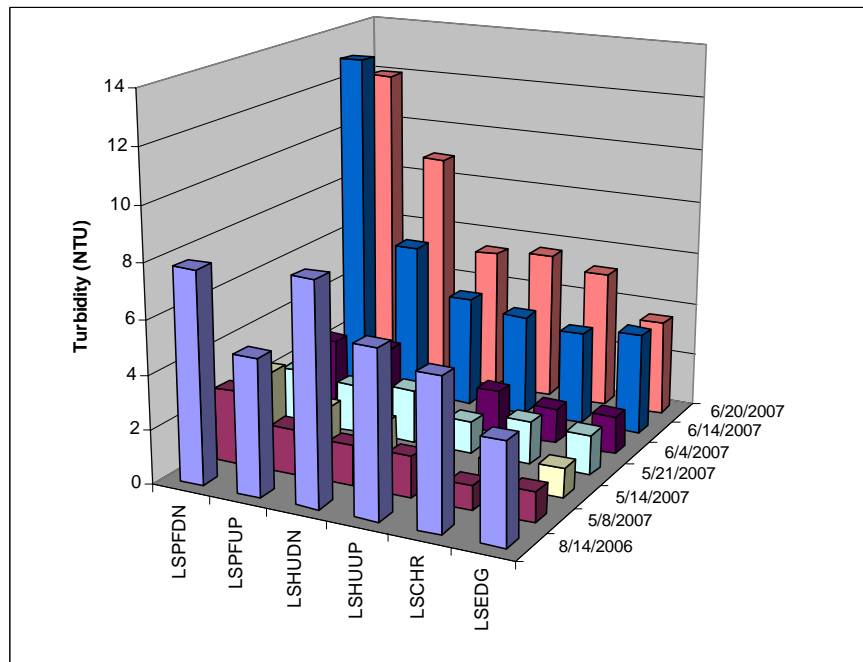


# Water Quality Evaluation of the Lower Little Susitna River



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## Summary

Water quality sampling was conducted on the Little Susitna River in order to address Alaska Clean Water Actions Plan priorities. Plan priorities were to evaluate potential impacts to water quality related to recreational use of the lower river: from Houston to Cook Inlet. Water samples were collected weekly from late July through September of 2007 and from early May through June of 2008 at four sampling sites located upstream from Houston, downstream from Houston at Miller's Reach, upstream of the boat launch at the Public Use Facility, and downstream of the boat launch. Samples were analyzed for pH, specific conductivity, total aromatic hydrocarbons, turbidity, and dissolved oxygen. Water temperature loggers were placed at Miller's Reach and downstream of the Public Use Facility. The relative abundance of juvenile salmon was determined through catch rates at each sampling station during August and September of 2007. The results of water chemical analyses and temperature were compared against State Water Quality Standards. Measures of fish abundance were used to determine if there was a biotic response to any of the water chemistry measures.

Concentrations of total aromatic hydrocarbons exceeded the State Water Quality Standard of 10 µg/L below the Public Use Facility on one sampling date in August of 2007 and on five sampling dates above and below the Public Use Facility in 2008. Concentrations of hydrocarbons over 70 µg/L were recorded below the Public Use Site. Changes in hydrocarbon concentrations coincided with increased boat use during the sport fisheries consistent with other studies. These concentrations are higher in the Little Susitna River than have been reported for the Kenai River and are likely due to differences in stream flows. We also observed concentrations of total aromatic hydrocarbons above State Water Quality Standards at the sampling location upstream from Houston on two occasions. Based on variation in concentrations with slight adjustment in the sampling site and differences in hydrocarbon constituents, we believe that contamination is due to runoff from an adjacent undeveloped parking area.

Stream water turbidity increased above, and to a greater extent, below the Public Use Facility during concentrated use. Turbidity was greater than 5 NTU above background concentrations on one occasion in August of 2007 and greater than 5 NTU above background concentrations for three consecutive weeks during June of 2008.

Stream water temperatures downstream of the Public Use Facility exceeded 15°C on 50% of the days recorded from May through September of 2007. However, comparisons with other studies reveal that water temperatures in the Little Susitna River are similar to other cool water streams within the region.

We measured differences in the catch rate of juvenile coho salmon during August concurrent with differences in turbidity and not during September when turbidity was similar among sites. These data do not confirm a biotic response to changes in turbidity, but suggest that further evaluation is warranted.

Water quality sampling should be continued on the Little Susitna River near the Public Use Facility to evaluate the extent and duration of contamination and to evaluate changes in concentration relative to boat motor types.

## Introduction

The Little Susitna River is located within South-central Alaska and flows from the Talkeetna Mountains adjacent to the communities of Wasilla and Houston. The river travels over 100 miles from 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. The river supports a highly popular salmon and trout fishery as well as recreational non-motorized and motorized boating. There is a relatively high degree of residential development 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 Little Susitna River is related to the salmon sport fishery. Access is limited to undeveloped boat launches near Houston (River Mile 62) and at the Public Use Facility (River Mile 25). In 2007, over 11,000 anglers accessed the Little Susitna River at the Public Use Facility during the Chinook and coho salmon sport fisheries.

The high degree of boat-accessed fishing, particularly near the Public Use Facility has raised concerns over potential impacts to water quality. Stream water turbidity appears to increase in the lower river during the sport fishery, which was confirmed by sampling conducted in 2006 and 2007 (Davis and Davis 2007). 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 (Oasis 2006, Oasis 2008).

The evaluation of potential impacts to water quality within Alaska is evaluated and prioritized through the Alaska Clean Water Actions Plan (ACWA). This plan is developed through the coordination among the state resources agencies including the Department of Environmental Conservation, the Department of Fish and Game, and the Department of Natural Resources. Based upon preliminary data, the state developed ACWA priorities for the Little Susitna River. These included intensive monitoring of the lower river (from Houston to Cook Inlet) for water quality parameters related to recreational use. Parameters included turbidity, dissolved oxygen, temperature, and hydrocarbons.

This study was developed and implemented to address these ACWA priorities. Stream water quality sampling was conducted at 4 locations. Two locations bracketed potential impacts surrounding the city of Houston, and two locations bracketed potential impacts near the Public Use Facility. Water quality parameters included hydrocarbons, water temperature, turbidity, pH, specific conductivity, and dissolved oxygen. These chemical and physical measures were accompanied by measures of the fish community. Data were collected during the fall of 2007 and the spring of 2008.

## Methods

Water samples were collected from the Little Susitna River above and below locations where there is consistent boat use (Table 1). Sampling locations were located near the Park's Highway upstream and downstream at Miller's reach; and above and below the Public Use Facility. Samples were collected weekly on a Saturday or Sunday between 12:00 and 16:00 from July 29, 2007 through September 16, 2007, and weekly from May 10 through June 29, 2008. Samples were analyzed for total aromatic hydrocarbons (TAH) (consisting of benzene, toluene, ethyl benzene, and xylene (BTEX)), dissolved oxygen, pH, specific conductivity, and turbidity (see the Sampling Plan and QAPP in Appendix B for detailed descriptions of sample collection and processing). Stream water temperature was recorded on each sampling date and measured continuously (one hour or 15 minute intervals) from data loggers (HOBO Stowaway or Water Temp Pro) located at Miller's Reach and below the Public Use Facility.

On each sampling date we recorded the number of trailers and vehicles parked at the Miller's Reach launch near Houston. We recorded the number of boats seen during sample collection at each site and the type of motor when possible (2-cycle or 4-cycle). We obtained the number of anglers using the Public Use Facility launch from records kept by the Alaska Division of Parks and Recreation at the entry station for 2007.

Juvenile fish were sampled at each sampling location using six baited (commercial salmon roe) minnow traps at each site on August 14 and September 16, 2007. Juvenile fish were identified and measured to fork length, observed for any deformities, eroded fins, lesions, or tumors (DELT anomalies) and released on site.

**Table 1. Location and description of water quality sampling locations.**

Site Name	Site Description	Latitude	Longitude	River Mile
LSHUUP	Upstream of Houston at the ADFG Weir Site	61° 37' 30.3"	149° 46' 57.5"	64
LSHUDN	Downstream of Houston at the Miller's Reach Boat Launch	61° 37' 16.6"	149° 50' 57.8"	59
LSPFUP	1.0 km upstream of the Public Use Site	61° 26' 29.8"	150° 09' 35.5"	25.5
LSPFDN	0.5 km downstream of the Public Use Site	61° 26' 07.4"	150° 10' 21.8"	24.8
LSPFDNX	LSPFDN replicate, 0.5 km downstream from Public Use Site	61° 26' 07.4"	150° 10' 21.8"	24.8

## Results

### Quality Assurance Objectives

The precisions of total aromatic hydrocarbon measures, or the agreement between replicates, met project objectives on 9 of the 15 sampling dates. Agreement between replicates occurred on all dates when concentrations were below detection limits. The poorest measure of precision was due to a difference of 3.15 µg/L, when the sample value was 5.25 µg/L and the replicate 2.10 µg/L. The largest difference between samples was

19.4 µg/L, when the sample value was 75.20 µg/L, and the replicate was 55.80 µg/L. Both sample and replicate values are shown in Figures 1 and 4.

Precision estimates are not reported in other studies for comparisons. Oasis Environmental, in hydrocarbon studies of the Kenai River and Big Lake, reports precision measures when concentrations exceed 10 times detection limits (Oasis 2008, Oasis 2006), which did not occur in those studies. Using the sum of BTEX detection limits, the TAH detection limit for this study is 2.5 µg/L. Therefore, using the standard developed by Oasis, precision would be reported for values over 25 µg/L. TAH concentrations exceeded this value on two sampling dates. Precision of samples on these dates exceeded objectives on one of these dates. Precision also is not reported by the Kenai Watershed Forum (2008). However, differences between duplicates appear to be similar to data presented here based on personal communication with Jim Czarneski (Kenai Watershed Forum). We believe that differences among replicates are due, at least in part, to variability in concentration throughout the water column. It appears likely that hydrophobic hydrocarbon molecules would be unevenly distributed through the water column. If this is the case, the average of multiple samples may be a better measure of TAH concentrations.

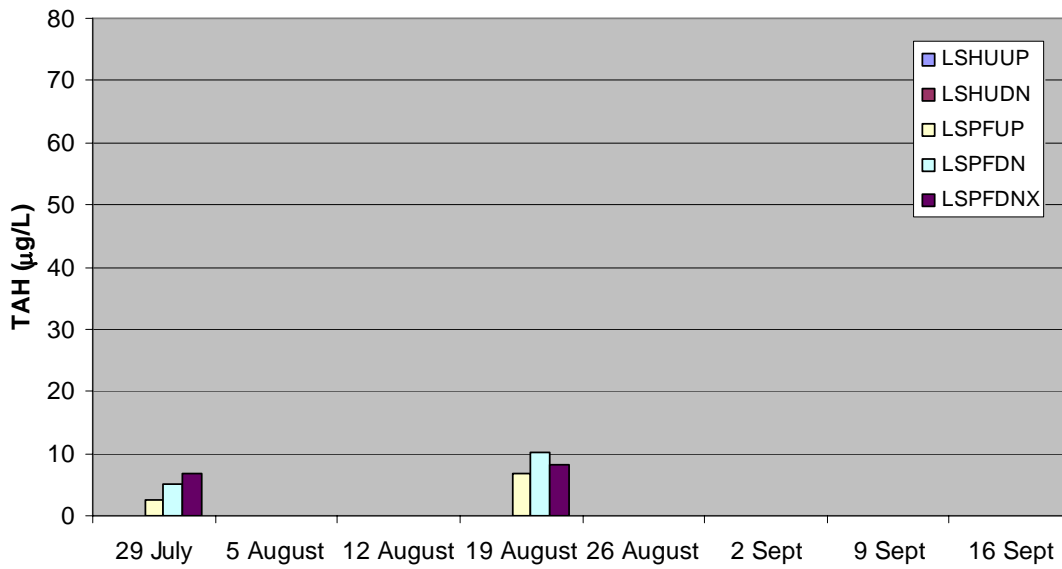
Stream water turbidity measures met precision objectives on all but four sampling dates. The maximum difference between turbidity replicates was 2.5 NTU when concentrations were 8.0 and 5.5 NTU for sample and replicate measures, respectively.

## Hydrocarbons

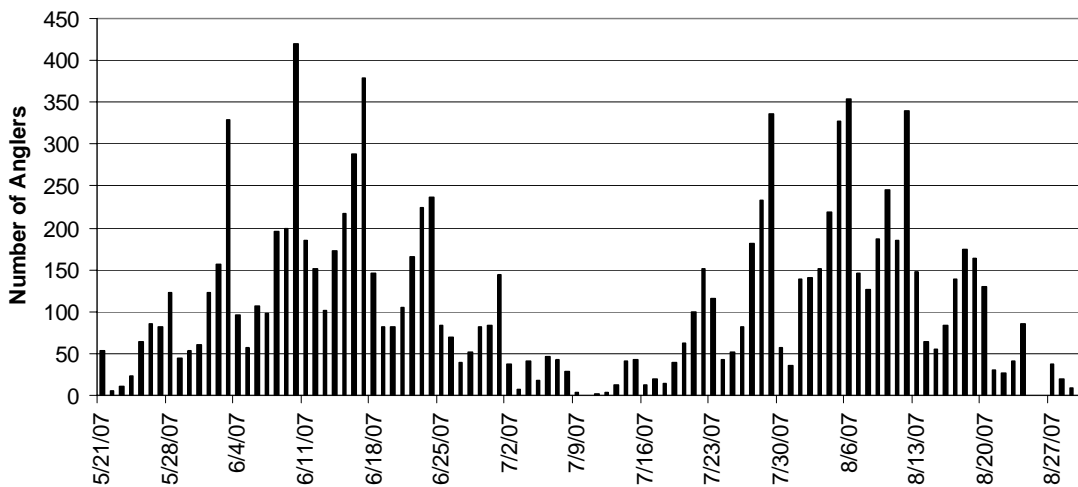
The concentration of TAH was below detection limits on most sampling dates at most location throughout the fall sampling. However, TAH were detected from samples collected on two sampling dates at sites located above and below the Public Use Facility boat launch and parking area on July 29 and August 19 of 2007 (Figure 1 and Appendix A). The state water quality standard for TAH is 10 µg/L (18 AAC 70.020 (b)(5)(A)(iii)). This concentration was exceeded on August 19 below the Public Use Facility when concentrations of 10.17 µg/L were recorded. However, results from a replicate sample taken at the same time and location were 8.15 µg/L resulting in an average of 9.16 µg/L.

