<1	µg/L	09-A012761
7/26/2009	Little Su	LS-3	TAH	3.8	µg/L	
7/26/2009	Little Su	LS-4	Toluene	4.4	µg/L	09-A012762
7/26/2009	Little Su	LS-4	Total Xylene	<1	µg/L	09-A012762
7/26/2009	Little Su	LS-4	Ethyl Benzene	<1	µg/L	09-A012762
7/26/2009	Little Su	LS-4	Benzene	<1	µg/L	09-A012762
7/26/2009	Little Su	LS-4	TAH	4.4	µg/L	
7/26/2009	Little Su	LS-5	Toluene	9.6	µg/L	09-A012763
7/26/2009	Little Su	LS-5	Total Xylene	3.2	µg/L	09-A012763
7/26/2009	Little Su	LS-5	Ethyl Benzene	1.2	µg/L	09-A012763
7/26/2009	Little Su	LS-5	Benzene	1.7	µg/L	09-A012763
7/26/2009	Little Su	LS-5	TAH	15.7	µg/L	
7/26/2009	Little Su	LS-6	Toluene	5.9	µg/L	09-A012764
7/26/2009	Little Su	LS-6	Total Xylene	<1	µg/L	09-A012764
7/26/2009	Little Su	LS-6	Ethyl Benzene	<1	µg/L	09-A012764
7/26/2009	Little Su	LS-6	Benzene	1.2	µg/L	09-A012764
7/26/2009	Little Su	LS-6	TAH	7.1	µg/L	
7/26/2009	Little Su	LS-7	Toluene	6.3	µg/L	09-A012765
7/26/2009	Little Su	LS-7	Total Xylene	2.5	µg/L	09-A012765
7/26/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A012765
7/26/2009	Little Su	LS-7	Benzene	1.3	µg/L	09-A012765
7/26/2009	Little Su	LS-7	TAH	10.1	µg/L	
7/26/2009	Little Su	LS-7x	Toluene	6.5	µg/L	09-A012766
7/26/2009	Little Su	LS-7x	Total Xylene	2.4	µg/L	09-A012766
7/26/2009	Little Su	LS-7x	Ethyl Benzene	1	µg/L	09-A012766
7/26/2009	Little Su	LS-7x	Benzene	1.6	µg/L	09-A012766
7/26/2009	Little Su	LS-7x	TAH	11.5	µg/L	
7/26/2009	Little Su	Trip Blank	Toluene	<1	µg/L	09-A012768
7/26/2009	Little Su	Trip Blank	Total Xylene	<1	µg/L	09-A012768

Date	Stream	Site	Measurement	Value	Units	Lab ID
7/26/2009	Little Su	Trip Blank	Ethyl Benzene	<1	µg/L	09-A012768
7/26/2009	Little Su	Trip Blank	Benzene	<1	µg/L	09-A012768
8/02/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A012777
8/02/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A012777
8/02/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A012777
8/02/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A012777
8/02/2009	Little Su	LS-1	Toluene	<1	µg/L	09-A012769
8/02/2009	Little Su	LS-1	Total Xylene	<1	µg/L	09-A012769
8/02/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A012769
8/02/2009	Little Su	LS-1	Benzene	<1	µg/L	09-A012769
8/02/2009	Little Su	LS-1	TAH	<1	µg/L	
8/02/2009	Little Su	LS-2	Toluene	2.4	µg/L	09-A012770
8/02/2009	Little Su	LS-2	Total Xylene	1.2	µg/L	09-A012770
8/02/2009	Little Su	LS-2	Ethyl Benzene	<1	µg/L	09-A012770
8/02/2009	Little Su	LS-2	Benzene	<1	µg/L	09-A012770
8/02/2009	Little Su	LS-2	TAH	3.6	µg/L	
8/02/2009	Little Su	LS-3	Toluene	2.4	µg/L	09-A012771
8/02/2009	Little Su	LS-3	Total Xylene	1.5	µg/L	09-A012771
8/02/2009	Little Su	LS-3	Ethyl Benzene	<1	µg/L	09-A012771
8/02/2009	Little Su	LS-3	Benzene	1.1	µg/L	09-A012771
8/02/2009	Little Su	LS-3	TAH	5	µg/L	
8/02/2009	Little Su	LS-4	Toluene	1.8	µg/L	09-A012772
8/02/2009	Little Su	LS-4	Total Xylene	<1	µg/L	09-A012772
8/02/2009	Little Su	LS-4	Ethyl Benzene	<1	µg/L	09-A012772
8/02/2009	Little Su	LS-4	Benzene	<1	µg/L	09-A012772
8/02/2009	Little Su	LS-4	TAH	1.8	µg/L	
8/02/2009	Little Su	LS-5	Toluene	2.9	µg/L	09-A012773
8/02/2009	Little Su	LS-5	Total Xylene	1.4	µg/L	09-A012773
8/02/2009	Little Su	LS-5	Ethyl Benzene	<1	µg/L	09-A012773
8/02/2009	Little Su	LS-5	Benzene	1.3	µg/L	09-A012773
8/02/2009	Little Su	LS-5	TAH	5.6	µg/L	
8/02/2009	Little Su	LS-6	Toluene	2	µg/L	09-A012774
8/02/2009	Little Su	LS-6	Total Xylene	<1	µg/L	09-A012774
8/02/2009	Little Su	LS-6	Ethyl Benzene	<1	µg/L	09-A012774
8/02/2009	Little Su	LS-6	Benzene	<1	µg/L	09-A012774
8/02/2009	Little Su	LS-6	TAH	2	µg/L	
8/02/2009	Little Su	LS-7	Toluene	2.7	µg/L	09-A012775
8/02/2009	Little Su	LS-7	Total Xylene	1.4	µg/L	09-A012775
8/02/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A012775
8/02/2009	Little Su	LS-7	Benzene	1.2	µg/L	09-A012775
8/02/2009	Little Su	LS-7	TAH	5.3	µg/L	
8/02/2009	Little Su	LS-7x	Toluene	3.1	µg/L	09-A012776
8/02/2009	Little Su	LS-7x	Total Xylene	1.5	µg/L	09-A012776
8/02/2009	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	09-A012776
8/02/2009	Little Su	LS-7x	Benzene	1.4	µg/L	09-A012776
8/02/2009	Little Su	LS-7x	TAH	6	µg/L	
8/02/2009	Little Su	Trip Blank	Toluene	<1	µg/L	09-A012778

Date	Stream	Site	Measurement	Value	Units	Lab ID
8/2/2009	Little Su	Trip Blank	Total Xylene	<1	µg/L	09-A012778
8/2/2009	Little Su	Trip Blank	Ethyl Benzene	<1	µg/L	09-A012778
8/2/2009	Little Su	Trip Blank	Benzene	<1	µg/L	09-A012778
8/8/2009	Little Su	0600 LS Intensive	Toluene	5.6	µg/L	09-A013167
8/8/2009	Little Su	0600 LS Intensive	Total Xylene	2.6	µg/L	09-A013167
8/8/2009	Little Su	0600 LS Intensive	Ethyl Benzene	1.1	µg/L	09-A013167
8/8/2009	Little Su	0600 LS Intensive	Benzene	2.2	µg/L	09-A013167
8/8/2009	Little Su	0600 LS Intensive	TAH	11.5	µg/L	
8/8/2009	Little Su	0900 LS Intensive	Toluene	8.4	µg/L	09-A013173
8/8/2009	Little Su	0900 LS Intensive	Total Xylene	4.1	µg/L	09-A013173
8/8/2009	Little Su	0900 LS Intensive	Ethyl Benzene	1.5	µg/L	09-A013173
8/8/2009	Little Su	0900 LS Intensive	Benzene	3	µg/L	09-A013173
8/8/2009	Little Su	0900 LS Intensive	TAH	17	µg/L	
8/8/2009	Little Su	1200 LS Intensive	Toluene	12.8	µg/L	09-A013168
8/8/2009	Little Su	1200 LS Intensive	Total Xylene	6.4	µg/L	09-A013168
8/8/2009	Little Su	1200 LS Intensive	Ethyl Benzene	2.4	µg/L	09-A013168
8/8/2009	Little Su	1200 LS Intensive	Benzene	5.6	µg/L	09-A013168
8/8/2009	Little Su	1200 LS Intensive	TAH	27.2	µg/L	
8/8/2009	Little Su	1500 LS Intensive	Toluene	3.3	µg/L	09-A013169
8/8/2009	Little Su	1500 LS Intensive	Total Xylene	1.6	µg/L	09-A013169
8/8/2009	Little Su	1500 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013169
8/8/2009	Little Su	1500 LS Intensive	Benzene	1.5	µg/L	09-A013169
8/8/2009	Little Su	1500 LS Intensive	TAH	6.4	µg/L	
8/8/2009	Little Su	1800 LS Intensive	Toluene	4.9	µg/L	09-A013170
8/8/2009	Little Su	1800 LS Intensive	Total Xylene	2.7	µg/L	09-A013170
8/8/2009	Little Su	1800 LS Intensive	Ethyl Benzene	1.1	µg/L	09-A013170
8/8/2009	Little Su	1800 LS Intensive	Benzene	2.2	µg/L	09-A013170
8/8/2009	Little Su	1800 LS Intensive	TAH	10.9	µg/L	
8/8/2009	Little Su	2100 LS Intensive	Toluene	4.9	µg/L	09-A013171
8/8/2009	Little Su	2100 LS Intensive	Total Xylene	2.3	µg/L	09-A013171
8/8/2009	Little Su	2100 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013171
8/8/2009	Little Su	2100 LS Intensive	Benzene	2.1	µg/L	09-A013171
8/8/2009	Little Su	2100 LS Intensive	TAH	9.3	µg/L	
8/8/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A013172
8/8/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A013172
8/8/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A013172
8/8/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A013172
8/9/2009	Little Su	0600 LS Intensive	Toluene	1.9	µg/L	09-A013174
8/9/2009	Little Su	0600 LS Intensive	Total Xylene	<1	µg/L	09-A013174
8/9/2009	Little Su	0600 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013174
8/9/2009	Little Su	0600 LS Intensive	Benzene	<1	µg/L	09-A013174
8/9/2009	Little Su	0600 LS Intensive	TAH	1.9	µg/L	
8/9/2009	Little Su	0900 LS Intensive	Toluene	4.3	µg/L	09-A013175
8/9/2009	Little Su	0900 LS Intensive	Total Xylene	2.1	µg/L	09-A013175
8/9/2009	Little Su	0900 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013175
8/9/2009	Little Su	0900 LS Intensive	Benzene	1.8	µg/L	09-A013175
8/9/2009	Little Su	0900 LS Intensive	TAH	8.2	µg/L	