High concentrations occurred during the coho sport fishery and coincided with times of heavy use as indicated by the number of registered anglers (Figure 2) and our observations of boat use. High use also was recorded on August 5 and August 12, 2007; however, concentrations of TAH were below detection limits. Differences among sampling dates may be related to differences in stream discharge, with higher flows diluting hydrocarbon inputs and resulting in lower concentrations. Stream discharge was not measured at the sampling locations; however, discharge recorded at the USGS gauging station (Station 15290000) located 70 miles upstream increased from 260 cfs on July 29 to 648 cfs on August 5, decreased to 415 cfs on August 12 and then to 296 cfs on August 19 (Figure 3).

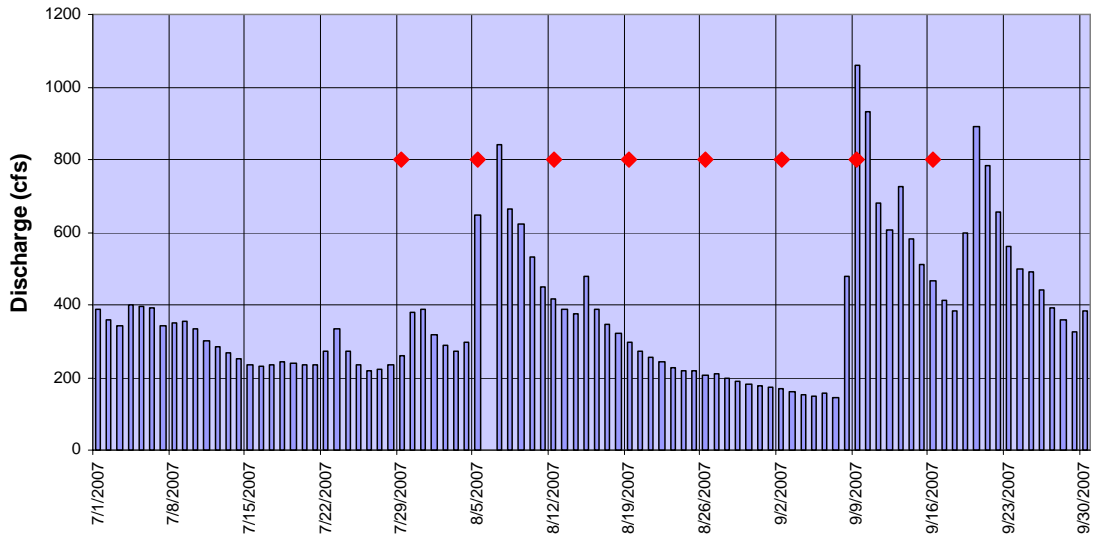
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**Figure 1. Concentrations of total aromatic hydrocarbons at the Little Susitna sampling stations in 2007. LSHUUP is upstream of Houston at or near the ADFG weir, LSHUDN is below Houston at the Miller’s Reach undeveloped launch, LSPFUP is approximately 1.0 km upstream of the Public Use Facility, LSPFDN is 0.5 km downstream from the Public use boat launch, and LSPFDNX is a replicate of the LSPFDN sample.**



**Figure 2. Number of anglers recorded at the entrance to the Public Use Facility campground and boat launch in 2007.**



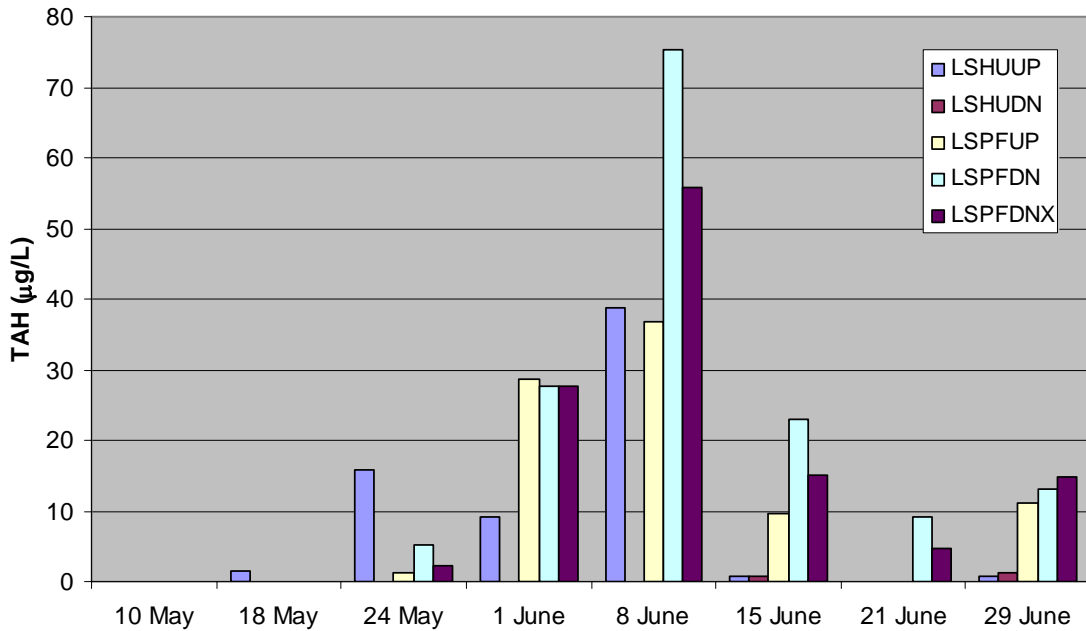
**Figure 3. Sampling dates (red triangles) relative to discharge recorded at the USGS sampling station.**

Spring 2008 sampling was conducted weekly on weekends from May 10 through June 29. Concentrations of TAH were below detection limits on May 10, above detection limits at one or more sites on the remaining sampling dates, and exceeded water quality standards at one or more sites on 5 of the 8 sampling dates (Figure 4). Concentrations exceeded water quality standards at sampling locations above and below the Public Use Facility; with concentrations slightly higher at the downstream location. Angler use data collected at the entrance booth are not yet available for 2008; however, high concentrations occurred during heavy use periods through the Chinook salmon sport fishery as recorded in May and June of 2007 (Figure 2). The number of trailers in the boat launch parking area was the best indication of use that we recorded. Highest use based on this measure was from June 1 through June 21 (Figure 5). Concentrations on June 21 were below detection limits even though indicators of use remained high. The differences in concentrations could not be explained entirely by differences in stream flow (Figure 6). In 2008 stream flows were measured at the sampling station 1.0 km upstream from the Public Use boat launch (except for June 29 due to equipment failure). Stream flows were 386 cfs on June 1, 465 cfs on June 8, 594 on June 15, and 404 on June 21. If the input of hydrocarbons were constant among these dates, concentrations should have been higher on June 21 as flows decreased.

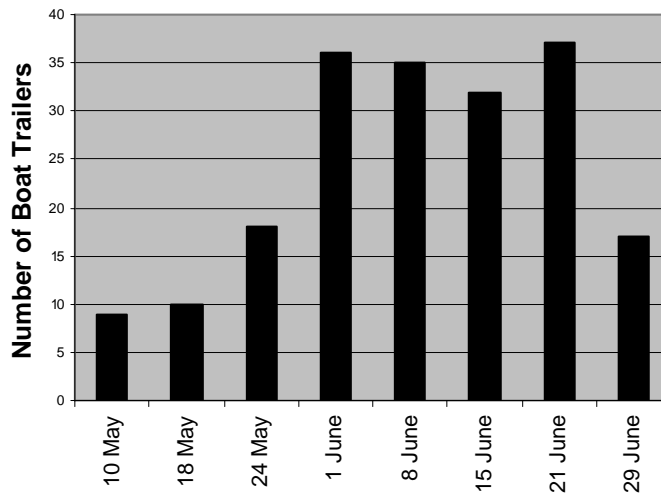
Concentrations of TAH also exceeded water quality standards at the reference site located upstream from Houston on three sampling dates in 2008. These high concentrations are not related to boat use and we hypothesize that they are due to runoff from an adjacent undeveloped parking area. This area of the stream is closed to sport fishing for salmon and there is little or no boat traffic. River access in this area is limited, and in 2007 we initiated sampling from a gravel pad used by the Alaska Department of Fish and Game (ADFG) to install and maintain a salmon counting weir. However, sampling was moved upstream approximately 50 m once the weir was installed. In 2008 we shifted our sampling station back to the ADFG weir site. Upon receipt of initial water sample results



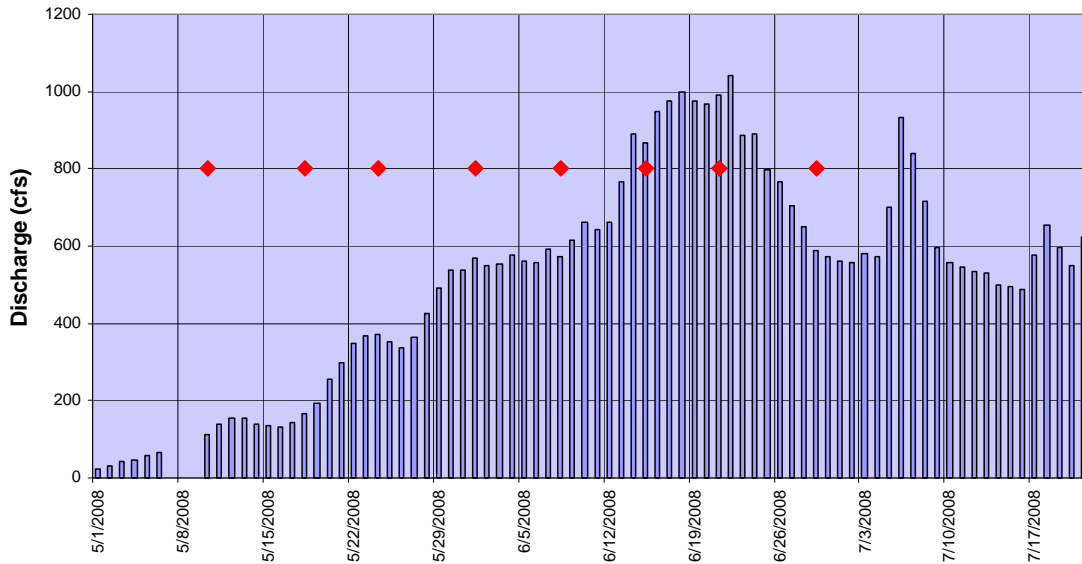
showing hydrocarbons within our samples, we suspected contamination from runoff and shifted our sampling location back upstream from June 15 through June 29. The constituents within samples at the upstream Houston site are different from those collected near the Public Use Facility. At the upstream Houston site, the dominant constituent are the total xylenes; while at the Public Use Site, toluene is the major component.



**Figure 4. Concentrations of total aromatic hydrocarbons at the Little Susitna sampling stations in May and June of 2008.**



**Figure 5. Number of boat trailers at the boat launch.**



**Figure 6. Water sampling dates (red diamonds) relative to stream flow at the USGS sampling station.**

## Turbidity

There is a visible increase in stream water turbidity during heavy boat use of the lower Little Susitna River throughout the coho and Chinook sport fisheries. We did not collect a sufficient number of samples to assess impairment as defined in Alaska's Draft Integrated Water Quality Monitoring and Assessment Report (ADEC 2008), which requires 20 samples collected during a 3 week period. Background turbidity was established from samples collected above and below the Park's Highway near Houston. These sites are located 30 miles away, but are the closest road-accessible locations upstream of the area potentially impacted by human activity. There are 5 tributaries entering the Little Susitna River between Houston and the Public Use Facility. These tributaries drain extensive wetland areas and are of low slope and are not expected to cause an increase in turbidity. Average turbidity from samples collected weekly from May 2007 through June 2008, excluding storm flows were 3.0 and 3.4 for sites located above and below Houston, respectively (Figures 7 and 8) (see Davis and Davis 2007 and Appendix A for spring 2007 data). During early May and late September of 2007, when there was little activity on the river, there were no differences in turbidity between the Houston sites and the sites near the Public Use Facility. During heavy use periods in August of 2007, and May and June of 2008, turbidity increased above and below the Public Use Facility relative to the upstream reference sites. The highest increase during August of 2007 occurred on the 12<sup>th</sup> when turbidity increased to 10 NTU downstream from the Public Use Facility. This is 7 NTU above average upstream values and 6 NTU above samples collected upstream on the same day (Table 2). Turbidity was similar among sites in September following the coho fishery, except for September 9, when large increases in turbidity were recorded near Houston following a storm event, but had not reached the lower Little Susitna in the time it took to drive to the sampling sites.

We measured larger differences in turbidity between reference and sites located near the Public Use Facility during the spring of 2008. The increase in turbidity coincided with increased boat use of the river. Early in the Chinook sport fishery in May and June, fishing activity was primarily downstream of the launch and increased turbidity was recorded at the downstream sampling site; however, as fishing followed the Chinook salmon upstream, turbidity began to increase upstream as well. As activity tapered off by the end of June, turbidity was similar between reference and lower-river sampling stations. Figure 9 shows the daily variability in turbidity during heavy use on July 26 and 27 of 2007 above and below the Public Use Facility. Turbidity at both sites is at 0 from midnight to approximately 05:00. Turbidity then increases through the day as use of the river increases<sup>1</sup>.

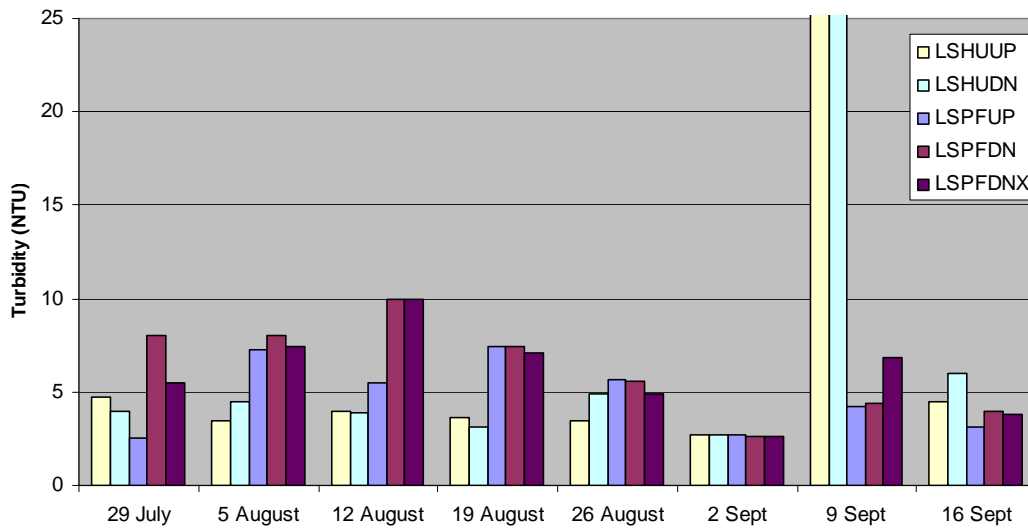


Figure 7. Stream water turbidity in 2007 at the Little Susitna sampling stations.