Date	Stream	Site	Measurement	Value	Units	Lab ID
8/9/2009	Little Su	1200 LS Intensive	Toluene	6.4	µg/L	09-A013176
8/9/2009	Little Su	1200 LS Intensive	Total Xylene	2.8	µg/L	09-A013176
8/9/2009	Little Su	1200 LS Intensive	Ethyl Benzene	1.1	µg/L	09-A013176
8/9/2009	Little Su	1200 LS Intensive	Benzene	2.6	µg/L	09-A013176
8/9/2009	Little Su	1200 LS Intensive	TAH	12.9	µg/L	
8/9/2009	Little Su	1500 LS Intensive	Toluene	3.2	µg/L	09-A013177
8/9/2009	Little Su	1500 LS Intensive	Total Xylene	1.4	µg/L	09-A013177
8/9/2009	Little Su	1500 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013177
8/9/2009	Little Su	1500 LS Intensive	Benzene	1.3	µg/L	09-A013177
8/9/2009	Little Su	1500 LS Intensive	TAH	5.9	µg/L	
8/9/2009	Little Su	1800 LS Intensive	Toluene	8.6	µg/L	09-A013178
8/9/2009	Little Su	1800 LS Intensive	Total Xylene	3.4	µg/L	09-A013178
8/9/2009	Little Su	1800 LS Intensive	Ethyl Benzene	1.3	µg/L	09-A013178
8/9/2009	Little Su	1800 LS Intensive	Benzene	3.3	µg/L	09-A013178
8/9/2009	Little Su	1800 LS Intensive	TAH	16.6	µg/L	
8/9/2009	Little Su	2100 LS Intensive	Toluene	3.5	µg/L	09-A013179
8/9/2009	Little Su	2100 LS Intensive	Total Xylene	1.4	µg/L	09-A013179
8/9/2009	Little Su	2100 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013179
8/9/2009	Little Su	2100 LS Intensive	Benzene	1.5	µg/L	09-A013179
8/9/2009	Little Su	2100 LS Intensive	TAH	6.4	µg/L	
8/9/2009	Little Su	2100x LS Intensive	Toluene	2.9	µg/L	09-A013180
8/9/2009	Little Su	2100x LS Intensive	Total Xylene	1.1	µg/L	09-A013180
8/9/2009	Little Su	2100x LS Intensive	Ethyl Benzene	<1	µg/L	09-A013180
8/9/2009	Little Su	2100x LS Intensive	Benzene	1.2	µg/L	09-A013180
8/9/2009	Little Su	2100x LS Intensive		5.2	µg/L	
8/9/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A013189
8/9/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A013189
8/9/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A013189
8/9/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A013189
8/9/2009	Little Su	LS-1	Toluene	3	µg/L	09-A013181
8/9/2009	Little Su	LS-1	Total Xylene	1.2	µg/L	09-A013181
8/9/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A013181
8/9/2009	Little Su	LS-1	Benzene	1.2	µg/L	09-A013181
8/9/2009	Little Su	LS-1	TAH	5.4	µg/L	
8/9/2009	Little Su	LS-16	Toluene	4.8	µg/L	09-A013192
8/9/2009	Little Su	LS-16	Total Xylene	1.8	µg/L	09-A013192
8/9/2009	Little Su	LS-16	Ethyl Benzene	<1	µg/L	09-A013192
8/9/2009	Little Su	LS-16	Benzene	2.3	µg/L	09-A013192
8/9/2009	Little Su	LS-16	TAH	8.9	µg/L	
8/9/2009	Little Su	LS-2	Toluene	2.5	µg/L	09-A013182
8/9/2009	Little Su	LS-2	Total Xylene	1	µg/L	09-A013182
8/9/2009	Little Su	LS-2	Ethyl Benzene	<1	µg/L	09-A013182
8/9/2009	Little Su	LS-2	Benzene	1	µg/L	09-A013182
8/9/2009	Little Su	LS-2	TAH	4.5	µg/L	
8/9/2009	Little Su	LS-3	Toluene	2.7	µg/L	09-A013183
8/9/2009	Little Su	LS-3	Total Xylene	1.2	µg/L	09-A013183
8/9/2009	Little Su	LS-3	Ethyl Benzene	<1	µg/L	09-A013183

Date	Stream	Site	Measurement	Value	Units	Lab ID
8/9/2009	Little Su	LS-3	Benzene	1.1	µg/L	09-A013183
8/9/2009	Little Su	LS-3	TAH	5	µg/L	
8/9/2009	Little Su	LS-32	Toluene	<1	µg/L	09-A013193
8/9/2009	Little Su	LS-32	Total Xylene	<1	µg/L	09-A013193
8/9/2009	Little Su	LS-32	Ethyl Benzene	<1	µg/L	09-A013193
8/9/2009	Little Su	LS-32	Benzene	<1	µg/L	09-A013193
8/9/2009	Little Su	LS-32	TAH	<1	µg/L	
8/9/2009	Little Su	LS-4	Toluene	2.9	µg/L	09-A013184
8/9/2009	Little Su	LS-4	Total Xylene	1.2	µg/L	09-A013184
8/9/2009	Little Su	LS-4	Ethyl Benzene	<1	µg/L	09-A013184
8/9/2009	Little Su	LS-4	Benzene	1.2	µg/L	09-A013184
8/9/2009	Little Su	LS-4	TAH	5.3	µg/L	
8/9/2009	Little Su	LS-5	Toluene	4.1	µg/L	09-A013185
8/9/2009	Little Su	LS-5	Total Xylene	1.7	µg/L	09-A013185
8/9/2009	Little Su	LS-5	Ethyl Benzene	<1	µg/L	09-A013185
8/9/2009	Little Su	LS-5	Benzene	1.6	µg/L	09-A013185
8/9/2009	Little Su	LS-5	TAH	7.4	µg/L	
8/9/2009	Little Su	LS-6	Toluene	5	µg/L	09-A013186
8/9/2009	Little Su	LS-6	Total Xylene	2	µg/L	09-A013186
8/9/2009	Little Su	LS-6	Ethyl Benzene	<1	µg/L	09-A013186
8/9/2009	Little Su	LS-6	Benzene	2	µg/L	09-A013186
8/9/2009	Little Su	LS-6	TAH	9	µg/L	
8/9/2009	Little Su	LS-7	Toluene	4.7	µg/L	09-A013187
8/9/2009	Little Su	LS-7	Total Xylene	1.9	µg/L	09-A013187
8/9/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A013187
8/9/2009	Little Su	LS-7	Benzene	1.7	µg/L	09-A013187
8/9/2009	Little Su	LS-7	TAH	8.3	µg/L	
8/9/2009	Little Su	LS-7X	Toluene	7.3	µg/L	09-A013188
8/9/2009	Little Su	LS-7X	Total Xylene	3	µg/L	09-A013188
8/9/2009	Little Su	LS-7X	Ethyl Benzene	1.2	µg/L	09-A013188
8/9/2009	Little Su	LS-7X	Benzene	2.6	µg/L	09-A013188
8/9/2009	Little Su	LS-7X	TAH	14.1	µg/L	
8/9/2009	Little Su	LS-8	Toluene	6.6	µg/L	09-A013191
8/9/2009	Little Su	LS-8	Total Xylene	2.7	µg/L	09-A013191
8/9/2009	Little Su	LS-8	Ethyl Benzene	<1	µg/L	09-A013191
8/9/2009	Little Su	LS-8	Benzene	2.7	µg/L	09-A013191
8/9/2009	Little Su	LS-8	TAH	12	µg/L	
8/9/2009	Little Su	Trip Blank	Toluene	<1	µg/L	09-A013190
8/9/2009	Little Su	Trip Blank	Total Xylene	<1	µg/L	09-A013190
8/9/2009	Little Su	Trip Blank	Ethyl Benzene	<1	µg/L	09-A013190
8/9/2009	Little Su	Trip Blank	Benzene	<1	µg/L	09-A013190
8/10/2009	Little Su	0600 LS Intensive	Toluene	6.1	µg/L	09-A013194
8/10/2009	Little Su	0600 LS Intensive	Total Xylene	3.1	µg/L	09-A013194
8/10/2009	Little Su	0600 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013194
8/10/2009	Little Su	0600 LS Intensive	Benzene	2	µg/L	09-A013194
8/10/2009	Little Su	0600 LS Intensive	TAH	11.2	µg/L	
8/10/2009	Little Su	0900 LS Intensive	Toluene	1.7	µg/L	09-A013196