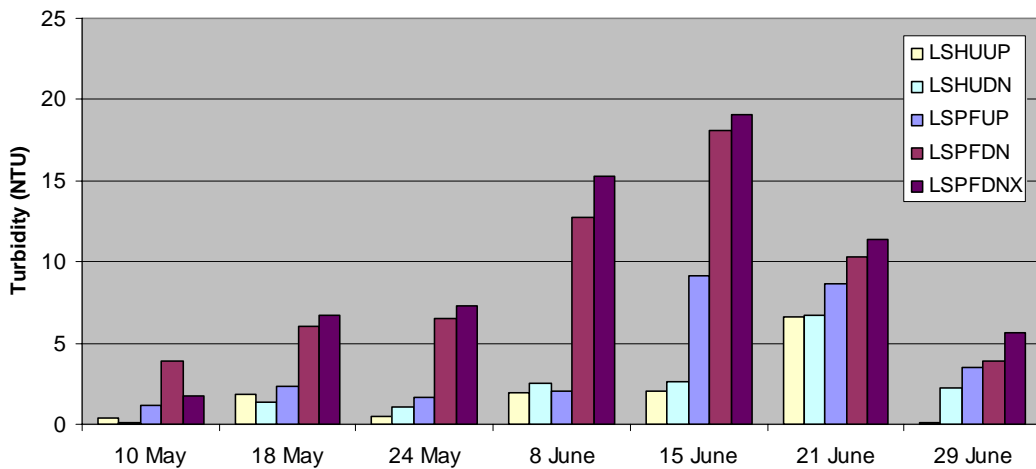
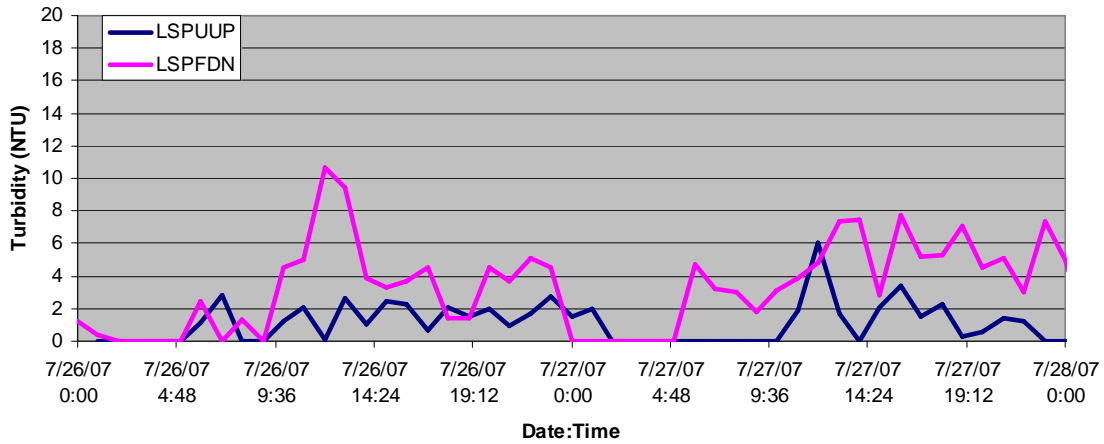


Figure 8. Stream water turbidity in the spring of 2008 at the Little Susitna sampling stations.

<sup>1</sup> Data collected by Hach Sondes hourly. These methods are not part of the study design and are not described within the approved QAPP for 2007/2008 but are included for data collection in 2008/2009.

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**Figure 9. Daily variability in turbidity at the lower river sampling stations during heavy use in July of 2007.**

Maximum turbidity recorded in the spring of 2008 was 18 NTU at the site below the Public Use Facility on June 15, which was 16 NTU above background. Turbidity at the reference site and above and below the Public Use Facility for each sampling date is shown in Table 2. There is a greater increase in turbidity below the Public Use Facility compared to the reference site than there is above. Differences were greater in the spring of 2008 than during the fall of 2007. Turbidity was 6 or more NTU above background at this site for three consecutive weeks in June of 2008.

**Table 2. Turbidity (NTU) at the upstream reference and sites located above and below the Public Use Facility and the difference among sites for each sampling date.**

Date	LSHUUP	LSPFUP	LSPFDN	LSHUUP to LSPFUP	LSHUUP to LSPFDN
7/29/2007	4.7	3.3	7.2	-1.4	2.5
8/5/2007	3.5	7.3	8	3.8	4.5
8/12/2007	4	5.5	10	1.5	6
8/19/2007	3.6	7.4	7.4	3.8	3.8
8/26/2007	3.5	5.7	5.6	2.2	2.1
9/2/2007	2.7	2.7	2.6	0	-0.1
9/9/2007	34	4.2	4.4	-29.8	-29.6
9/17/2007	4.5	3.1	4	-1.4	-0.5
5/10/2008	0.38	1.18	3.89	0.8	3.51
5/18/2008	1.84	2.31	6.04	0.47	4.2
5/24/2008	0.47	1.62	6.47	1.15	6
6/8/2008	1.96	2.03	12.7	0.07	10.74
6/15/2008	2.07	9.17	18.1	7.1	16.03
6/21/2008	6.59	8.63	10.3	2.04	3.71
6/29/2008	0.12	3.54	3.89	3.42	3.77

## Water Chemistry and Temperature

The results of sample analyses for pH, specific conductivity, and dissolved oxygen are provided in Appendix A. Stream water pH was near neutral on most sampling dates, ranging from 7.1 to 7.4. However, pH dropped to 6.8 during storm flows at Houston on September 9, 2007. Specific conductivity ranged from 60 to 90  $\mu\text{S}/\text{cm}$ . Dissolved oxygen was near saturation on all sampling dates.

Stream water temperatures ranged from 6 to 20°C from May through September of 2007 at the Public Use Facility (Figure 10) and from 4 to 16°C at Miller's Reach (Figure 11). Water temperatures in the Little Susitna River are poorly correlated with regional air temperatures with low  $r^2$  values for regressions between daily maximum stream temperatures and daily maximum air temperatures (Table 3). State water quality standards are 15°C for migration and rearing of anadromous salmon, and 13°C for spawning and incubation (11 AAC 70.070 (b)(10)(A)(iii)). Water temperatures in the lower river often exceed these temperatures, while temperatures near Houston only exceeded 13°C on 13 days in 2007.

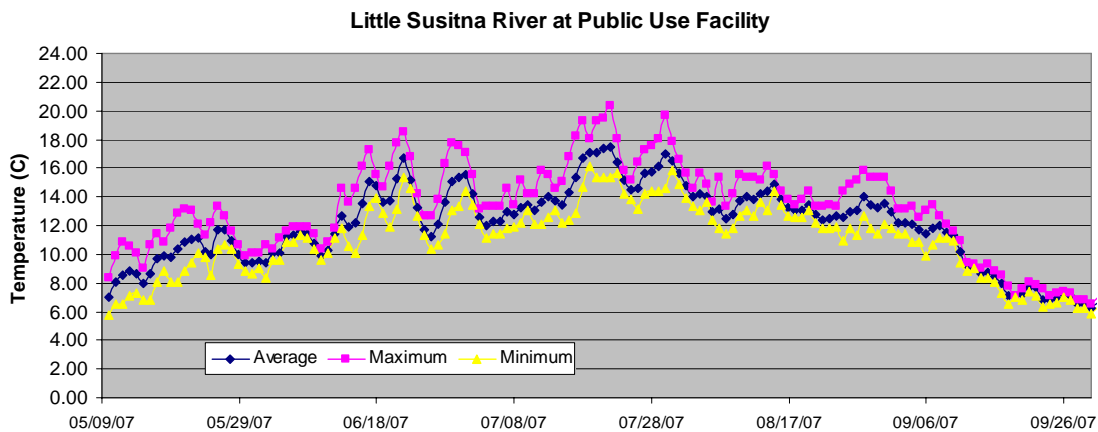


Figure 10. Daily temperature statistics from data recorded below the Public Use Facility.

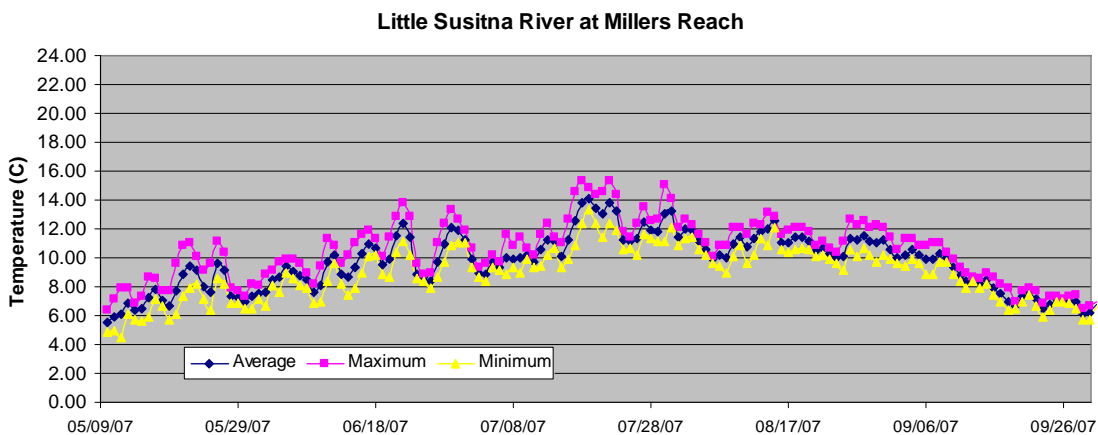


Figure 11. Daily temperature statistics from data recorded at Miller's Reach near the city of Houston.

**Table 3. Stream water temperature statistics for two locations on the Little Susitna River for May through September of 2007 and May and June of 2008. Cumulative degree days are the sum of daily average temperatures. Regression coefficient and regression  $r^2$  is for the relationship between maximum daily air temperature and maximum daily water temperature.**

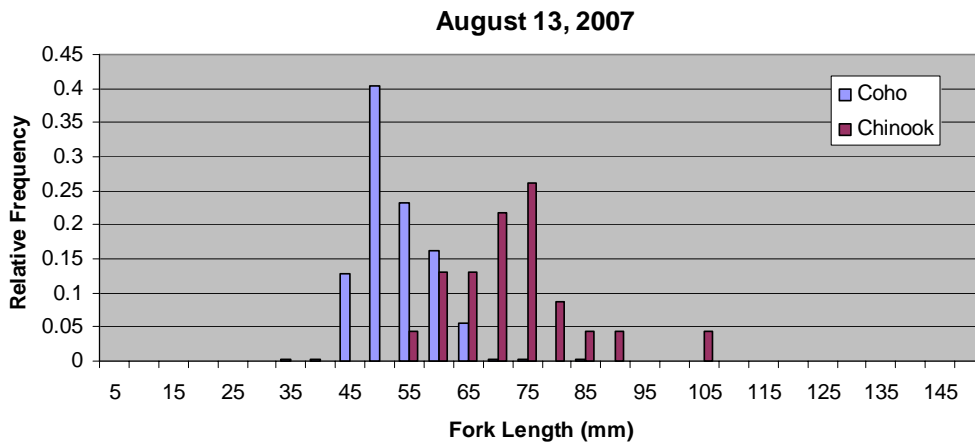
	<b>Public Use Facility 2007</b>	<b>Millers Reach 2007</b>	<b>Public Use Facility 2008</b>	<b>Millers Reach 2008</b>
<b>Season Maximum</b>	20.31	15.35	14.39	10.58
<b>Maximum Range</b>	5.35	3.87	5.50	3.57
<b>Total Days</b>	157	157	51	51
<b>Days Max Temp &gt;13</b>	87	13	14	0
<b>Days Max Temp &gt;15</b>	47	3	0	0
<b>Days Max Temp &gt;20</b>	1	0	0	0
<b>June Cumulative Degree Days</b>	380	292	313	247
<b>July Cumulative Degree Days</b>	457	353	N/A	N/A
<b>August Cumulative Degree Days</b>	416	342	N/A	N/A
<b>September Cumulative Degree Days</b>	266	245	N/A	N/A
<b>Regression Coefficient</b>	0.54	0.37	N/A	N/A
<b>Regression <math>r^2</math></b>	0.51	0.45	N/A	N/A

## Juvenile Fish

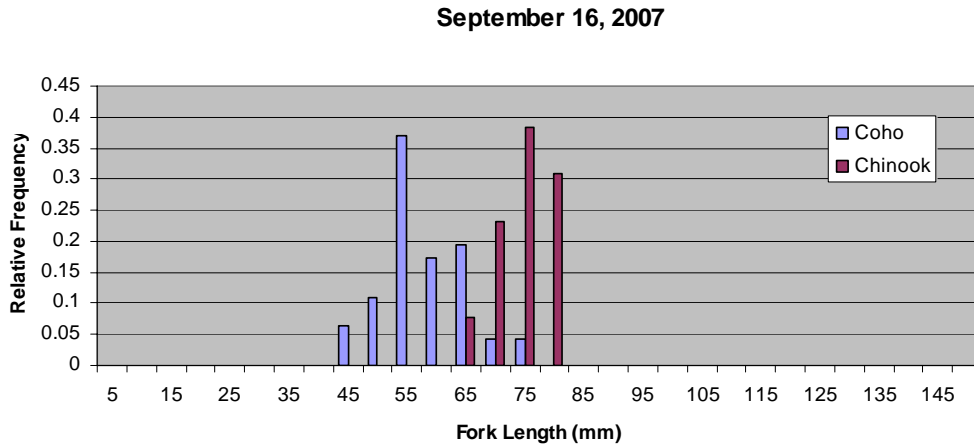
A total of 333 juvenile salmonids were captured at the four sampling stations in August of 2007 and 67 in September. Juvenile coho salmon dominated the catch, with juvenile Chinook salmon, Dolly Varden char, and rainbow trout also present (Table 4). We observed no tumors or lesions on any of the fish. Only a few fish had eroded dorsal and anal fins; however, these injuries could have occurred within the traps. Catch rates of coho salmon were greatest near Miller's Reach and upstream of the Public Use facility in August. In September catch rates of coho salmon were lowest upstream of Houston and similar among the remaining 3 sites. Chinook salmon were most abundant at Miller's Reach in both August and September. Rainbow trout were captured at all locations, but Dolly Varden were not captured in the lower river. Coho and Chinook salmon were composed primarily of a single age class in both August and September based upon length distribution (Figures 12 and 13).