Date	Stream	Site	Measurement	Value	Units	Lab ID
8/10/2009	Little Su	0900 LS Intensive	Total Xylene	<1	µg/L	09-A013196
8/10/2009	Little Su	0900 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013196
8/10/2009	Little Su	0900 LS Intensive	Benzene	<1	µg/L	09-A013196
8/10/2009	Little Su	0900 LS Intensive	TAH	1.7	µg/L	
8/10/2009	Little Su	1200 LS Intensive	Toluene	1.9	µg/L	09-A013195
8/10/2009	Little Su	1200 LS Intensive	Total Xylene	<1	µg/L	09-A013195
8/10/2009	Little Su	1200 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013195
8/10/2009	Little Su	1200 LS Intensive	Benzene	<1	µg/L	09-A013195
8/10/2009	Little Su	1200 LS Intensive	TAH	1.9	µg/L	
8/10/2009	Little Su	1500 LS Intensive	Toluene	1.9	µg/L	09-A013197
8/10/2009	Little Su	1500 LS Intensive	Total Xylene	<1	µg/L	09-A013197
8/10/2009	Little Su	1500 LS Intensive	Ethyl Benzene	<1	µg/L	09-A013197
8/10/2009	Little Su	1500 LS Intensive	Benzene	<1	µg/L	09-A013197
8/10/2009	Little Su	1500 LS Intensive	TAH	1.9	µg/L	
8/10/2009	Little Su	1500x LS Intensive	Toluene	2.5	µg/L	09-A013199
8/10/2009	Little Su	1500x LS Intensive	Total Xylene	1.1	µg/L	09-A013199
8/10/2009	Little Su	1500x LS Intensive	Ethyl Benzene	<1	µg/L	09-A013199
8/10/2009	Little Su	1500x LS Intensive	Benzene	1.1	µg/L	09-A013199
8/10/2009	Little Su	1500x LS Intensive	TAH	4.7	µg/L	
8/10/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A013198
8/10/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A013198
8/10/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A013198
8/10/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A013198
8/16/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A014228
8/16/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A014228
8/16/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A014228
8/16/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A014228
8/16/2009	Little Su	LS-1	Toluene	2.2	µg/L	09-A014220
8/16/2009	Little Su	LS-1	Total Xylene	<1	µg/L	09-A014220
8/16/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A014220
8/16/2009	Little Su	LS-1	Benzene	<1	µg/L	09-A014220
8/16/2009	Little Su	LS-1	TAH	2.2	µg/L	
8/16/2009	Little Su	LS-2	Toluene	2.3	µg/L	09-A014221
8/16/2009	Little Su	LS-2	Total Xylene	<1	µg/L	09-A014221
8/16/2009	Little Su	LS-2	Ethyl Benzene	<1	µg/L	09-A014221
8/16/2009	Little Su	LS-2	Benzene	<1	µg/L	09-A014221
8/16/2009	Little Su	LS-2	TAH	2.3	µg/L	
8/16/2009	Little Su	LS-3	Toluene	2.7	µg/L	09-A014222
8/16/2009	Little Su	LS-3	Total Xylene	1	µg/L	09-A014222
8/16/2009	Little Su	LS-3	Ethyl Benzene	<1	µg/L	09-A014222
8/16/2009	Little Su	LS-3	Benzene	1	µg/L	09-A014222
8/16/2009	Little Su	LS-3	TAH	4.7	µg/L	
8/16/2009	Little Su	LS-4	Toluene	3.7	µg/L	09-A014223
8/16/2009	Little Su	LS-4	Total Xylene	1.5	µg/L	09-A014223
8/16/2009	Little Su	LS-4	Ethyl Benzene	<1	µg/L	09-A014223
8/16/2009	Little Su	LS-4	Benzene	1.5	µg/L	09-A014223
8/16/2009	Little Su	LS-4	TAH	6.7	µg/L	

Date	Stream	Site	Measurement	Value	Units	Lab ID
8/16/2009	Little Su	LS-5	Toluene	2.9	µg/L	09-A014224
8/16/2009	Little Su	LS-5	Total Xylene	1.2	µg/L	09-A014224
8/16/2009	Little Su	LS-5	Ethyl Benzene	<1	µg/L	09-A014224
8/16/2009	Little Su	LS-5	Benzene	1.3	µg/L	09-A014224
8/16/2009	Little Su	LS-5	TAH	5.4	µg/L	
8/16/2009	Little Su	LS-6	Toluene	2.9	µg/L	09-A014225
8/16/2009	Little Su	LS-6	Total Xylene	1.2	µg/L	09-A014225
8/16/2009	Little Su	LS-6	Ethyl Benzene	<1	µg/L	09-A014225
8/16/2009	Little Su	LS-6	Benzene	1.2	µg/L	09-A014225
8/16/2009	Little Su	LS-6	TAH	5.3	µg/L	
8/16/2009	Little Su	LS-7	Toluene	3	µg/L	09-A014226
8/16/2009	Little Su	LS-7	Total Xylene	1.2	µg/L	09-A014226
8/16/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A014226
8/16/2009	Little Su	LS-7	Benzene	1.3	µg/L	09-A014226
8/16/2009	Little Su	LS-7	TAH	5.5	µg/L	
8/16/2009	Little Su	LS-7x	Toluene	3	µg/L	09-A014227
8/16/2009	Little Su	LS-7x	Total Xylene	1.3	µg/L	09-A014227
8/16/2009	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	09-A014227
8/16/2009	Little Su	LS-7x	Benzene	1.3	µg/L	09-A014227
8/16/2009	Little Su	LS-7x	TAH	5.6	µg/L	
8/16/2009	Little Su	Trip Blank	Toluene	<1	µg/L	09-A014229
8/16/2009	Little Su	Trip Blank	Total Xylene	<1	µg/L	09-A014229
8/16/2009	Little Su	Trip Blank	Ethyl Benzene	<1	µg/L	09-A014229
8/16/2009	Little Su	Trip Blank	Benzene	<1	µg/L	09-A014229
8/23/2009	Little Su	Field Blank	Toluene	<1	µg/L	09-A014238
8/23/2009	Little Su	Field Blank	Total Xylene	<1	µg/L	09-A014238
8/23/2009	Little Su	Field Blank	Ethyl Benzene	<1	µg/L	09-A014238
8/23/2009	Little Su	Field Blank	Benzene	<1	µg/L	09-A014238
8/23/2009	Little Su	LS-1	Toluene	1.3	µg/L	09-A014230
8/23/2009	Little Su	LS-1	Total Xylene	<1	µg/L	09-A014230
8/23/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A014230
8/23/2009	Little Su	LS-1	Benzene	<1	µg/L	09-A014230
8/23/2009	Little Su	LS-1	TAH	1.3	µg/L	
8/23/2009	Little Su	LS-2	Toluene	1.5	µg/L	09-A014231
8/23/2009	Little Su	LS-2	Total Xylene	<1	µg/L	09-A014231
8/23/2009	Little Su	LS-2	Ethyl Benzene	<1	µg/L	09-A014231
8/23/2009	Little Su	LS-2	Benzene	<1	µg/L	09-A014231
8/23/2009	Little Su	LS-2	TAH	1.5	µg/L	
8/23/2009	Little Su	LS-3	Toluene	1.6	µg/L	09-A014232
8/23/2009	Little Su	LS-3	Total Xylene	<1	µg/L	09-A014232
8/23/2009	Little Su	LS-3	Ethyl Benzene	<1	µg/L	09-A014232
8/23/2009	Little Su	LS-3	Benzene	<1	µg/L	09-A014232
8/23/2009	Little Su	LS-3	TAH	1.6	µg/L	
8/23/2009	Little Su	LS-4	Toluene	1.7	µg/L	09-A014233
8/23/2009	Little Su	LS-4	Total Xylene	<1	µg/L	09-A014233
8/23/2009	Little Su	LS-4	Ethyl Benzene	<1	µg/L	09-A014233
8/23/2009	Little Su	LS-4	Benzene	<1	µg/L	09-A014233