**Table 4. Total salmonid catch and catch per trap for each sampling station in August and September of 2007.**

<b>August 13</b>					
<b>Total Catch</b>	<b>Coho</b>	<b>Chinook</b>	<b>DV</b>	<b>Rainbow</b>	<b>Total Salmonids</b>
<b>LSHUUP</b>	32	2	3	1	38
<b>LSHUDN</b>	106	19	1	0	126
<b>LSPFUP</b>	131	1	0	3	135
<b>LSPFDN</b>	33	1	0	0	34
<b>Catch/Trap</b>	<b>Coho</b>	<b>Chinook</b>	<b>DV</b>	<b>Rainbow</b>	<b>Total Salmonids</b>
<b>LSHUUP</b>	5.3	0.3	0.5	0.2	6.3
<b>LSHUDN</b>	17.7	3.2	0.2	0.0	21.0
<b>LSPFUP</b>	21.8	0.2	0.0	0.5	22.5
<b>LSPFDN</b>	5.5	0.2	0.0	0.0	5.7
<b>September 16</b>					
<b>Total Catch</b>	<b>Coho</b>	<b>Chinook</b>	<b>DV</b>	<b>Rainbow</b>	<b>Total Salmonids</b>
<b>LSHUUP</b>	4	1	0	2	7
<b>LSHUDN</b>	13	11	2	2	28
<b>LSPFUP</b>	15	0	0	1	16
<b>LSPFDN</b>	14	1	0	1	16
<b>Catch/Trap</b>	<b>Coho</b>	<b>Chinook</b>	<b>DV</b>	<b>Rainbow</b>	<b>Total Salmonids</b>
<b>LSHUUP</b>	0.7	0.2	0.0	0.3	1.2
<b>LSHUDN</b>	2.2	1.8	0.3	0.3	4.7
<b>LSPFUP</b>	2.5	0.0	0.0	0.2	2.7
<b>LSPFDN</b>	2.3	0.2	0.0	0.2	2.7



**Figure 12. Length frequency distribution for coho and Chinook salmon in August of 2007.**



**Figure 13. Length frequency distribution for coho and Chinook salmon in September of 2007.**

## Discussion

The concentrations of TAH within the Little Susitna River exceeded State Water Quality Standards on multiple dates above and below the Public Use Facility during the Chinook salmon fishery in June of 2008 and on one sampling date during the coho fishery in August of 2007. The concentrations during June of 2008 were much greater than those previously reported for the Kenai River (Oasis 2008, Kenai Watershed Forum 2008). We observed 11 to 12 boats on the Little Susitna River during hydrocarbon sampling at the two sites above and below the Public Use Facility. While not strictly comparable due to differences in the time to take samples, these numbers are within the range observed on the Kenai River (Oasis 2008). However, the volume of water within the Little Susitna River, near 500 cfs, is considerably lower than on the Kenai River near Soldotna, where flows are near 15,000 to 16,000 cfs. Similar use with reduced dilution due to lower flows would result in higher concentrations.

Boat use has been shown to be the causal factor related to increased concentrations of TAH within the Kenai River (Oasis 2008) and appears to be the source of hydrocarbons within the Little Susitna River. The use of two-cycle engines is believed to be the primary source; however, improper handling of fuels also could be a contributing factor. Based on our limited surveys, the ratio of 4-cycle to 2-cycle motors was 1:1 in 2007 and increased to near 2:1 in 2008. If 2-cycle motors are the primary source, concentrations should decrease over time as more 4-cycle motors are used. Monitoring of the extent and duration of hydrocarbon contamination along with the type of motors used should be continued in order to test this hypothesis.

We believe that the source of hydrocarbon contamination upstream from Houston was from the adjacent parking area due to the relative amount of constituents within samples and after ruling out other potential sources of contamination. Other potential sources investigated include residual contamination of the sampler or contamination of the sample bottles in the vehicle during transportation to sampling sites. Since all of the



sample bottles were stored and transported together, high concentrations of total xylenes occurred only at LSHUUP, and no hydrocarbons were found in trip blanks, we do not believe that the sample bottles were contaminated in transport. On each sampling date, we started at LSHUUP and worked downstream to LSPFDN. The sampler was cleaned with detergent and water from the Talkeetna Municipal well prior to each sampling event. If the cleaning process introduced hydrocarbons to the sampler, it would be expected to occur on all sampling dates, which it did not, unless there was short term contamination of the Municipal well which seems unlikely. Total xylenes were the major hydrocarbon component from LSHUUP samples, and this component was not found in samples collected from LSPFDNX the week before, so residual contamination of the sampler from the previous week is not possible. Since toluene, and not total xylenes, dominated hydrocarbon samples near the Public Use Facility, and in samples collected on the Kenai River, and we did not observe any boats at the upstream site, we do not believe that motor boats could have been the source of hydrocarbon contamination. The undeveloped parking area near the LSHUUP sampling locations contains garbage and other debris. It is certainly possible that the site has been used as an oil disposal area; however, we do not know if this could result in the volumes necessary to result in consistent contamination.

Stream water turbidity exceeded a 5 NTU difference compared to reference condition for three consecutive weeks at the sampling site located below the Public Use Facility. Differences in turbidity are clearly related to boat use as values within heavy use areas are the same as at reference conditions when boats are absent in the spring and fall and during the hours of 00:00 and 05:00. Turbidity values do not exceed State Water Quality Standards for the growth and propagation of fish and it is not clear whether the increase in turbidity is affecting primary production or the distribution or growth of juvenile salmonids. We measured differences in the abundance of juvenile salmon above and below the Public Use Facility in August during a time when there also were differences in turbidity and similar abundances in September when there were no differences. However, this does not confirm a causal relationship. Other factors that were not measured could have explained these differences such as the distribution of adult salmon, or differences in habitat characteristics. Further study is needed to identify whether differences in turbidity or TAH are having an adverse effect on the biotic community.

Stream water temperatures within the lower river near the Public Use Facility also exceeded State Water Quality Standards. In a separate study, ARRI measured stream water temperatures at 34 locations throughout the Matanuska-Susitna Borough during 2007 (Davis and Davis 2008). Among these sites, maximum stream water temperatures exceeded 15°C over 50% of the time in all but eight of the sampling locations. Based upon measures at these 34 locations, streams were segregated into cool, moderate, and warm water sites. The Little Susitna River at the Public Use Facility was among the cooler of those streams with moderate temperatures. Other streams with moderate temperatures included small and large low-sloped brown-water streams within the Susitna River drainage.

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## **Appendix A. Water Chemistry Results**

Water Quality Evaluation of the Lower Little Susitna River  
 July 2008

Site	Date	Measurement	Value	Units
LSCHR	8/14/2006	Alkalinity	28	mg/L CaCO <sub>3</sub>
LSEDG	8/14/2006	Alkalinity	26	mg/L CaCO <sub>3</sub>
LSHUDN	8/14/2006	Alkalinity	26	mg/L CaCO <sub>3</sub>
LSHUUP	8/14/2006	Alkalinity	28	mg/L CaCO <sub>3</sub>
LSPFDN	8/14/2006	Alkalinity	38	mg/L CaCO <sub>3</sub>
LSPFUP	8/14/2006	Alkalinity	38	mg/L CaCO <sub>3</sub>
LSCHR	5/14/2007	Alkalinity	34	mg/L CaCO <sub>3</sub>
LSEDG	5/14/2007	Alkalinity	34	mg/L CaCO <sub>3</sub>
LSHUDN	5/14/2007	Alkalinity	40	mg/L CaCO <sub>3</sub>
LSHUUP	5/14/2007	Alkalinity	40	mg/L CaCO <sub>3</sub>
LSPFDN	5/14/2007	Alkalinity	42	mg/L CaCO <sub>3</sub>
LSPFDNX	5/14/2007	Alkalinity	40	mg/L CaCO <sub>3</sub>
LSPFUP	5/14/2007	Alkalinity	62	mg/L CaCO <sub>3</sub>
LSCHR	5/21/2007	Alkalinity	32	mg/L CaCO <sub>3</sub>
LSEDG	5/21/2007	Alkalinity	24	mg/L CaCO <sub>3</sub>
LSHUDN	5/21/2007	Alkalinity	38	mg/L CaCO <sub>3</sub>
LSHUUP	5/21/2007	Alkalinity	38	mg/L CaCO <sub>3</sub>
LSPFDN	5/21/2007	Alkalinity	40	mg/L CaCO <sub>3</sub>
LSPFDNX	5/21/2007	Alkalinity	42	mg/L CaCO <sub>3</sub>
LSPFUP	5/21/2007	Alkalinity	68	mg/L CaCO <sub>3</sub>
LSCHR	6/4/2007	Alkalinity	24	mg/L CaCO <sub>3</sub>
LSEDG	6/4/2007	Alkalinity	18	mg/L CaCO <sub>3</sub>
LSHUDN	6/4/2007	Alkalinity	32	mg/L CaCO <sub>3</sub>
LSHUUP	6/4/2007	Alkalinity	30	mg/L CaCO <sub>3</sub>
LSPFDN	6/4/2007	Alkalinity	36	mg/L CaCO <sub>3</sub>
LSPFDNX	6/4/2007	Alkalinity	36	mg/L CaCO <sub>3</sub>
LSPFUP	6/4/2007	Alkalinity	36	mg/L CaCO <sub>3</sub>
LSCHR	6/12/2007	Alkalinity	26	mg/L CaCO <sub>3</sub>
LSEDG	6/12/2007	Alkalinity	20	mg/L CaCO <sub>3</sub>
LSHUDN	6/12/2007	Alkalinity	30	mg/L CaCO <sub>3</sub>
LSHUUP	6/12/2007	Alkalinity	30	mg/L CaCO <sub>3</sub>
LSPFDN	6/12/2007	Alkalinity	36	mg/L CaCO <sub>3</sub>
LSPFDNX	6/12/2007	Alkalinity	36	mg/L CaCO <sub>3</sub>
LSPFUP	6/12/2007	Alkalinity	36	mg/L CaCO <sub>3</sub>
LSCHR	8/14/2006	Ammonia Nitrogen	0.43	mg/L
LSEDG	8/14/2006	Ammonia Nitrogen	0.024	mg/L
LSHUDN	8/14/2006	Ammonia Nitrogen	0.68	mg/L
LSHUUP	8/14/2006	Ammonia Nitrogen	0.08	mg/L
LSPFDN	8/14/2006	Ammonia Nitrogen	0.10	mg/L
LSPFUP	8/14/2006	Ammonia Nitrogen	0.091	mg/L
LSCHR	5/14/2007	Ammonia Nitrogen	0.088	mg/L
LSEDG	5/14/2007	Ammonia Nitrogen	0.38	mg/L
LSHUDN	5/14/2007	Ammonia Nitrogen	0.044	mg/L

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Site	Date	Measurement	Value	Units
LSHUUP	5/14/2007	Ammonia Nitrogen	<0.005	mg/L
LSPFDN	5/14/2007	Ammonia Nitrogen	0.025	mg/L
LSPFDNX	5/14/2007	Ammonia Nitrogen	0.03	mg/L
LSPFUP	5/14/2007	Ammonia Nitrogen	0.091	mg/L
LSCHR	5/21/2007	Ammonia Nitrogen	0.01	mg/L
LSEDG	5/21/2007	Ammonia Nitrogen	<0.005	mg/L
LSHUDN	5/21/2007	Ammonia Nitrogen	<0.005	mg/L
LSHUUP	5/21/2007	Ammonia Nitrogen	<0.005	mg/L
LSPFDN	5/21/2007	Ammonia Nitrogen	0.14	mg/L
LSPFDNX	5/21/2007	Ammonia Nitrogen	<0.005	mg/L
LSPFUP	5/21/2007	Ammonia Nitrogen	0.007	mg/L
LSCHR	6/4/2007	Ammonia Nitrogen	0.063	mg/L
LSEDG	6/4/2007	Ammonia Nitrogen	<0.005	mg/L
LSHUDN	6/4/2007	Ammonia Nitrogen	0.021	mg/L
LSHUUP	6/4/2007	Ammonia Nitrogen	<0.005	mg/L
LSPFDN	6/4/2007	Ammonia Nitrogen	<0.005	mg/L
LSPFDNX	6/4/2007	Ammonia Nitrogen	<0.005	mg/L
LSPFUP	6/4/2007	Ammonia Nitrogen	<0.005	mg/L
LSCHR	6/12/2007	Ammonia Nitrogen	0.014	mg/L
LSEDG	6/12/2007	Ammonia Nitrogen	0.038	mg/L
LSHUDN	6/12/2007	Ammonia Nitrogen	0.056	mg/L
LSHUUP	6/12/2007	Ammonia Nitrogen	0.054	mg/L
LSPFDN	6/12/2007	Ammonia Nitrogen	0.009	mg/L
LSPFDNX	6/12/2007	Ammonia Nitrogen	0.011	mg/L
LSPFUP	6/12/2007	Ammonia Nitrogen	0.012	mg/L
LSCHR	6/20/2007	Ammonia Nitrogen	0.02	mg/L
LSEDG	6/20/2007	Ammonia Nitrogen	0.064	mg/L
LSHUDN	6/20/2007	Ammonia Nitrogen	0.074	mg/L
LSHUUP	6/20/2007	Ammonia Nitrogen	0.013	mg/L
LSPFDN	6/20/2007	Ammonia Nitrogen	0.035	mg/L
LSPFDNX	6/20/2007	Ammonia Nitrogen	0.046	mg/L
LSPFUP	6/20/2007	Ammonia Nitrogen	0.025	mg/L
LSHUDN	7/29/2007	Benzene	<0.5	mg/L
LSHUUP	7/29/2007	Benzene	<0.5	mg/L
LSPFDN	7/29/2007	Benzene	<0.5	mg/L
LSPFDNX	7/29/2007	Benzene	1.4	mg/L
LSPFUP	7/29/2007	Benzene	<0.5	mg/L
LSHUDN	8/5/2007	Benzene	<0.5	mg/L
LSHUUP	8/5/2007	Benzene	<0.5	mg/L
LSPFDN	8/5/2007	Benzene	<0.5	mg/L
LSPFDNX	8/5/2007	Benzene	<0.5	mg/L
LSPFUP	8/5/2007	Benzene	<0.5	mg/L
LSHUDN	8/12/2007	Benzene	<0.5	mg/L
LSHUUP	8/12/2007	Benzene	<0.5	mg/L

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Site	Date	Measurement	Value	Units
LSPFDN	8/12/2007	Benzene	<0.5	mg/L
LSPFDNX	8/12/2007	Benzene	<0.5	mg/L
LSPFUP	8/12/2007	Benzene	<0.5	mg/L
LSHUDN	8/19/2007	Benzene	<0.5	mg/L
LSHUUP	8/19/2007	Benzene	<0.5	mg/L
LSPFDN	8/19/2007	Benzene	<0.5	mg/L
LSPFDNX	8/19/2007	Benzene	<0.5	mg/L
LSPFUP	8/19/2007	Benzene	<0.5	mg/L
LSHUDN	8/26/2007	Benzene	<0.5	mg/L
LSHUUP	8/26/2007	Benzene	<0.5	mg/L
LSPFDN	8/26/2007	Benzene	<0.5	mg/L
LSPFDNX	8/26/2007	Benzene	<0.5	mg/L
LSHUDN	9/2/2007	Benzene	<0.5	mg/L
LSHUUP	9/2/2007	Benzene	<0.5	mg/L
LSPFDN	9/2/2007	Benzene	<0.5	mg/L
LSPFDNX	9/2/2007	Benzene	<0.5	mg/L
LSPFUP	9/2/2007	Benzene	<0.5	mg/L
LSHUDN	9/9/2007	Benzene	<0.5	mg/L
LSHUUP	9/9/2007	Benzene	<0.5	mg/L
LSPFDN	9/9/2007	Benzene	<0.5	mg/L
LSPFDNX	9/9/2007	Benzene	<0.5	mg/L
LSPFUP	9/9/2007	Benzene	<0.5	mg/L
LSHUDN	9/16/2007	Benzene	<0.5	mg/L
LSHUUP	9/16/2007	Benzene	<0.5	mg/L
LSPFDN	9/16/2007	Benzene	<0.5	mg/L
LSPFDNX	9/16/2007	Benzene	<0.5	mg/L
LSPFUP	9/16/2007	Benzene	<0.5	mg/L
LSHUDN	5/10/2008	Benzene	<0.5	mg/L
LSHUUP	5/10/2008	Benzene	<0.5	mg/L
LSPFDN	5/10/2008	Benzene	<0.5	mg/L
LSPFDNX	5/10/2008	Benzene	<0.5	mg/L
LSPFUP	5/10/2008	Benzene	<0.5	mg/L
LSHUDN	5/18/2008	Benzene	<0.5	mg/L
LSHUUP	5/18/2008	Benzene	<0.5	mg/L
LSPFDN	5/18/2008	Benzene	<0.5	mg/L
LSPFDNX	5/18/2008	Benzene	<0.5	mg/L
LSPFUP	5/18/2008	Benzene	<0.5	mg/L
LSHUDN	5/24/2008	Benzene	<0.5	mg/L
LSHUUP	5/24/2008	Benzene	<0.5	mg/L
LSPFDN	5/24/2008	Benzene	2.29	mg/L
LSPFDNX	5/24/2008	Benzene	<0.5	mg/L
LSPFUP	5/24/2008	Benzene	<0.5	mg/L
LSHUDN	6/1/2008	Benzene	<0.5	mg/L
LSHUUP	6/1/2008	Benzene	<0.5	mg/L

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Site	Date	Measurement	Value	Units
LSPFDN	6/1/2008	Benzene	9.52	mg/L
LSPFDNX	6/1/2008	Benzene	10.2	mg/L
LSPFUP	6/1/2008	Benzene	9.53	mg/L
LSHUDN	6/8/2008	Benzene	<0.5	mg/L
LSHUUP	6/8/2008	Benzene	<0.5	mg/L
LSPFDN	6/8/2008	Benzene	<0.5	mg/L
LSPFDNX	6/8/2008	Benzene	<0.5	mg/L
LSPFUP	6/8/2008	Benzene	<0.5	mg/L
LSHUDN	6/15/2008	Benzene	<0.5	mg/L
LSHUUP	6/15/2008	Benzene	<0.5	mg/L
LSPFDN	6/15/2008	Benzene	6.24	mg/L
LSPFDNX	6/15/2008	Benzene	4.47	mg/L
LSPFUP	6/15/2008	Benzene	2.83	mg/L
LSHUDN	6/21/2008	Benzene	<0.5	mg/L
LSHUUP	6/21/2008	Benzene	<0.5	mg/L
LSPFDN	6/21/2008	Benzene	<0.5	mg/L
LSPFDNX	6/21/2008	Benzene	<0.5	mg/L
LSPFUP	6/21/2008	Benzene	<0.5	mg/L
LSHUDN	6/29/2008	Benzene	<0.5	mg/L
LSHUUP	6/29/2008	Benzene	<0.5	mg/L
LSPFDN	6/29/2008	Benzene	3.33	mg/L
LSPFDNX	6/29/2008	Benzene	3.79	mg/L
LSPFUP	6/29/2008	Benzene	2.79	mg/L
LSCHR	8/14/2006	D.O.	11.43	mg/L
LSEDG	8/14/2006	D.O.	12.41	mg/L
LSHUDN	8/14/2006	D.O.	10.02	mg/L
LSHUUP	8/14/2006	D.O.	11.14	mg/L
LSPFDN	8/14/2006	D.O.	9.79	mg/L
LSPFUP	8/14/2006	D.O.	10.29	mg/L
LSCHR	5/14/2007	D.O.	11.64	mg/L
LSEDG	5/14/2007	D.O.	12.53	mg/L
LSHUDN	5/14/2007	D.O.	13.4	mg/L
LSHUUP	5/14/2007	D.O.	12.63	mg/L
LSPFDN	5/14/2007	D.O.	11.64	mg/L
LSPFUP	5/14/2007	D.O.	11.29	mg/L
LSCHR	5/21/2007	D.O.	12.45	mg/L
LSEDG	5/21/2007	D.O.	12.71	mg/L
LSHUDN	5/21/2007	D.O.	11.92	mg/L
LSPFDN	5/21/2007	D.O.	10.31	mg/L
LSPFUP	5/21/2007	D.O.	10.15	mg/L
LSCHR	6/4/2007	D.O.	11.2	mg/l
LSEDG	6/4/2007	D.O.	11.9	mg/L
LSHUDN	6/4/2007	D.O.	10.1	mg/L
LSHUUP	6/4/2007	D.O.	10.1	mg/L

Water Quality Evaluation of the Lower Little Susitna River  
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Site	Date	Measurement	Value	Units
LSPFDN	6/4/2007	D.O.	9.15	mg/L
LSPFUP	6/4/2007	D.O.	9.1	mg/L
LSCHR	6/14/2007	D.O.	12.24	mg/L
LSEDG	6/14/2007	D.O.	12.44	mg/L
LSHUDN	6/14/2007	D.O.	11.05	mg/L
LSHUUP	6/14/2007	D.O.	11.32	mg/L
LSPFDN	6/14/2007	D.O.	9.1	mg/L
LSPFUP	6/14/2007	D.O.	9.0	mg/L
LSCHR	6/20/2007	D.O.	12.15	mg/L
LSEDG	6/20/2007	D.O.	11.47	mg/L
LSHUDN	6/20/2007	D.O.	11.4	mg/L
LSHUUP	6/20/2007	D.O.	11.81	mg/L
LSPFDN	6/20/2007	D.O.	10.66	mg/L
LSPFUP	6/20/2007	D.O.	10.04	mg/L
LSHUDN	8/26/2007	D.O.	10.47	mg/L
LSHUUP	8/26/2007	D.O.	10.48	mg/L
LSPFDN	8/26/2007	D.O.	10.47	mg/L
LSPFUP	8/26/2007	D.O.	10.55	mg/L
LSPFDN	7/23/2007	D.O.	9.45	mg/L
LSPFDNX	7/23/2007	D.O.	9.45	mg/L
LSPFUP	7/23/2007	D.O.	9.29	mg/L
LSHUDN	7/29/2007	D.O.	10.42	mg/L
LSHUUP	7/29/2007	D.O.	10.45	mg/L
LSPFDN	7/29/2007	D.O.	9.4	mg/L
LSPFUP	7/29/2007	D.O.	9.55	mg/L
LSHUDN	8/5/2007	D.O.	10.92	mg/L
LSHUUP	8/5/2007	D.O.	11.26	mg/L
LSPFDN	8/5/2007	D.O.	10.29	mg/L
LSPFUP	8/5/2007	D.O.	10.38	mg/L
LSHUDN	8/12/2007	D.O.	10.16	mg/L
LSHUUP	8/12/2007	D.O.	10.42	mg/L
LSPFDN	8/12/2007	D.O.	10.31	mg/L
LSPFUP	8/12/2007	D.O.	10.53	mg/L
LSHUDN	8/19/2007	D.O.	10.3	mg/L
LSHUUP	8/19/2007	D.O.	10.6	mg/L
LSPFDN	8/19/2007	D.O.	10.46	mg/L
LSPFUP	8/19/2007	D.O.	10.5	mg/L
LSCHR	8/14/2006	D.O. %	96.7	Percent Saturation
LSEDG	8/14/2006	D.O. %	104.2	Percent Saturation
LSHUDN	8/14/2006	D.O. %	95.4	Percent Saturation
LSHUUP	8/14/2006	D.O. %	95.7	Percent Saturation
LSPFDN	8/14/2006	D.O. %	92.4	Percent Saturation
LSPFUP	8/14/2006	D.O. %	94.9	Percent Saturation
LSCHR	5/14/2007	D.O. %	97.6	Percent Saturation



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Site	Date	Measurement	Value	Units
LSEDG	5/14/2007	D.O. %	98.3	Percent Saturation
LSHUDN	5/14/2007	D.O. %	107	Percent Saturation
LSHUUP	5/14/2007	D.O. %	100.7	Percent Saturation
LSPFDN	5/14/2007	D.O. %	99.7	Percent Saturation
LSPFUP	5/14/2007	D.O. %	96.7	Percent Saturation
LSCHR	5/21/2007	D.O. %	100.9	Percent Saturation
LSEDG	5/21/2007	D.O. %	100.6	Percent Saturation
LSHUDN	5/21/2007	D.O. %	101.4	Percent Saturation
LSPFDN	5/21/2007	D.O. %	95.3	Percent Saturation
LSPFUP	5/21/2007	D.O. %	91.3	Percent Saturation
LSCHR	6/4/2007	D.O. %	98	Percent Saturation
LSEDG	6/4/2007	D.O. %	100	Percent Saturation
LSHUDN	6/4/2007	D.O. %	95	Percent Saturation
LSHUUP	6/4/2007	D.O. %	95	Percent Saturation
LSPFDN	6/4/2007	D.O. %	85.1	Percent Saturation
LSPFUP	6/4/2007	D.O. %	95.3	Percent Saturation
LSCHR	6/14/2007	D.O. %	99	Percent Saturation
LSEDG	6/14/2007	D.O. %	99.1	Percent Saturation
LSHUDN	6/14/2007	D.O. %	95.8	Percent Saturation
LSHUUP	6/14/2007	D.O. %	95.7	Percent Saturation
LSPFDN	6/14/2007	D.O. %	95	Percent Saturation
LSPFUP	6/14/2007	D.O. %	94	Percent Saturation
LSCHR	6/20/2007	D.O. %	106.5	Percent Saturation
LSEDG	6/20/2007	D.O. %	102.5	Percent Saturation
LSHUDN	6/20/2007	D.O. %	102.9	Percent Saturation
LSHUUP	6/20/2007	D.O. %	104.9	Percent Saturation
LSPFDN	6/20/2007	D.O. %	106.3	Percent Saturation
LSPFUP	6/20/2007	D.O. %	102.3	Percent Saturation
LSPFDN	7/23/2007	D.O. %	94	Percent Saturation
LSPFDNX	7/23/2007	D.O. %	93.9	Percent Saturation
LSPFUP	7/23/2007	D.O. %	94.5	Percent Saturation
LSHUDN	7/29/2007	D.O. %	99.2	Percent Saturation
LSHUUP	7/29/2007	D.O. %	95.4	Percent Saturation
LSPFDN	7/29/2007	D.O. %	99.5	Percent Saturation
LSPFUP	7/29/2007	D.O. %	102.2	Percent Saturation
LSHUDN	8/5/2007	D.O. %	96	Percent Saturation
LSHUUP	8/5/2007	D.O. %	97.9	Percent Saturation
LSPFDN	8/5/2007	D.O. %	97.8	Percent Saturation
LSPFUP	8/5/2007	D.O. %	100.3	Percent Saturation
LSHUDN	8/12/2007	D.O. %	93.3	Percent Saturation
LSHUUP	8/12/2007	D.O. %	94	Percent Saturation
LSPFDN	8/12/2007	D.O. %	101.7	Percent Saturation
LSPFUP	8/12/2007	D.O. %	104.5	Percent Saturation
LSHUDN	8/19/2007	D.O. %	93	Percent Saturation

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Site	Date	Measurement	Value	Units
LSHUUP	8/19/2007	D.O. %	94.8	Percent Saturation
LSPFDN	8/19/2007	D.O. %	102.5	Percent Saturation
LSPFUP	8/19/2007	D.O. %	104	Percent Saturation
LSHUDN	8/26/2007	D.O. %	94	Percent Saturation
LSHUUP	8/26/2007	D.O. %	91.1	Percent Saturation
LSPFDN	8/26/2007	D.O. %	99.8	Percent Saturation
LSPFUP	8/26/2007	D.O. %	98.1	Percent Saturation
LSHUDN	7/29/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	7/29/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	7/29/2007	Ethyl Benzene	<0.5	mg/L
LSPFDNX	7/29/2007	Ethyl Benzene	<0.5	mg/L
LSPFUP	7/29/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	8/5/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	8/5/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	8/5/2007	Ethyl Benzene	<0.5	mg/L
LSPFDNX	8/5/2007	Ethyl Benzene	<0.5	mg/L
LSPFUP	8/5/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	8/12/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	8/12/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	8/12/2007	Ethyl Benzene	<0.5	mg/L
LSPFDNX	8/12/2007	Ethyl Benzene	<0.5	mg/L
LSPFUP	8/12/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	8/19/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	8/19/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	8/19/2007	Ethyl Benzene	<0.5	mg/L
LSPFDNX	8/19/2007	Ethyl Benzene	<0.5	mg/L
LSPFUP	8/19/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	8/26/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	8/26/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	8/26/2007	Ethyl Benzene	<0.5	mg/L
LSPFDNX	8/26/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	9/2/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	9/2/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	9/2/2007	Ethyl Benzene	<0.5	mg/L
LSPFDNX	9/2/2007	Ethyl Benzene	<0.5	mg/L
LSPFUP	9/2/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	9/9/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	9/9/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	9/9/2007	Ethyl Benzene	<0.5	mg/L
LSPFDNX	9/9/2007	Ethyl Benzene	<0.5	mg/L
LSPFUP	9/9/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	9/16/2007	Ethyl Benzene	<0.5	mg/L
LSHUUP	9/16/2007	Ethyl Benzene	<0.5	mg/L
LSPFDN	9/16/2007	Ethyl Benzene	<0.5	mg/L