Date	Stream	Site	Measurement	Value	Units	Lab ID
8/23/2009	Little Su	LS-4	TAH	1.7	µg/L	
8/23/2009	Little Su	LS-5	Toluene	1.3	µg/L	09-A014234
8/23/2009	Little Su	LS-5	Total Xylene	<1	µg/L	09-A014234
8/23/2009	Little Su	LS-5	Ethyl Benzene	<1	µg/L	09-A014234
8/23/2009	Little Su	LS-5	Benzene	<1	µg/L	09-A014234
8/23/2009	Little Su	LS-5	Benzene	1.3	µg/L	
8/23/2009	Little Su	LS-6	Toluene	2.1	µg/L	09-A014235
8/23/2009	Little Su	LS-6	Total Xylene	<1	µg/L	09-A014235
8/23/2009	Little Su	LS-6	Ethyl Benzene	<1	µg/L	09-A014235
8/23/2009	Little Su	LS-6	Benzene	<1	µg/L	09-A014235
8/23/2009	Little Su	LS-6	TAH	2.1	µg/L	
8/23/2009	Little Su	LS-7	Toluene	3.3	µg/L	09-A014236
8/23/2009	Little Su	LS-7	Total Xylene	1.2	µg/L	09-A014236
8/23/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A014236
8/23/2009	Little Su	LS-7	Benzene	1.1	µg/L	09-A014236
8/23/2009	Little Su	LS-7	TAH	5.6	µg/L	
8/23/2009	Little Su	LS-7x	Toluene	2.8	µg/L	09-A014237
8/23/2009	Little Su	LS-7x	Total Xylene	<1	µg/L	09-A014237
8/23/2009	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	09-A014237
8/23/2009	Little Su	LS-7x	Benzene	<1	µg/L	09-A014237
8/23/2009	Little Su	LS-7x	TAH	2.8	µg/L	
8/23/2009	Little Su	Trip Blank	Toluene	<1	µg/L	09-A014239
8/23/2009	Little Su	Trip Blank	Total Xylene	<1	µg/L	09-A014239
8/23/2009	Little Su	Trip Blank	Ethyl Benzene	<1	µg/L	09-A014239
8/23/2009	Little Su	Trip Blank	Benzene	<1	µg/L	09-A014239
8/30/2009	Little Su	LS-1	Toluene	2.2	µg/L	09-A014733
8/30/2009	Little Su	LS-1	Total Xylene	<1	µg/L	09-A014733
8/30/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A014733
8/30/2009	Little Su	LS-1	Benzene	1.2	µg/L	09-A014733
8/30/2009	Little Su	LS-1	TAH	3.4	µg/L	
8/30/2009	Little Su	LS-2	Toluene	2.1	µg/L	09-A014734
8/30/2009	Little Su	LS-2	Total Xylene	<1	µg/L	09-A014734
8/30/2009	Little Su	LS-2	Ethyl Benzene	<1	µg/L	09-A014734
8/30/2009	Little Su	LS-2	Benzene	1	µg/L	09-A014734
8/30/2009	Little Su	LS-2	TAH	3.1	µg/L	
8/30/2009	Little Su	LS-3	Toluene	1.6	µg/L	09-A014735
8/30/2009	Little Su	LS-3	Total Xylene	<1	µg/L	09-A014735
8/30/2009	Little Su	LS-3	Ethyl Benzene	<1	µg/L	09-A014735
8/30/2009	Little Su	LS-3	Benzene	<1	µg/L	09-A014735
8/30/2009	Little Su	LS-3	TAH	1.6	µg/L	
8/30/2009	Little Su	LS-4	Toluene	2.4	µg/L	09-A014736
8/30/2009	Little Su	LS-4	Total Xylene	<1	µg/L	09-A014736
8/30/2009	Little Su	LS-4	Ethyl Benzene	<1	µg/L	09-A014736
8/30/2009	Little Su	LS-4	Benzene	1.2	µg/L	09-A014736
8/30/2009	Little Su	LS-4	TAH	3.6	µg/L	
8/30/2009	Little Su	LS-5	Toluene	2.2	µg/L	09-A014737
8/30/2009	Little Su	LS-5	Total Xylene	<1	µg/L	09-A014737

Date	Stream	Site	Measurement	Value	Units	Lab ID
8/30/2009	Little Su	LS-5	Ethyl Benzene	<1	µg/L	09-A014737
8/30/2009	Little Su	LS-5	Benzene	1.1	µg/L	09-A014737
8/30/2009	Little Su	LS-5	TAH	3.3	µg/L	
8/30/2009	Little Su	LS-6	Toluene	2.6	µg/L	09-A014738
8/30/2009	Little Su	LS-6	Total Xylene	<1	µg/L	09-A014738
8/30/2009	Little Su	LS-6	Ethyl Benzene	<1	µg/L	09-A014738
8/30/2009	Little Su	LS-6	Benzene	1.2	µg/L	09-A014738
8/30/2009	Little Su	LS-6	TAH	3.8	µg/L	
8/30/2009	Little Su	LS-7	Toluene	1.8	µg/L	09-A014739
8/30/2009	Little Su	LS-7	Total Xylene	<1	µg/L	09-A014739
8/30/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A014739
8/30/2009	Little Su	LS-7	Benzene	<1	µg/L	09-A014739
8/30/2009	Little Su	LS-7	TAH	1.i8	µg/L	
8/30/2009	Little Su	LS-8	Toluene	3.5	µg/L	09-A014740
8/30/2009	Little Su	LS-8	Total Xylene	<1	µg/L	09-A014740
8/30/2009	Little Su	LS-8	Ethyl Benzene	<1	µg/L	09-A014740
8/30/2009	Little Su	LS-8	Benzene	1.6	µg/L	09-A014740
8/30/2009	Little Su	LS-8	TAH	5.1	µg/L	
9/5/2009	Little Su	LS-1	Toluene	1.3	µg/L	09-A015049
9/5/2009	Little Su	LS-1	Total Xylene	<1	µg/L	09-A015049
9/5/2009	Little Su	LS-1	Ethyl Benzene	<1	µg/L	09-A015049
9/5/2009	Little Su	LS-1	Benzene	<1	µg/L	09-A015049
9/5/2009	Little Su	LS-1	TAH	1.3	µg/L	
9/5/2009	Little Su	LS-3	Toluene	1	µg/L	09-A015050
9/5/2009	Little Su	LS-3	Total Xylene	<1	µg/L	09-A015050
9/5/2009	Little Su	LS-3	Ethyl Benzene	<1	µg/L	09-A015050
9/5/2009	Little Su	LS-3	Benzene	<1	µg/L	09-A015050
9/5/2009	Little Su	LS-3	TAH	1	µg/L	
9/5/2009	Little Su	LS-7	Toluene	2.8	µg/L	09-A015051
9/5/2009	Little Su	LS-7	Total Xylene	<1	µg/L	09-A015051
9/5/2009	Little Su	LS-7	Ethyl Benzene	<1	µg/L	09-A015051
9/5/2009	Little Su	LS-7	Benzene	1.3	µg/L	09-A015051
9/5/2009	Little Su	LS-7	TAH	4.1	µg/L	
9/5/2009	Little Su	Trip Blank	Toluene	<1	µg/L	09-A015052
9/5/2009	Little Su	Trip Blank	Total Xylene	<1	µg/L	09-A015052
9/5/2009	Little Su	Trip Blank	Ethyl Benzene	<1	µg/L	09-A015052
9/5/2009	Little Su	Trip Blank	Benzene	<1	µg/L	09-A015052
5/23/2010	Little Su	LS-1	Benzene	<1	µg/L	10-A008680
5/23/2010	Little Su	LS-1	Toluene	<1	µg/L	10-A008680
5/23/2010	Little Su	LS-1	Ethyl Benzene	<1	µg/L	10-A008680
5/23/2010	Little Su	LS-1	Total Xylene	<1	µg/L	10-A008680
5/23/2010	Little Su	LS-1	TAH	<1	µg/L	
5/23/2010	Little Su	LS-2	Benzene	<1	µg/L	10-A008681
5/23/2010	Little Su	LS-2	Toluene	1.27	µg/L	10-A008681
5/23/2010	Little Su	LS-2	Ethyl Benzene	<1	µg/L	10-A008681
5/23/2010	Little Su	LS-2	Total Xylene	<1	µg/L	10-A008681
5/23/2010	Little Su	LS-2	TAH	1.27	µg/L	

Date	Stream	Site	Measurement	Value	Units	Lab ID
5/23/2010	Little Su	LS-3	Benzene	1.59	µg/L	10-A008682
5/23/2010	Little Su	LS-3	Toluene	1.73	µg/L	10-A008682
5/23/2010	Little Su	LS-3	Ethyl Benzene	<1	µg/L	10-A008682
5/23/2010	Little Su	LS-3	Total Xylene	2.3	µg/L	10-A008682
5/23/2010	Little Su	LS-3	TAH	5.62	µg/L	
5/23/2010	Little Su	LS-5	Benzene	2.25	µg/L	10-A008683
5/23/2010	Little Su	LS-5	Toluene	6.44	µg/L	10-A008683
5/23/2010	Little Su	LS-5	Ethyl Benzene	<1	µg/L	10-A008683
5/23/2010	Little Su	LS-5	Total Xylene	3.02	µg/L	10-A008683
5/23/2010	Little Su	LS-5	TAH	11.71	µg/L	
5/23/2010	Little Su	LS-6	Benzene	<1	µg/L	10-A008684
5/23/2010	Little Su	LS-6	Toluene	3.04	µg/L	10-A008684
5/23/2010	Little Su	LS-6	Ethyl Benzene	<1	µg/L	10-A008684
5/23/2010	Little Su	LS-6	Total Xylene	<1	µg/L	10-A008684
5/23/2010	Little Su	LS-6	TAH	3.04	µg/L	
5/23/2010	Little Su	LS-7	Benzene	<1	µg/L	10-A008685
5/23/2010	Little Su	LS-7	Toluene	3.39	µg/L	10-A008685
5/23/2010	Little Su	LS-7	Ethyl Benzene	<1	µg/L	10-A008685
5/23/2010	Little Su	LS-7	Total Xylene	<1	µg/L	10-A008685
5/23/2010	Little Su	LS-7	TAH	3.39	µg/L	
5/23/2010	Little Su	LS-7x	Benzene	<1	µg/L	10-A008686
5/23/2010	Little Su	LS-7x	Toluene	2.99	µg/L	10-A008686
5/23/2010	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	10-A008686
5/23/2010	Little Su	LS-7x	Total Xylene	<1	µg/L	10-A008686
5/23/2010	Little Su	LS-7x	TAH	2.99	µg/L	
5/30/2010	Little Su	LS-1	Benzene	1.09	µg/L	10-A008689
5/30/2010	Little Su	LS-1	Toluene	3.08	µg/L	10-A008689
5/30/2010	Little Su	LS-1	Ethyl Benzene	<1	µg/L	10-A008689
5/30/2010	Little Su	LS-1	Total Xylene	<1	µg/L	10-A008689
5/30/2010	Little Su	LS-1	TAH	4.17	µg/L	
5/30/2010	Little Su	LS-2	Benzene	1.1	µg/L	10-a008690
5/30/2010	Little Su	LS-2	Toluene	3.13	µg/L	10-a008690
5/30/2010	Little Su	LS-2	Ethyl Benzene	<1	µg/L	10-a008690
5/30/2010	Little Su	LS-2	Total Xylene	<1	µg/L	10-a008690
5/30/2010	Little Su	LS-2	TAH	4.23	µg/L	
5/30/2010	Little Su	LS-3	Benzene	1.31	µg/L	10-A008691
5/30/2010	Little Su	LS-3	Toluene	3.55	µg/L	10-A008691
5/30/2010	Little Su	LS-3	Ethyl Benzene	<1	µg/L	10-A008691
5/30/2010	Little Su	LS-3	Total Xylene	<1	µg/L	10-A008691
5/30/2010	Little Su	LS-3	TAH	4.86	µg/L	
5/30/2010	Little Su	LS-5	Benzene	<1	µg/L	10-A008692
5/30/2010	Little Su	LS-5	Toluene	2.55	µg/L	10-A008692
5/30/2010	Little Su	LS-5	Ethyl Benzene	<1	µg/L	10-A008692
5/30/2010	Little Su	LS-5	Total Xylene	<1	µg/L	10-A008692
5/30/2010	Little Su	LS-5	TAH	2.55	µg/L	
5/30/2010	Little Su	LS-6	Benzene	<1	µg/L	10-A008693
5/30/2010	Little Su	LS-6	Toluene	2.2	µg/L	10-A008693

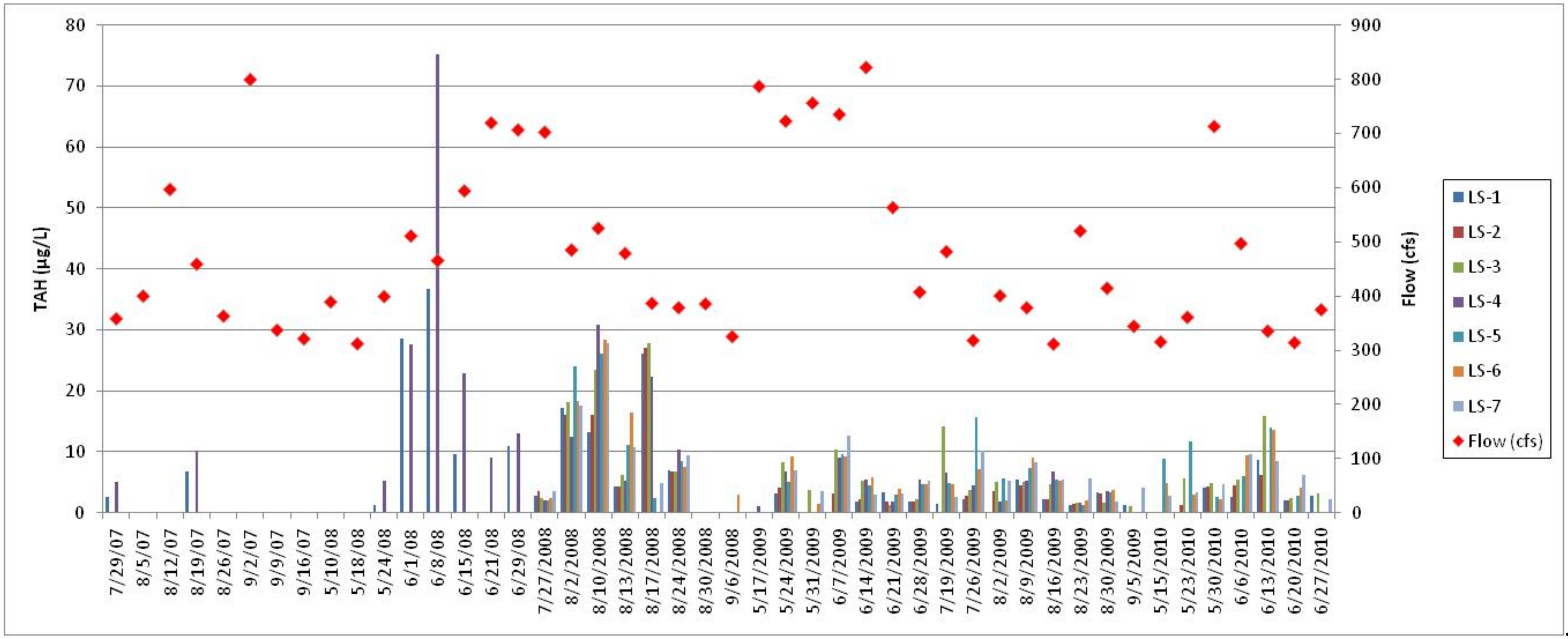
Date	Stream	Site	Measurement	Value	Units	Lab ID
5/30/2010	Little Su	LS-6	Ethyl Benzene	<1	µg/L	10-A008693
5/30/2010	Little Su	LS-6	Total Xylene	<1	µg/L	10-A008693
5/30/2010	Little Su	LS-6	TAH	2.2	µg/L	
5/30/2010	Little Su	LS-7	Benzene	1.1	µg/L	10-A008694
5/30/2010	Little Su	LS-7	Toluene	2.62	µg/L	10-A008694
5/30/2010	Little Su	LS-7	Ethyl Benzene	<1	µg/L	10-A008694
5/30/2010	Little Su	LS-7	Total Xylene	1	µg/L	10-A008694
5/30/2010	Little Su	LS-7	TAH	4.72	µg/L	
5/30/2010	Little Su	LS-7x	Benzene	1.85	µg/L	10-A008695
5/30/2010	Little Su	LS-7x	Toluene	4.89	µg/L	10-A008695
5/30/2010	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	10-A008695
5/30/2010	Little Su	LS-7x	Total Xylene	1.19	µg/L	10-A008695
5/30/2010	Little Su	LS-7x	TAH	7.93	µg/L	
6/13/2010	Little Su	LS-1	Benzene	1.89	µg/L	10-A009376
6/13/2010	Little Su	LS-1	Toluene	5.74	µg/L	10-A009376
6/13/2010	Little Su	LS-1	Ethyl Benzene	<1	µg/L	10-A009376
6/13/2010	Little Su	LS-1	Total Xylene	1.07	µg/L	10-A009376
6/13/2010	Little Su	LS-1	TAH	8.7	µg/L	
6/13/2010	Little Su	LS-2	Benzene	1.38	µg/L	10-A009377
6/13/2010	Little Su	LS-2	Toluene	4.82	µg/L	10-A009377
6/13/2010	Little Su	LS-2	Ethyl Benzene	<1	µg/L	10-A009377
6/13/2010	Little Su	LS-2	Total Xylene	<1	µg/L	10-A009377
6/13/2010	Little Su	LS-2	TAH	6.2	µg/L	
6/13/2010	Little Su	LS-3	Benzene	3.03	µg/L	10-A009378
6/13/2010	Little Su	LS-3	Toluene	8.78	µg/L	10-A009378
6/13/2010	Little Su	LS-3	Ethyl Benzene	1	µg/L	10-A009378
6/13/2010	Little Su	LS-3	Total Xylene	2.98	µg/L	10-A009378
6/13/2010	Little Su	LS-3	TAH	15.79	µg/L	
6/13/2010	Little Su	LS-5	Benzene	2.71	µg/L	10-A009379
6/13/2010	Little Su	LS-5	Toluene	8.36	µg/L	10-A009379
6/13/2010	Little Su	LS-5	Ethyl Benzene	<1	µg/L	10-A009379
6/13/2010	Little Su	LS-5	Total Xylene	2.82	µg/L	10-A009379
6/13/2010	Little Su	LS-5	TAH	13.89	µg/L	
6/13/2010	Little Su	LS-6	Benzene	2.62	µg/L	10-A009380
6/13/2010	Little Su	LS-6	Toluene	8.01	µg/L	10-A009380
6/13/2010	Little Su	LS-6	Ethyl Benzene	<1	µg/L	10-A009380
6/13/2010	Little Su	LS-6	Total Xylene	3.05	µg/L	10-A009380
6/13/2010	Little Su	LS-6	TAH	13.68	µg/L	
6/13/2010	Little Su	LS-7	Benzene	1.91	µg/L	10-A009381
6/13/2010	Little Su	LS-7	Toluene	5.52	µg/L	10-A009381
6/13/2010	Little Su	LS-7	Ethyl Benzene	<1	µg/L	10-A009381
6/13/2010	Little Su	LS-7	Total Xylene	1.05	µg/L	10-A009381
6/13/2010	Little Su	LS-7	TAH	8.48	µg/L	
6/13/2010	Little Su	LS-7x	Benzene	1.73	µg/L	10-A009382
6/13/2010	Little Su	LS-7x	Toluene	5.26	µg/L	10-A009382
6/13/2010	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	10-A009382
6/13/2010	Little Su	LS-7x	Total Xylene	1.09	µg/L	10-A009382