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Site	Date	Measurement	Value	Units
LSPFDNX	9/16/2007	Ethyl Benzene	<0.5	mg/L
LSPFUP	9/16/2007	Ethyl Benzene	<0.5	mg/L
LSHUDN	5/10/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	5/10/2008	Ethyl Benzene	<0.5	mg/L
LSPFDN	5/10/2008	Ethyl Benzene	<0.5	mg/L
LSPFDNX	5/10/2008	Ethyl Benzene	<0.5	mg/L
LSPFUP	5/10/2008	Ethyl Benzene	<0.5	mg/L
LSHUDN	5/18/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	5/18/2008	Ethyl Benzene	<0.5	mg/L
LSPFDN	5/18/2008	Ethyl Benzene	<0.5	mg/L
LSPFDNX	5/18/2008	Ethyl Benzene	<0.5	mg/L
LSPFUP	5/18/2008	Ethyl Benzene	<0.5	mg/L
LSHUDN	5/24/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	5/24/2008	Ethyl Benzene	2.89	mg/L
LSPFDN	5/24/2008	Ethyl Benzene	<0.5	mg/L
LSPFDNX	5/24/2008	Ethyl Benzene	<0.5	mg/L
LSPFUP	5/24/2008	Ethyl Benzene	<0.5	mg/L
LSHUDN	6/1/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	6/1/2008	Ethyl Benzene	1.48	mg/L
LSPFDN	6/1/2008	Ethyl Benzene	1.36	mg/L
LSPFDNX	6/1/2008	Ethyl Benzene	1.34	mg/L
LSPFUP	6/1/2008	Ethyl Benzene	1.41	mg/L
LSHUDN	6/8/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	6/8/2008	Ethyl Benzene	6.91	mg/L
LSPFDN	6/8/2008	Ethyl Benzene	0.5	mg/L
LSPFDNX	6/8/2008	Ethyl Benzene	<0.5	mg/L
LSPFUP	6/8/2008	Ethyl Benzene	<0.5	mg/L
LSHUDN	6/15/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	6/15/2008	Ethyl Benzene	<0.5	mg/L
LSPFDN	6/15/2008	Ethyl Benzene	1.17	mg/L
LSPFDNX	6/15/2008	Ethyl Benzene	0.76	mg/L
LSPFUP	6/15/2008	Ethyl Benzene	0.52	mg/L
LSHUDN	6/21/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	6/21/2008	Ethyl Benzene	<0.5	mg/L
LSPFDN	6/21/2008	Ethyl Benzene	<0.5	mg/L
LSPFDNX	6/21/2008	Ethyl Benzene	<0.5	mg/L
LSPFUP	6/21/2008	Ethyl Benzene	<0.5	mg/L
LSHUDN	6/29/2008	Ethyl Benzene	<0.5	mg/L
LSHUUP	6/29/2008	Ethyl Benzene	<0.5	mg/L
LSPFDN	6/29/2008	Ethyl Benzene	0.83	mg/L
LSPFDNX	6/29/2008	Ethyl Benzene	0.89	mg/L
LSPFUP	6/29/2008	Ethyl Benzene	0.54	mg/L
LSCHR	5/21/2007	Fecal Coliform	0	cfu/100 ml
LSEDG	5/21/2007	Fecal Coliform	5	cfu/100 ml

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Site	Date	Measurement	Value	Units
LSHUDN	5/21/2007	Fecal Coliform	2	cfu/100 ml
LSPFDN	5/21/2007	Fecal Coliform	0	cfu/100 ml
LSPFDNX	5/21/2007	Fecal Coliform	5	cfu/100 ml
LSCHR	6/4/2007	Fecal Coliform	39	cfu/100 ml
LSEDG	6/4/2007	Fecal Coliform	2	cfu/100 ml
LSHUDN	6/4/2007	Fecal Coliform	12	cfu/100 ml
LSPFDN	6/4/2007	Fecal Coliform	18	cfu/100 ml
LSPFDNX	6/4/2007	Fecal Coliform	12	cfu/100 ml
LSCHR	6/12/2007	Fecal Coliform	2	cfu/100 ml
LSEDG	6/12/2007	Fecal Coliform	0	cfu/100 ml
LSHUDN	6/12/2007	Fecal Coliform	10	cfu/100 ml
LSPFDN	6/12/2007	Fecal Coliform	58	cfu/100 ml
LSPFDNX	6/12/2007	Fecal Coliform	58	cfu/100 ml
LSCHR	6/18/2007	Fecal Coliform	2	cfu/100 ml
LSEDG	6/18/2007	Fecal Coliform	0	cfu/100 ml
LSHUDN	6/18/2007	Fecal Coliform	11	cfu/100 ml
LSPFDN	6/18/2007	Fecal Coliform	61	cfu/100 ml
LSPFDNX	6/18/2007	Fecal Coliform	34	cfu/100 ml
LSCHR	8/14/2006	Nitrate+Nitrite	0.011	mg/L
LSEDG	8/14/2006	Nitrate+Nitrite	0.035	mg/L
LSHUDN	8/14/2006	Nitrate+Nitrite	0.025	mg/L
LSHUUP	8/14/2006	Nitrate+Nitrite	0.01	mg/L
LSPFDN	8/14/2006	Nitrate+Nitrite	0.021	mg/L
LSPFUP	8/14/2006	Nitrate+Nitrite	0.04	mg/L
LSCHR	5/14/2007	Nitrate+Nitrite	0.51	mg/L
LSEDG	5/14/2007	Nitrate+Nitrite	0.59	mg/L
LSHUDN	5/14/2007	Nitrate+Nitrite	0.35	mg/L
LSHUUP	5/14/2007	Nitrate+Nitrite	0.38	mg/L
LSPFDN	5/14/2007	Nitrate+Nitrite	0.16	mg/L
LSPFDNX	5/14/2007	Nitrate+Nitrite	0.17	mg/L
LSPFUP	5/14/2007	Nitrate+Nitrite	0.13	mg/L
LSCHR	5/21/2007	Nitrate+Nitrite	0.43	mg/L
LSEDG	5/21/2007	Nitrate+Nitrite	0.3	mg/L
LSHUDN	5/21/2007	Nitrate+Nitrite	36	mg/L
LSHUUP	5/21/2007	Nitrate+Nitrite	0.40	mg/L
LSPFDN	5/21/2007	Nitrate+Nitrite	0.19	mg/L
LSPFDNX	5/21/2007	Nitrate+Nitrite	0.2	mg/L
LSPFUP	5/21/2007	Nitrate+Nitrite	0.21	mg/L
LSCHR	6/4/2007	Nitrate+Nitrite	0.21	mg/L
LSEDG	6/4/2007	Nitrate+Nitrite	0.12	mg/L
LSHUDN	6/4/2007	Nitrate+Nitrite	0.21	mg/L
LSHUUP	6/4/2007	Nitrate+Nitrite	0.25	mg/L
LSPFDN	6/4/2007	Nitrate+Nitrite	0.16	mg/L
LSPFDNX	6/4/2007	Nitrate+Nitrite	0.17	mg/L

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Site	Date	Measurement	Value	Units
LSPFUP	6/4/2007	Nitrate+Nitrite	0.18	mg/L
LSCHR	6/12/2007	Nitrate+Nitrite	0.14	mg/L
LSEDG	6/12/2007	Nitrate+Nitrite	0.079	mg/L
LSHUDN	6/12/2007	Nitrate+Nitrite	0.17	mg/L
LSHUUP	6/12/2007	Nitrate+Nitrite	0.15	mg/L
LSPFDN	6/12/2007	Nitrate+Nitrite	0.15	mg/L
LSPFDNX	6/12/2007	Nitrate+Nitrite	0.15	mg/L
LSPFUP	6/12/2007	Nitrate+Nitrite	0.15	mg/L
LSCHR	6/20/2007	Nitrate+Nitrite	0.12	mg/L
LSEDG	6/20/2007	Nitrate+Nitrite	0.10	mg/L
LSHUDN	6/20/2007	Nitrate+Nitrite	0.18	mg/L
LSHUUP	6/20/2007	Nitrate+Nitrite	0.19	mg/L
LSPFDN	6/20/2007	Nitrate+Nitrite	0.14	mg/L
LSPFDNX	6/20/2007	Nitrate+Nitrite	0.12	mg/L
LSPFUP	6/20/2007	Nitrate+Nitrite	0.13	mg/L
LSCHR	8/14/2006	pH	7.18	
LSEDG	8/14/2006	pH	7.3	
LSHUDN	8/14/2006	pH	7.17	
LSHUUP	8/14/2006	pH	7.16	
LSPFDN	8/14/2006	pH	7.32	
LSPFDNX	8/14/2006	pH	7.32	
LSPFUP	8/14/2006	pH	7.36	
LSCHR	5/14/2007	pH	7.17	
LSEDG	5/14/2007	pH	7.42	
LSHUDN	5/14/2007	pH	7.28	
LSHUUP	5/14/2007	pH	7.25	
LSPFDN	5/14/2007	pH	7.3	
LSPFDNX	5/14/2007	pH	7.32	
LSPFUP	5/14/2007	pH	7.37	
LSCHR	5/21/2007	pH	7.21	
LSEDG	5/21/2007	pH	7.32	
LSHUDN	5/21/2007	pH	7.33	
LSHUUP	5/21/2007	pH	7.32	
LSPFDN	5/21/2007	pH	7.43	
LSPFDNX	5/21/2007	pH	7.43	
LSPFUP	5/21/2007	pH	7.45	
LSCHR	6/4/2007	pH	7.05	
LSEDG	6/4/2007	pH	7.09	
LSHUDN	6/4/2007	pH	7.15	
LSHUUP	6/4/2007	pH	7.11	
LSPFDN	6/4/2007	pH	7.25	
LSPFDNX	6/4/2007	pH	7.25	
LSPFUP	6/4/2007	pH	7.21	
LSCHR	6/14/2007	pH	7.03	

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Site	Date	Measurement	Value	Units
LSEDG	6/14/2007	pH	7.1	
LSHUDN	6/14/2007	pH	7.1	
LSHUUP	6/14/2007	pH	7.06	
LSPFDN	6/14/2007	pH	7.26	
LSPFDNX	6/14/2007	pH	7.23	
LSPFUP	6/14/2007	pH	7.34	
LSCHR	6/20/2007	pH	7.03	
LSEDG	6/20/2007	pH	7.05	
LSHUDN	6/20/2007	pH	7.06	
LSHUUP	6/20/2007	pH	7.07	
LSPFDN	6/20/2007	pH	7.15	
LSPFDNX	6/20/2007	pH	7.16	
LSPFUP	6/20/2007	pH	7.19	
LSPFDN	7/23/2007	pH	7.10	
LSPFDNX	7/23/2007	pH	7.10	
LSPFUP	7/23/2007	pH	7.08	
LSHUDN	7/29/2007	pH	7.13	
LSHUUP	7/29/2007	pH	7.11	
LSPFDN	7/29/2007	pH	7.35	
LSPFDNX	7/29/2007	pH	7.34	
LSPFUP	7/29/2007	pH	7.54	
LSHUDN	8/5/2007	pH	7.11	
LSHUUP	8/5/2007	pH	7.11	
LSPFDN	8/5/2007	pH	7.17	
LSPFDNX	8/5/2007	pH	7.17	
LSPFUP	8/5/2007	pH	7.1	
LSHUDN	8/12/2007	pH	7.21	
LSHUUP	8/12/2007	pH	7.17	
LSPFDN	8/12/2007	pH	7.29	
LSPFDNX	8/12/2007	pH	7.3	
LSPFUP	8/12/2007	pH	7.28	
LSHUDN	8/19/2007	pH	7.19	
LSHUUP	8/19/2007	pH	7.14	
LSPFDN	8/19/2007	pH	7.35	
LSPFDNX	8/19/2007	pH	7.35	
LSPFUP	8/19/2007	pH	7.35	
LSHUDN	8/26/2007	pH	7.13	
LSHUUP	8/26/2007	pH	7.1	
LSPFDN	8/26/2007	pH	7.36	
LSPFDNX	8/26/2007	pH	7.36	
LSPFUP	8/26/2007	pH	7.33	
LSHUDN	9/9/2007	pH	6.81	
LSHUUP	9/9/2007	pH	6.76	
LSPFDN	9/9/2007	pH	7.24	

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LSPFDNX	9/9/2007	pH	7.27	
LSPFUP	9/9/2007	pH	7.27	
LSHUDN	9/17/2007	pH	7.04	
LSHUUP	9/17/2007	pH	6.91	
LSPFDN	9/17/2007	pH	7.02	
LSPFDNX	9/17/2007	pH	7.01	
LSPFUP	9/17/2007	pH	7.11	
LSHUDN	5/10/2008	pH	7.33	
LSHUUP	5/10/2008	pH	7.28	
LSPFDN	5/10/2008	pH	7.2	
LSPFDNX	5/10/2008	pH	7.27	
LSPFUP	5/10/2008	pH	7.27	
LSHUDN	5/18/2008	pH	7.6	
LSHUUP	5/18/2008	pH	7.61	
LSPFDN	5/18/2008	pH	7.52	
LSPFDNX	5/18/2008	pH	7.5	
LSPFUP	5/18/2008	pH	7.54	
LSHUDN	5/24/2008	pH	7.47	
LSHUUP	5/24/2008	pH	7.45	
LSPFDN	5/24/2008	pH	7.36	
LSPFDNX	5/24/2008	pH	7.23	
LSPFUP	5/24/2008	pH	7.48	
LSHUDN	6/8/2008	pH	7.5	
LSHUUP	6/8/2008	pH	7.43	
LSPFDN	6/8/2008	pH	7.56	
LSPFDNX	6/8/2008	pH	7.54	
LSPFUP	6/8/2008	pH	7.79	
LSHUDN	6/15/2008	pH	7.37	
LSHUUP	6/15/2008	pH	7.33	
LSPFDN	6/15/2008	pH	7.42	
LSPFDNX	6/15/2008	pH	7.42	
LSPFUP	6/15/2008	pH	7.36	
LSHUDN	6/21/2008	pH	7.54	
LSHUUP	6/21/2008	pH	7.49	
LSPFDN	6/21/2008	pH	7.62	
LSPFDNX	6/21/2008	pH	7.62	
LSPFUP	6/21/2008	pH	7.65	
LSHUDN	6/29/2008	pH	7.3	
LSHUUP	6/29/2008	pH	7.25	
LSPFDN	6/29/2008	pH	7.28	
LSPFDNX	6/29/2008	pH	7.3	
LSPFUP	6/29/2008	pH	7.2	
LSCHR	8/14/2006	Specific Conductance	61.6	μS/cm
LSEGD	8/14/2006	Specific Conductance	56.3	μS/cm