Date	Stream	Site	Measurement	Value	Units	Lab ID
6/13/2010	Little Su	LS-7x	TAH	8.08	µg/L	
5/15/2010	Little Su	LS-1	Benzene	<1	µg/L	10-A007923
5/15/2010	Little Su	LS-1	Toluene	<1	µg/L	10-A007923
5/15/2010	Little Su	LS-1	Ethyl Benzene	<1	µg/L	10-A007923
5/15/2010	Little Su	LS-1	Total Xylene	<1	µg/L	10-A007923
5/15/2010	Little Su	LS-1	TAH	<1	µg/L	
5/15/2010	Little Su	LS-2	Benzene	<1	µg/L	10-A007924
5/15/2010	Little Su	LS-2	Toluene	<1	µg/L	10-A007924
5/15/2010	Little Su	LS-2	Ethyl Benzene	<1	µg/L	10-A007924
5/15/2010	Little Su	LS-2	Total Xylene	<1	µg/L	10-A007924
5/15/2010	Little Su	LS-2	TAH	<1	µg/L	
5/15/2010	Little Su	LS-3	Benzene	<1	µg/L	10-A007925
5/15/2010	Little Su	LS-3	Toluene	<1	µg/L	10-A007925
5/15/2010	Little Su	LS-3	Ethyl Benzene	<1	µg/L	10-A007925
5/15/2010	Little Su	LS-3	Total Xylene	<1	µg/L	10-A007925
5/15/2010	Little Su	LS-3	TAH	<1	µg/L	
5/15/2010	Little Su	LS-5	Benzene	1.81	µg/L	10-A007926
5/15/2010	Little Su	LS-5	Toluene	4.62	µg/L	10-A007926
5/15/2010	Little Su	LS-5	Ethyl Benzene	<1	µg/L	10-A007926
5/15/2010	Little Su	LS-5	Total Xylene	2.37	µg/L	10-A007926
5/15/2010	Little Su	LS-5	TAH	8.8	µg/L	
5/15/2010	Little Su	LS-6	Benzene	1.13	µg/L	10-A007927
5/15/2010	Little Su	LS-6	Toluene	2.31	µg/L	10-A007927
5/15/2010	Little Su	LS-6	Ethyl Benzene	<1	µg/L	10-A007927
5/15/2010	Little Su	LS-6	Total Xylene	1.46	µg/L	10-A007927
5/15/2010	Little Su	LS-6	TAH	4.9	µg/L	
5/15/2010	Little Su	LS-7	Benzene	<1	µg/L	10-A007928
5/15/2010	Little Su	LS-7	Toluene	1.54	µg/L	10-A007928
5/15/2010	Little Su	LS-7	Ethyl Benzene	<1	µg/L	10-A007928
5/15/2010	Little Su	LS-7	Total Xylene	1.22	µg/L	10-A007928
5/15/2010	Little Su	LS-7	TAH	2.76	µg/L	
5/15/2010	Little Su	LS-7x	Benzene	<1	µg/L	10-A007929
5/15/2010	Little Su	LS-7x	Toluene	1.71	µg/L	10-A007929
5/15/2010	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	10-A007929
5/15/2010	Little Su	LS-7x	Total Xylene	1.17	µg/L	10-A007929
5/15/2010	Little Su	LS-7x	TAH	2.88	µg/L	
6/6/2010	Little Su	LS-1	Benzene	<1	µg/L	10-A009367
6/6/2010	Little Su	LS-1	Toluene	2.61	µg/L	10-A009367
6/6/2010	Little Su	LS-1	Ethyl Benzene	<1	µg/L	10-A009367
6/6/2010	Little Su	LS-1	Total Xylene	<1	µg/L	10-A009367
6/6/2010	Little Su	LS-1	TAH	2.61	µg/L	
6/6/2010	Little Su	LS-2	Benzene	1.11	µg/L	10-A009368
6/6/2010	Little Su	LS-2	Toluene	3.44	µg/L	10-A009368
6/6/2010	Little Su	LS-2	Ethyl Benzene	<1	µg/L	10-A009368
6/6/2010	Little Su	LS-2	Total Xylene	<1	µg/L	10-A009368
6/6/2010	Little Su	LS-2	TAH	4.55	µg/L	
6/6/2010	Little Su	LS-3	Benzene	1.38	µg/L	10-A009369