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LSHUDN	8/14/2006	Specific Conductance	63.8	μS/cm
LSHUUP	8/14/2006	Specific Conductance	63.2	μS/cm
LSPFDN	8/14/2006	Specific Conductance	88.2	μS/cm
LSPFDNX	8/14/2006	Specific Conductance	87.5	μS/cm
LSPFUP	8/14/2006	Specific Conductance	84.4	μS/cm
LSCHR	5/8/2007	Specific Conductance	88.8	μS/cm
LSEDG	5/8/2007	Specific Conductance	87.3	μS/cm
LSEDGX	5/8/2007	Specific Conductance	87.6	μS/cm
LSHUDN	5/8/2007	Specific Conductance	96.9	μS/cm
LSPFDN	5/8/2007	Specific Conductance	87	μS/cm
LSPFDNX	5/8/2007	Specific Conductance	89.1	μS/cm
LSCHR	5/14/2007	Specific Conductance	95.5	μS/cm
LSEDG	5/14/2007	Specific Conductance	98.9	μS/cm
LSHUDN	5/14/2007	Specific Conductance	101.8	μS/cm
LSHUUP	5/14/2007	Specific Conductance	100.6	μS/cm
LSPFDN	5/14/2007	Specific Conductance	95.5	μS/cm
LSPFDNX	5/14/2007	Specific Conductance	94.4	μS/cm
LSPFUP	5/14/2007	Specific Conductance	138.8	μS/cm
LSCHR	5/21/2007	Specific Conductance	87.2	μS/cm
LSEDG	5/21/2007	Specific Conductance	69.8	μS/cm
LSHUDN	5/21/2007	Specific Conductance	99.9	μS/cm
LSHUUP	5/21/2007	Specific Conductance	94.5	μS/cm
LSPFDN	5/21/2007	Specific Conductance	102.1	μS/cm
LSPFDNX	5/21/2007	Specific Conductance	101.7	μS/cm
LSPFUP	5/21/2007	Specific Conductance	150.1	μS/cm
LSCHR	6/4/2007	Specific Conductance	66.5	μS/cm
LSEDG	6/4/2007	Specific Conductance	50.8	μS/cm
LSHUDN	6/4/2007	Specific Conductance	79	μS/cm
LSHUUP	6/4/2007	Specific Conductance	77.9	μS/cm
LSPFDN	6/4/2007	Specific Conductance	89.5	μS/cm
LSPFDNX	6/4/2007	Specific Conductance	89.3	μS/cm
LSPFUP	6/4/2007	Specific Conductance	89.5	μS/cm
LSCHR	6/14/2007	Specific Conductance	57.5	μS/cm
LSEDG	6/14/2007	Specific Conductance	46	μS/cm
LSHUDN	6/14/2007	Specific Conductance	66.7	μS/cm
LSHUUP	6/14/2007	Specific Conductance	64.4	μS/cm
LSPFDN	6/14/2007	Specific Conductance	78.8	μS/cm
LSPFDNX	6/14/2007	Specific Conductance	76.9	μS/cm
LSPFUP	6/14/2007	Specific Conductance	104.1	μS/cm
LSCHR	6/20/2007	Specific Conductance	60.5	μS/cm
LSEDG	6/20/2007	Specific Conductance	52.3	μS/cm
LSHUDN	6/20/2007	Specific Conductance	76	μS/cm
LSHUUP	6/20/2007	Specific Conductance	73.3	μS/cm
LSPFDN	6/20/2007	Specific Conductance	80.5	μS/cm



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Site	Date	Measurement	Value	Units
LSPFDNX	6/20/2007	Specific Conductance	80.2	μS/cm
LSPFUP	6/20/2007	Specific Conductance	99.5	μS/cm
LSPFDN	7/23/2007	Specific Conductance	97.4	μS/cm
LSPFDNX	7/23/2007	Specific Conductance	98.1	μS/cm
LSPFUP	7/23/2007	Specific Conductance	94.1	μS/cm
LSHUDN	7/29/2007	Specific Conductance	90	μS/cm
LSHUUP	7/29/2007	Specific Conductance	88.2	μS/cm
LSPFDN	7/29/2007	Specific Conductance	95.4	μS/cm
LSPFDNX	7/29/2007	Specific Conductance	99.9	μS/cm
LSPFUP	7/29/2007	Specific Conductance	130.2	μS/cm
LSHUDN	8/5/2007	Specific Conductance	88.6	μS/cm
LSHUUP	8/5/2007	Specific Conductance	84.4	μS/cm
LSPFDN	8/5/2007	Specific Conductance	92.5	μS/cm
LSPFDNX	8/5/2007	Specific Conductance	94.2	μS/cm
LSPFUP	8/5/2007	Specific Conductance	97	μS/cm
LSHUDN	8/12/2007	Specific Conductance	75.1	μS/cm
LSHUUP	8/12/2007	Specific Conductance	73.6	μS/cm
LSPFDN	8/12/2007	Specific Conductance	78.6	μS/cm
LSPFDNX	8/12/2007	Specific Conductance	76.6	μS/cm
LSPFUP	8/12/2007	Specific Conductance	81.1	μS/cm
LSHUDN	8/19/2007	Specific Conductance	97.4	μS/cm
LSHUUP	8/19/2007	Specific Conductance	86.5	μS/cm
LSPFDN	8/19/2007	Specific Conductance	91.8	μS/cm
LSPFDNX	8/19/2007	Specific Conductance	91.7	μS/cm
LSPFUP	8/19/2007	Specific Conductance	91.8	μS/cm
LSHUDN	8/26/2007	Specific Conductance	91	μS/cm
LSHUUP	8/26/2007	Specific Conductance	89.7	μS/cm
LSPFDN	8/26/2007	Specific Conductance	99.9	μS/cm
LSPFDNX	8/26/2007	Specific Conductance	99.4	μS/cm
LSPFUP	8/26/2007	Specific Conductance	108.1	μS/cm
LSHUDN	9/9/2007	Specific Conductance	66.8	μS/cm
LSHUUP	9/9/2007	Specific Conductance	58.8	μS/cm
LSPFDN	9/9/2007	Specific Conductance	102.2	μS/cm
LSPFDNX	9/9/2007	Specific Conductance	102.2	μS/cm
LSPFUP	9/9/2007	Specific Conductance	100.4	μS/cm
LSHUDN	9/17/2007	Specific Conductance	84.1	μS/cm
LSHUUP	9/17/2007	Specific Conductance	79.8	μS/cm
LSPFDN	9/17/2007	Specific Conductance	81.2	μS/cm
LSPFDNX	9/17/2007	Specific Conductance	83.7	μS/cm
LSPFUP	9/17/2007	Specific Conductance	85.4	μS/cm
LSHUDN	5/10/2008	Specific Conductance	94.4	μS/cm
LSHUUP	5/10/2008	Specific Conductance	92.2	μS/cm
LSPFDN	5/10/2008	Specific Conductance	88.9	μS/cm
LSPFDNX	5/10/2008	Specific Conductance	88.9	μS/cm

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Site	Date	Measurement	Value	Units
LSPFUP	5/10/2008	Specific Conductance	99.2	μS/cm
LSHUDN	5/18/2008	Specific Conductance	95.8	μS/cm
LSHUUP	5/18/2008	Specific Conductance	91.1	μS/cm
LSPFDN	5/18/2008	Specific Conductance	94.5	μS/cm
LSPFDNX	5/18/2008	Specific Conductance	95.2	μS/cm
LSPFUP	5/18/2008	Specific Conductance	98.6	μS/cm
LSHUDN	5/24/2008	Specific Conductance	83.5	μS/cm
LSHUUP	5/24/2008	Specific Conductance	83.8	μS/cm
LSPFDN	5/24/2008	Specific Conductance	124.6	μS/cm
LSPFDNX	5/24/2008	Specific Conductance	92.9	μS/cm
LSPFUP	5/24/2008	Specific Conductance	90.7	μS/cm
LSHUDN	6/8/2008	Specific Conductance	81.6	μS/cm
LSHUUP	6/8/2008	Specific Conductance	81.8	μS/cm
LSPFDN	6/8/2008	Specific Conductance	89.3	μS/cm
LSPFDNX	6/8/2008	Specific Conductance	88.9	μS/cm
LSPFUP	6/8/2008	Specific Conductance	149.2	μS/cm
LSHUDN	6/15/2008	Specific Conductance	71.2	μS/cm
LSHUUP	6/15/2008	Specific Conductance	77.5	μS/cm
LSPFDN	6/15/2008	Specific Conductance	80	μS/cm
LSPFDNX	6/15/2008	Specific Conductance	80	μS/cm
LSPFUP	6/15/2008	Specific Conductance	91.7	μS/cm
LSHUDN	6/21/2008	Specific Conductance	65.1	μS/cm
LSHUUP	6/21/2008	Specific Conductance	66.6	μS/cm
LSPFDN	6/21/2008	Specific Conductance	71.5	μS/cm
LSPFDNX	6/21/2008	Specific Conductance	75	μS/cm
LSPFUP	6/21/2008	Specific Conductance	77.9	μS/cm
LSHUDN	6/29/2008	Specific Conductance	80.3	μS/cm
LSHUUP	6/29/2008	Specific Conductance	79.2	μS/cm
LSPFDN	6/29/2008	Specific Conductance	83.9	μS/cm
LSPFDNX	6/29/2008	Specific Conductance	81.2	μS/cm
LSPFUP	6/29/2008	Specific Conductance	83.2	μS/cm
LSCHR	8/14/2006	Temperature	8.1	Celsius
LSEDG	8/14/2006	Temperature	7.4	Celsius
LSHUDN	8/14/2006	Temperature	8.8	Celsius
LSHUUP	8/14/2006	Temperature	8.6	Celsius
LSPFDN	8/14/2006	Temperature	12.6	Celsius
LSPFUP	8/14/2006	Temperature	12	Celsius
LSCHR	5/14/2007	Temperature	6.2	Celsius
LSEDG	5/14/2007	Temperature	5	Celsius
LSHUDN	5/14/2007	Temperature	6.1	Celsius
LSHUUP	5/14/2007	Temperature	5.6	Celsius
LSPFDN	5/14/2007	Temperature	8.6	Celsius
LSPFUP	5/14/2007	Temperature	8.6	Celsius
LSCHR	5/21/2007	Temperature	6.4	Celsius

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Site	Date	Measurement	Value	Units
LSEDG	5/21/2007	Temperature	5.4	Celsius
LSHUDN	5/21/2007	Temperature	8.3	Celsius
LSPFDN	5/21/2007	Temperature	11.9	Celsius
LSPFUP	5/21/2007	Temperature	10.7	Celsius
LSCHR	6/4/2007	Temperature	6.5	Celsius
LSEDG	6/4/2007	Temperature	6	Celsius
LSHUDN	6/4/2007	Temperature	8.5	Celsius
LSHUUP	6/4/2007	Temperature	8	Celsius
LSPFDN	6/4/2007	Temperature	12.1	Celsius
LSPFUP	6/4/2007	Temperature	12.4	Celsius
LSCHR	6/14/2007	Temperature	6.2	Celsius
LSEDG	6/14/2007	Temperature	5.7	Celsius
LSHUDN	6/14/2007	Temperature	8.3	Celsius
LSHUUP	6/14/2007	Temperature	8.0	Celsius
LSPFUP	6/14/2007	Temperature	13	Celsius
LSCHR	6/20/2007	Temperature	9.7	Celsius
LSEDG	6/20/2007	Temperature	10.3	Celsius
LSHUDN	6/20/2007	Temperature	10.7	Celsius
LSHUUP	6/20/2007	Temperature	10	Celsius
LSPFDN	6/20/2007	Temperature	15.3	Celsius
LSPFUP	6/20/2007	Temperature	16.6	Celsius
LSPFDN	7/23/2007	Temperature	15.1	Celsius
LSPFDNX	7/23/2007	Temperature	15	Celsius
LSPFUP	7/23/2007	Temperature	15.1	Celsius
LSHUDN	7/29/2007	Temperature	12.7	Celsius
LSHUUP	7/29/2007	Temperature	11.3	Celsius
LSPFDN	7/29/2007	Temperature	18	Celsius
LSPFUP	7/29/2007	Temperature	18.7	Celsius
LSHUDN	8/5/2007	Temperature	9.7	Celsius
LSHUUP	8/5/2007	Temperature	9.3	Celsius
LSPFDN	8/5/2007	Temperature	13.1	Celsius
LSPFUP	8/5/2007	Temperature	13.1	Celsius
LSHUDN	8/12/2007	Temperature	11.4	Celsius
LSHUUP	8/12/2007	Temperature	10.6	Celsius
LSPFDN	8/12/2007	Temperature	14.9	Celsius
LSPFUP	8/12/2007	Temperature	15.2	Celsius
LSHUDN	8/19/2007	Temperature	10.9	Celsius
LSHUUP	8/19/2007	Temperature	10.3	Celsius
LSPFDN	8/19/2007	Temperature	14.6	Celsius
LSPFUP	8/19/2007	Temperature	14.9	Celsius
LSHUDN	8/26/2007	Temperature	9.9	Celsius
LSHUUP	8/26/2007	Temperature	9.3	Celsius
LSPFDN	8/26/2007	Temperature	13.2	Celsius
LSPFUP	8/26/2007	Temperature	12.5	Celsius