Date	Stream	Site	Measurement	Value	Units	Lab ID
6/6/2010	Little Su	LS-3	Toluene	4.14	µg/L	10-A009369
6/6/2010	Little Su	LS-3	Ethyl Benzene	<1	µg/L	10-A009369
6/6/2010	Little Su	LS-3	Total Xylene	<1	µg/L	10-A009369
6/6/2010	Little Su	LS-3	TAH	5.52	µg/L	
6/6/2010	Little Su	LS-5	Benzene	1.44	µg/L	10-A009370
6/6/2010	Little Su	LS-5	Toluene	4.53	µg/L	10-A009370
6/6/2010	Little Su	LS-5	Ethyl Benzene	<1	µg/L	10-A009370
6/6/2010	Little Su	LS-5	Total Xylene	<1	µg/L	10-A009370
6/6/2010	Little Su	LS-5	TAH	5.97	µg/L	
6/6/2010	Little Su	LS-6	Benzene	1.88	µg/L	10-A009371
6/6/2010	Little Su	LS-6	Toluene	5.69	µg/L	10-A009371
6/6/2010	Little Su	LS-6	Ethyl Benzene	<1	µg/L	10-A009371
6/6/2010	Little Su	LS-6	Total Xylene	1.85	µg/L	10-A009371
6/6/2010	Little Su	LS-6	TAH	9.42	µg/L	
6/6/2010	Little Su	LS-7	Benzene	1.82	µg/L	10-A009372
6/6/2010	Little Su	LS-7	Toluene	5.77	µg/L	10-A009372
6/6/2010	Little Su	LS-7	Ethyl Benzene	<1	µg/L	10-A009372
6/6/2010	Little Su	LS-7	Total Xylene	1.94	µg/L	10-A009372
6/6/2010	Little Su	LS-7	TAH	9.53	µg/L	
6/6/2010	Little Su	LS-7x	Benzene	1.67	µg/L	10-A009373
6/6/2010	Little Su	LS-7x	Toluene	5.56	µg/L	10-A009373
6/6/2010	Little Su	LS-7x	Ethyl Benzene	<1	µg/L	10-A009373
6/6/2010	Little Su	LS-7x	Total Xylene	1.18	µg/L	10-A009373
6/6/2010	Little Su	LS-7x	TAH	8.41	µg/L	
6/19/2010	Little Su	LS Intensive 0600	Benzene	<1	µg/L	10-A009632
6/19/2010	Little Su	LS Intensive 0600	Toluene	1.76	µg/L	10-A009632
6/19/2010	Little Su	LS Intensive 0600	Ethyl Benzene	<1	µg/L	10-A009632
6/19/2010	Little Su	LS Intensive 0600	Total Xylene	<1	µg/L	10-A009632
6/19/2010	Little Su	LS Intensive 0600	TAH	1.76	µg/L	
6/19/2010	Little Su	LS Intensive 0900	Benzene	<1	µg/L	10-A009633
6/19/2010	Little Su	LS Intensive 0900	Toluene	2.88	µg/L	10-A009633
6/19/2010	Little Su	LS Intensive 0900	Ethyl Benzene	<1	µg/L	10-A009633
6/19/2010	Little Su	LS Intensive 0900	Total Xylene	<1	µg/L	10-A009633
6/19/2010	Little Su	LS Intensive 0900	TAH	2.88	µg/L	
6/19/2010	Little Su	LS Intensive 1200	Benzene	<1	µg/L	10-A009634
6/19/2010	Little Su	LS Intensive 1200	Toluene	2.73	µg/L	10-A009634
6/19/2010	Little Su	LS Intensive 1200	Ethyl Benzene	<1	µg/L	10-A009634
6/19/2010	Little Su	LS Intensive 1200	Total Xylene	<1	µg/L	10-A009634
6/19/2010	Little Su	LS Intensive 1200	TAH	2.73	µg/L	
6/19/2010	Little Su	LS Intensive 1500	Benzene	1.79	µg/L	10-A009635
6/19/2010	Little Su	LS Intensive 1500	Toluene	5.4	µg/L	10-A009635
6/19/2010	Little Su	LS Intensive 1500	Ethyl Benzene	<1	µg/L	10-A009635
6/19/2010	Little Su	LS Intensive 1500	Total Xylene	1.12	µg/L	10-A009635
6/19/2010	Little Su	LS Intensive 1500	TAH	8.31	µg/L	
6/19/2010	Little Su	LS Intensive 1800	Benzene	<1	µg/L	10-A009636
6/19/2010	Little Su	LS Intensive 1800	Toluene	2.7	µg/L	10-A009636
6/19/2010	Little Su	LS Intensive 1800	Ethyl Benzene	<1	µg/L	10-A009636

Date	Stream	Site	Measurement	Value	Units	Lab ID
6/19/2010	Little Su	LS Intensive 1800	Total Xylene	<1	µg/L	10-A009636
6/19/2010	Little Su	LS Intensive 1800	TAH	2.7	µg/L	
6/19/2010	Little Su	LS Intensive 2100	Benzene	1.74	µg/L	10-A009637
6/19/2010	Little Su	LS Intensive 2100	Toluene	5.2	µg/L	10-A009637
6/19/2010	Little Su	LS Intensive 2100	Ethyl Benzene	<1	µg/L	10-A009637
6/19/2010	Little Su	LS Intensive 2100	Total Xylene	<1	µg/L	10-A009637
6/19/2010	Little Su	LS Intensive 2100	TAH	6.94	µg/L	
6/20/2010	Little Su	LS Intensive 0600	Benzene	<1	µg/L	10-A009639
6/20/2010	Little Su	LS Intensive 0600	Toluene	<1	µg/L	10-A009639
6/20/2010	Little Su	LS Intensive 0600	Ethyl Benzene	<1	µg/L	10-A009639
6/20/2010	Little Su	LS Intensive 0600	Total Xylene	<1	µg/L	10-A009639
6/20/2010	Little Su	LS Intensive 0600	TAH	<1	µg/L	
6/20/2010	Little Su	LS Intensive 0900	Benzene	1.93	µg/L	10-A009640
6/20/2010	Little Su	LS Intensive 0900	Toluene	6.41	µg/L	10-A009640
6/20/2010	Little Su	LS Intensive 0900	Ethyl Benzene	<1	µg/L	10-A009640
6/20/2010	Little Su	LS Intensive 0900	Total Xylene	1.36	µg/L	10-A009640
6/20/2010	Little Su	LS Intensive 0900	TAH	9.7	µg/L	
6/20/2010	Little Su	LS Intensive 1200	Benzene	<1	µg/L	10-A009641
6/20/2010	Little Su	LS Intensive 1200	Toluene	2.49	µg/L	10-A009641
6/20/2010	Little Su	LS Intensive 1200	Ethyl Benzene	<1	µg/L	10-A009641
6/20/2010	Little Su	LS Intensive 1200	Total Xylene	<1	µg/L	10-A009641
6/20/2010	Little Su	LS Intensive 1200	TAH	2.49	µg/L	
6/20/2010	Little Su	LS Intensive 1500	Benzene	<1	µg/L	10-A009642
6/20/2010	Little Su	LS Intensive 1500	Toluene	3.05	µg/L	10-A009642
6/20/2010	Little Su	LS Intensive 1500	Ethyl Benzene	<1	µg/L	10-A009642
6/20/2010	Little Su	LS Intensive 1500	Total Xylene	<1	µg/L	10-A009642
6/20/2010	Little Su	LS Intensive 1500	TAH	3.05	µg/L	
6/20/2010	Little Su	LS Intensive 1800	Benzene	1.49	µg/L	10-A009643
6/20/2010	Little Su	LS Intensive 1800	Toluene	4.16	µg/L	10-A009643
6/20/2010	Little Su	LS Intensive 1800	Ethyl Benzene	<1	µg/L	10-A009643
6/20/2010	Little Su	LS Intensive 1800	Total Xylene	2.75	µg/L	10-A009643
6/20/2010	Little Su	LS Intensive 1800	TAH	8.4	µg/L	
6/20/2010	Little Su	LS Intensive 2100	Benzene	<1	µg/L	10-A009644
6/20/2010	Little Su	LS Intensive 2100	Toluene	2.32	µg/L	10-A009644
6/20/2010	Little Su	LS Intensive 2100	Ethyl Benzene	<1	µg/L	10-A009644
6/20/2010	Little Su	LS Intensive 2100	Total Xylene	<1	µg/L	10-A009644
6/20/2010	Little Su	LS Intensive 2100	TAH	2.32	µg/L	
6/20/2010	Little Su	LS-6	Benzene	1.04	µg/L	10-A009647
6/20/2010	Little Su	LS-6	Toluene	3.15	µg/L	10-A009647
6/20/2010	Little Su	LS-6	Ethyl Benzene	<1	µg/L	10-A009647
6/20/2010	Little Su	LS-6	Total Xylene	<1	µg/L	10-A009647
6/20/2010	Little Su	LS-6	TAH	4.19	µg/L	
6/20/2010	Little Su	LS-2	Benzene	<1	µg/L	10-A009648
6/20/2010	Little Su	LS-2	Toluene	2.09	µg/L	10-A009648
6/20/2010	Little Su	LS-2	Ethyl Benzene	<1	µg/L	10-A009648
6/20/2010	Little Su	LS-2	Total Xylene	<1	µg/L	10-A009648
6/20/2010	Little Su	LS-2	TAH	2.09	µg/L	

Date	Stream	Site	Measurement	Value	Units	Lab ID
6/20/2010	Little Su	LS-7	Benzene	1.48	µg/L	10-A009649
6/20/2010	Little Su	LS-7	Toluene	4.78	µg/L	10-A009649
6/20/2010	Little Su	LS-7	Ethyl Benzene	<1	µg/L	10-A009649
6/20/2010	Little Su	LS-7	Total Xylene	<1	µg/L	10-A009649
6/20/2010	Little Su	LS-7	TAH	6.26	µg/L	
6/20/2010	Little Su	LS-5	Benzene	<1	µg/L	10-A009650
6/20/2010	Little Su	LS-5	Toluene	2.83	µg/L	10-A009650
6/20/2010	Little Su	LS-5	Ethyl Benzene	<1	µg/L	10-A009650
6/20/2010	Little Su	LS-5	Total Xylene	<1	µg/L	10-A009650
6/20/2010	Little Su	LS-5	TAH	2.83	µg/L	
6/20/2010	Little Su	LS-1	Benzene	<1	µg/L	10-A009651
6/20/2010	Little Su	LS-1	Toluene	2.02	µg/L	10-A009651
6/20/2010	Little Su	LS-1	Ethyl Benzene	<1	µg/L	10-A009651
6/20/2010	Little Su	LS-1	Total Xylene	<1	µg/L	10-A009651
6/20/2010	Little Su	LS-1	TAH	2.02	µg/L	
6/20/2010	Little Su	LS-16	Benzene	2.06	µg/L	10-A009652
6/20/2010	Little Su	LS-16	Toluene	6.35	µg/L	10-A009652
6/20/2010	Little Su	LS-16	Ethyl Benzene	<1	µg/L	10-A009652
6/20/2010	Little Su	LS-16	Total Xylene	1.1	µg/L	10-A009652
6/20/2010	Little Su	LS-16	TAH	9.51	µg/L	
6/20/2010	Little Su	LS-8	Benzene	1.48	µg/L	10-A009653
6/20/2010	Little Su	LS-8	Toluene	4.66	µg/L	10-A009653
6/20/2010	Little Su	LS-8	Ethyl Benzene	<1	µg/L	10-A009653
6/20/2010	Little Su	LS-8	Total Xylene	<1	µg/L	10-A009653
6/20/2010	Little Su	LS-8	TAH	6.14	µg/L	
6/27/2010	Little Su	LS-1	Benzene	<1	µg/L	10-A010057
6/27/2010	Little Su	LS-1	Toluene	2.7	µg/L	10-A010057
6/27/2010	Little Su	LS-1	Ethyl Benzene	<1	µg/L	10-A010057
6/27/2010	Little Su	LS-1	Total Xylene	<1	µg/L	10-A010057
6/27/2010	Little Su	LS-1	TAH	2.7	µg/L	
6/27/2010	Little Su	LS-3	Benzene	<1	µg/L	10-A010058
6/27/2010	Little Su	LS-3	Toluene	3.09	µg/L	10-A010058
6/27/2010	Little Su	LS-3	Ethyl Benzene	<1	µg/L	10-A010058
6/27/2010	Little Su	LS-3	Total Xylene	<1	µg/L	10-A010058
6/27/2010	Little Su	LS-3	TAH	3.09	µg/L	
6/27/2010	Little Su	LS-7	Benzene	<1	µg/L	10-A010059
6/27/2010	Little Su	LS-7	Toluene	2.31	µg/L	10-A010059
6/27/2010	Little Su	LS-7	Ethyl Benzene	<1	µg/L	10-A010059
6/27/2010	Little Su	LS-7	Total Xylene	<1	µg/L	10-A010059
6/27/2010	Little Su	LS-7	TAH	2.31	µg/L	



TAH concentrations for all sampling dates and all sampling locations near the PUF. Red diamonds are stream discharge.

Appendix B. Public Use Facility Entrance Booth Boat Counts

The total boat count at the entrance booth in 2009 was 1348 and 410, or 30.4% of those used 2-Cycle motors. In 2008 total boat counts at the entrance booth was 1810 and 575, or 31.76% used 2-Cycle motors.

Date	Day	Boat Totals	2-Cycle	Percent 2-Cycle	Total/Week	Percent of Season Use/Week	Percent of Weekly Use by Day
5/16/2009	Sat	12	0	0.0			75.0
5/17/2009	Sun	4	0	0.0	16	1.19	25.0
5/20/2009	Wed	3	0	0.0			10.7
5/21/2009	Thurs	4	0	0.0			14.2
5/22/2009	Fri	11	0	0.0			39.2
5/23/2009	Sat	10	0	0.0	28	2.08	35.7
6/8/2009	Mon	16	5	31.3			12.9
6/9/2009	Tues	13	1	7.7			10.5
6/10/2009	Wed	6	2	33.3			4.84
6/11/2009	Thurs	7	1	14.3			5.65
6/12/2009	Fri	28	5	17.9			22.6
6/13/2009	Sat	19	4	21.1			15.3
6/14/2009	Sun	35	12	34.3	124	9.20	28.2
6/15/2009	Mon	7	2	28.6			7.4
6/16/2009	Tues	6	3	50.0			6.3
6/18/2009	Thurs	7	2	28.6			7.4
6/19/2009	Fri	25	9	36.0			26.3
6/20/2009	Sat	29	10	34.5			30.5
6/21/2009	Sun	21	7	33.3	95	7.05	22.1
6/22/2009	Mon	22	10	45.5			17.2
6/23/2009	Tues	13	4	30.8			10.2
6/25/2009	Thurs	20	4	20.0			15.6
6/26/2009	Fri	23	8	34.8			17.9
6/27/2009	Sat	26	8	30.8			20.3
6/28/2009	Sun	24	8	33.3	128	9.50	18.8
6/29/2009	Mon	8	2	25.0			26.8
6/30/2009	Tues	2	1	50.0			6.7
7/1/2009	Wed	5	0	0.0			16.7
7/2/2009	Thurs	15	3	20.0	30	2.23	50.0
7/13/2009	Mon	3	1	33.3			6.1
7/14/2009	Tues	3	0	0.0			6.1
7/15/2009	Wed	3	0	0.0			6.1
7/16/2009	Thurs	8	1	12.5			16.3
7/17/2009	Fri	3	1	33.3			6.1
7/18/2009	Sat	8	1	12.5			16.3
7/19/2009	Sun	21	5	23.8	49	3.64	42.9
7/20/2009	Mon	7	3	42.9			8.2
7/21/2009	Tues	5	3	60.0			5.9
7/22/2009	Wed	6	1	16.7			7.1
7/23/2009	Thurs	8	3	37.5			9.4
7/24/2009	Fri	17	7	41.2			20.0
7/25/2009	sat	20	10	50.0			23.5
7/26/2009	Sun	22	9	40.9	85	6.31	25.9
7/27/2009	Mon	8	6	75.0			5.9

Date	Day	Boat Totals	2-Cycle	Percent 2-Cycle	Total/Week	Percent of Season Use/Week	Percent of Weekly Use by Day
7/28/2009	Tues	8	4	50.0			5.9
7/29/2009	Wed	16	5	31.3			11.9
7/30/2009	Thurs	28	8	28.6			20.7
7/31/2009	Fri	26	9	34.6			19.3
8/1/2009	Sat	33	11	33.3			24.4
8/2/2009	Sun	16	6	37.5	135	10.01	11.9
8/3/2009	Mon	42	16	38.1			16.4
8/4/2009	Tues	14	2	14.3			5.5
8/5/2009	Wed	17	0	0.0			6.6
8/6/2009	Thurs	45	10	22.2			17.6
8/7/2009	Fri	50	19	38.0			19.5
8/8/2009	Sat	40	14	35.0			15.6
8/9/2009	Sun	48	16	33.3	256	18.99	18.8
8/10/2009	Mon	30	12	40.0			15.8
8/11/2009	Tues	20	10	50.0			10.5
8/12/2009	Wed	21	8	38.1			11.1
8/13/2009	Thurs	33	10	30.3			17.4
8/14/2009	Fri	28	7	25.0			14.7
8/15/2009	Sat	34	8	23.5			17.9
8/16/2009	Sun	24	8	33.3	190	14.09	12.6
8/17/2009	Mon	17	6	35.3			13.4
8/18/2009	Tues	12	3	25.0			9.5
8/19/2009	Wed	6	3	50.0			4.7
8/20/2009	Thurs	13	7	53.8			10.2
8/21/2009	Fri	19	6	31.6			14.9
8/22/2009	Sat	25	8	32.0			19.7
8/23/2009	Sun	35	11	31.4	127	9.42	27.6
8/24/2009	Mon	2	1	50.0			3.6
8/25/2009	Tues	10	1	10.0			17.9
8/26/2009	Wed	12	4	33.3			21.4
8/27/2009	Thurs	5	1	20.0			8.9
8/28/2009	Fri	6	2	33.3			10.7
8/29/2009	Sat	13	5	38.5			23.2
8/30/2009	Sun	8	2	25.0	56	4.15	14.3
8/31/2009	Mon	3	0	0.0			9.4
9/1/2009	Tues	5	2	40.0			15.6
9/2/2009	Wed	2	0	0.0			6.3
9/3/2009	Thurs	4	0	0.0			12.5
9/5/2009	Sat	3	0	0.0			9.4
9/6/2009	Sun	7	2	28.6	32	2.37	21.9
9/7/2009	Mon	2	1	50.0			40.0
9/8/2009	Tues	3	0	0.0	5	0.37	60.0

Appendix C. Site Photographs

Appendix D. Quality Assurance Project Plan