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Site	Date	Measurement	Value	Units
LSHUDN	7/29/2007	Toluene	<0.5	mg/L
LSHUUP	7/29/2007	Toluene	<0.5	mg/L
LSPFDN	7/29/2007	Toluene	4.1	mg/L
LSPFDNX	7/29/2007	Toluene	4.3	mg/L
LSPFUP	7/29/2007	Toluene	2.6	mg/L
LSHUDN	8/5/2007	Toluene	<0.5	mg/L
LSHUUP	8/5/2007	Toluene	<0.5	mg/L
LSPFDN	8/5/2007	Toluene	<0.5	mg/L
LSPFDNX	8/5/2007	Toluene	<0.5	mg/L
LSPFUP	8/5/2007	Toluene	<0.5	mg/L
LSHUDN	8/12/2007	Toluene	<0.5	mg/L
LSHUUP	8/12/2007	Toluene	<0.5	mg/L
LSPFDN	8/12/2007	Toluene	<0.5	mg/L
LSPFDNX	8/12/2007	Toluene	<0.5	mg/L
LSPFUP	8/12/2007	Toluene	<0.5	mg/L
LSHUDN	8/19/2007	Toluene	<0.5	mg/L
LSHUUP	8/19/2007	Toluene	<0.5	mg/L
LSPFDN	8/19/2007	Toluene	8.17	mg/L
LSPFDNX	8/19/2007	Toluene	6.57	mg/L
LSPFUP	8/19/2007	Toluene	5.6	mg/L
LSHUDN	8/26/2007	Toluene	<0.5	mg/L
LSHUUP	8/26/2007	Toluene	<0.5	mg/L
LSPFDN	8/26/2007	Toluene	<0.5	mg/L
LSPFDNX	8/26/2007	Toluene	<0.5	mg/L
LSHUDN	9/2/2007	Toluene	<0.5	mg/L
LSHUUP	9/2/2007	Toluene	<0.5	mg/L
LSPFDN	9/2/2007	Toluene	<0.5	mg/L
LSPFDNX	9/2/2007	Toluene	<0.5	mg/L
LSPFUP	9/2/2007	Toluene	<0.5	mg/L
LSHUDN	9/9/2007	Toluene	<0.5	mg/L
LSHUUP	9/9/2007	Toluene	<0.5	mg/L
LSPFDN	9/9/2007	Toluene	<0.5	mg/L
LSPFDNX	9/9/2007	Toluene	<0.5	mg/L
LSPFUP	9/9/2007	Toluene	<0.5	mg/L
LSHUDN	9/16/2007	Toluene	<0.5	mg/L
LSHUUP	9/16/2007	Toluene	<0.5	mg/L
LSPFDN	9/16/2007	Toluene	<0.5	mg/L
LSPFDNX	9/16/2007	Toluene	<0.5	mg/L
LSPFUP	9/16/2007	Toluene	<0.5	mg/L
LSHUDN	5/10/2008	Toluene	<0.5	mg/L
LSHUUP	5/10/2008	Toluene	<0.5	mg/L
LSPFDN	5/10/2008	Toluene	<0.5	mg/L
LSPFDNX	5/10/2008	Toluene	<0.5	mg/L
LSPFUP	5/10/2008	Toluene	<0.5	mg/L

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Site	Date	Measurement	Value	Units
LSHUDN	5/18/2008	Toluene	<0.5	mg/L
LSHUUP	5/18/2008	Toluene	<0.5	mg/L
LSPFDN	5/18/2008	Toluene	<0.5	mg/L
LSPFDNX	5/18/2008	Toluene	<0.5	mg/L
LSPFUP	5/18/2008	Toluene	<0.5	mg/L
LSHUDN	5/24/2008	Toluene	<0.5	mg/L
LSHUUP	5/24/2008	Toluene	4.73	mg/L
LSPFDN	5/24/2008	Toluene	2.96	mg/L
LSPFDNX	5/24/2008	Toluene	2.1	mg/L
LSPFUP	5/24/2008	Toluene	1.2	mg/L
LSHUDN	6/1/2008	Toluene	<0.5	mg/L
LSHUUP	6/1/2008	Toluene	2.89	mg/L
LSPFDN	6/1/2008	Toluene	13.0	mg/L
LSPFDNX	6/1/2008	Toluene	12.9	mg/L
LSPFUP	6/1/2008	Toluene	13.7	mg/L
LSHUDN	6/8/2008	Toluene	<0.5	mg/L
LSHUUP	6/8/2008	Toluene	7.64	mg/L
LSPFDN	6/8/2008	Toluene	74.7	mg/L
LSPFDNX	6/8/2008	Toluene	55.8	mg/L
LSPFUP	6/8/2008	Toluene	36.7	mg/L
LSHUDN	6/15/2008	Toluene	0.73	mg/L
LSHUUP	6/15/2008	Toluene	0.73	mg/L
LSPFDN	6/15/2008	Toluene	12.3	mg/L
LSPFDNX	6/15/2008	Toluene	7.61	mg/L
LSPFUP	6/15/2008	Toluene	4.88	mg/L
LSHUDN	6/21/2008	Toluene	<0.5	mg/L
LSHUUP	6/21/2008	Toluene	<0.5	mg/L
LSPFDN	6/21/2008	Toluene	9.09	mg/L
LSPFDNX	6/21/2008	Toluene	3.08	mg/L
LSPFUP	6/21/2008	Toluene	<0.5	mg/L
LSHUDN	6/29/2008	Toluene	1.15	mg/L
LSHUUP	6/29/2008	Toluene	0.7	mg/L
LSPFDN	6/29/2008	Toluene	7.47	mg/L
LSPFDNX	6/29/2008	Toluene	8.32	mg/L
LSPFUP	6/29/2008	Toluene	6.05	mg/L
LSCHR	8/14/2006	Total Dissolved Phosphorus	0.044	mg/L
LSEDG	8/14/2006	Total Dissolved Phosphorus	0.011	mg/L
LSHUDN	8/14/2006	Total Dissolved Phosphorus	0.093	mg/L
LSHUUP	8/14/2006	Total Dissolved Phosphorus	0.1	mg/L
LSPFDN	8/14/2006	Total Dissolved Phosphorus	0.033	mg/L
LSPFUP	8/14/2006	Total Dissolved Phosphorus	0.04	mg/L
LSCHR	5/14/2007	Total Dissolved Phosphorus	0.005	mg/L
LSEDG	5/14/2007	Total Dissolved Phosphorus	0.02	mg/L
LSHUDN	5/14/2007	Total Dissolved Phosphorus	0.007	mg/L

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Site	Date	Measurement	Value	Units
LSHUUP	5/14/2007	Total Dissolved Phosphorus	0.005	mg/L
LSPFDN	5/14/2007	Total Dissolved Phosphorus	0.007	mg/L
LSPFDNX	5/14/2007	Total Dissolved Phosphorus	0.007	mg/L
LSPFUP	5/14/2007	Total Dissolved Phosphorus	0.007	mg/L
LSCHR	5/21/2007	Total Dissolved Phosphorus	0.017	mg/L
LSEDG	5/21/2007	Total Dissolved Phosphorus	0.014	mg/L
LSHUDN	5/21/2007	Total Dissolved Phosphorus	0.011	mg/L
LSHUUP	5/21/2007	Total Dissolved Phosphorus	0.011	mg/L
LSPFDN	5/21/2007	Total Dissolved Phosphorus	0.017	mg/L
LSPFDNX	5/21/2007	Total Dissolved Phosphorus	0.014	mg/L
LSPFUP	5/21/2007	Total Dissolved Phosphorus	0.017	mg/L
LSCHR	6/4/2007	Total Dissolved Phosphorus	0.09	mg/L
LSEDG	6/4/2007	Total Dissolved Phosphorus	0.034	mg/L
LSHUDN	6/4/2007	Total Dissolved Phosphorus	0.044	mg/L
LSHUUP	6/4/2007	Total Dissolved Phosphorus	0.032	mg/L
LSPFDN	6/4/2007	Total Dissolved Phosphorus	0.043	mg/L
LSPFDNX	6/4/2007	Total Dissolved Phosphorus	0.031	mg/L
LSPFUP	6/4/2007	Total Dissolved Phosphorus	0.032	mg/L
LSCHR	6/12/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSEDG	6/12/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSHUDN	6/12/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSHUUP	6/12/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSPFDN	6/12/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSPFDNX	6/12/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSPFUP	6/12/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSCHR	6/20/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSEDG	6/20/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSHUDN	6/20/2007	Total Dissolved Phosphorus	0.005	mg/L
LSHUUP	6/20/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSPFDN	6/20/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSPFDNX	6/20/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSPFUP	6/20/2007	Total Dissolved Phosphorus	<0.001	mg/L
LSCHR	8/14/2006	Total Phosphorus	0.045	mg/L
LSEDG	8/14/2006	Total Phosphorus	0.013	mg/L
LSHUDN	8/14/2006	Total Phosphorus	0.12	mg/L
LSHUUP	8/14/2006	Total Phosphorus	0.1	mg/L
LSPFDN	8/14/2006	Total Phosphorus	0.039	mg/L
LSPFUP	8/14/2006	Total Phosphorus	0.043	mg/L
LSCHR	5/14/2007	Total Phosphorus	0.015	mg/L
LSEDG	5/14/2007	Total Phosphorus	0.013	mg/L
LSHUDN	5/14/2007	Total Phosphorus	0.012	mg/L
LSHUUP	5/14/2007	Total Phosphorus	0.034	mg/L
LSPFDN	5/14/2007	Total Phosphorus	0.053	mg/L
LSPFDNX	5/14/2007	Total Phosphorus	0.046	mg/L

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Site	Date	Measurement	Value	Units
LSPFUP	5/14/2007	Total Phosphorus	0.006	mg/L
LSCHR	5/21/2007	Total Phosphorus	0.016	mg/L
LSEDG	5/21/2007	Total Phosphorus	0.014	mg/L
LSHUDN	5/21/2007	Total Phosphorus	0.018	mg/L
LSHUUP	5/21/2007	Total Phosphorus	0.016	mg/L
LSPFDN	5/21/2007	Total Phosphorus	0.017	mg/L
LSPFDNX	5/21/2007	Total Phosphorus	0.016	mg/L
LSPFUP	5/21/2007	Total Phosphorus	0.017	mg/L
LSCHR	6/4/2007	Total Phosphorus	0.026	mg/L
LSEDG	6/4/2007	Total Phosphorus	0.04	mg/L
LSHUDN	6/4/2007	Total Phosphorus	0.053	mg/L
LSHUUP	6/4/2007	Total Phosphorus	0.04	mg/L
LSPFDN	6/4/2007	Total Phosphorus	0.05	mg/L
LSPFDNX	6/4/2007	Total Phosphorus	0.055	mg/L
LSPFUP	6/4/2007	Total Phosphorus	0.041	mg/L
LSCHR	6/12/2007	Total Phosphorus	0.02	mg/L
LSEDG	6/12/2007	Total Phosphorus	0.009	mg/L
LSHUDN	6/12/2007	Total Phosphorus	0.028	mg/L
LSHUUP	6/12/2007	Total Phosphorus	0.016	mg/L
LSPFDN	6/12/2007	Total Phosphorus	0.034	mg/L
LSPFDNX	6/12/2007	Total Phosphorus	0.05	mg/L
LSPFUP	6/12/2007	Total Phosphorus	0.038	mg/L
LSCHR	6/20/2007	Total Phosphorus	0.02	mg/L
LSEDG	6/20/2007	Total Phosphorus	0.016	mg/L
LSHUDN	6/20/2007	Total Phosphorus	0.022	mg/L
LSHUUP	6/20/2007	Total Phosphorus	0.015	mg/L
LSPFDN	6/20/2007	Total Phosphorus	0.07	mg/L
LSPFDNX	6/20/2007	Total Phosphorus	0.044	mg/L
LSPFUP	6/20/2007	Total Phosphorus	0.026	mg/L
LSHUDN	7/29/2007	Total Xylene	<1.0	mg/L
LSHUUP	7/29/2007	Total Xylene	<1.0	mg/L
LSPFDN	7/29/2007	Total Xylene	1.0	mg/L
LSPFDNX	7/29/2007	Total Xylene	1.1	mg/L
LSPFUP	7/29/2007	Total Xylene	<1.0	mg/L
LSHUDN	8/5/2007	Total Xylene	<1.0	mg/L
LSHUUP	8/5/2007	Total Xylene	<1.0	mg/L
LSPFDN	8/5/2007	Total Xylene	<1.0	mg/L
LSPFDNX	8/5/2007	Total Xylene	<1.0	mg/L
LSPFUP	8/5/2007	Total Xylene	<1.0	mg/L
LSHUDN	8/12/2007	Total Xylene	<1.0	mg/L
LSHUUP	8/12/2007	Total Xylene	<1.0	mg/L
LSPFDN	8/12/2007	Total Xylene	<1.0	mg/L
LSPFDNX	8/12/2007	Total Xylene	<1.0	mg/L
LSPFUP	8/12/2007	Total Xylene	<1.0	mg/L

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Site	Date	Measurement	Value	Units
LSHUDN	8/19/2007	Total Xylene	<1.0	mg/L
LSHUUP	8/19/2007	Total Xylene	<1.0	mg/L
LSPFDN	8/19/2007	Total Xylene	2	mg/L
LSPFDNX	8/19/2007	Total Xylene	1.58	mg/L
LSPFUP	8/19/2007	Total Xylene	1.1	mg/L
LSHUDN	8/26/2007	Total Xylene	<1.0	mg/L
LSHUUP	8/26/2007	Total Xylene	<1.0	mg/L
LSPFDN	8/26/2007	Total Xylene	<1.0	mg/L
LSPFDNX	8/26/2007	Total Xylene	<1.0	mg/L
LSHUDN	9/2/2007	Total Xylene	<1.0	mg/L
LSHUUP	9/2/2007	Total Xylene	<1.0	mg/L
LSPFDN	9/2/2007	Total Xylene	<1.0	mg/L
LSPFDNX	9/2/2007	Total Xylene	<1.0	mg/L
LSPFUP	9/2/2007	Total Xylene	<1.0	mg/L
LSHUDN	9/9/2007	Total Xylene	<1.0	mg/L
LSHUUP	9/9/2007	Total Xylene	<1.0	mg/L
LSPFDN	9/9/2007	Total Xylene	<1.0	mg/L
LSPFDNX	9/9/2007	Total Xylene	<1.0	mg/L
LSPFUP	9/9/2007	Total Xylene	<1.0	mg/L
LSHUDN	9/16/2007	Total Xylene	<1.0	mg/L
LSHUUP	9/16/2007	Total Xylene	<1.0	mg/L
LSPFDN	9/16/2007	Total Xylene	<1.0	mg/L
LSPFDNX	9/16/2007	Total Xylene	<1.0	mg/L
LSPFUP	9/16/2007	Total Xylene	<1.0	mg/L
LSHUDN	5/10/2008	Total Xylene	<1	mg/L
LSHUUP	5/10/2008	Total Xylene	<1	mg/L
LSPFDN	5/10/2008	Total Xylene	<1	mg/L
LSPFDNX	5/10/2008	Total Xylene	<1	mg/L
LSPFUP	5/10/2008	Total Xylene	<1	mg/L
LSHUDN	5/18/2008	Total Xylene	<1	mg/L
LSHUUP	5/18/2008	Total Xylene	1.53	mg/L
LSPFDN	5/18/2008	Total Xylene	<1	mg/L
LSPFDNX	5/18/2008	Total Xylene	<1	mg/L
LSPFUP	5/18/2008	Total Xylene	<1	mg/L
LSHUDN	5/24/2008	Total Xylene	<1	mg/L
LSHUUP	5/24/2008	Total Xylene	8.22	mg/L
LSPFDN	5/24/2008	Total Xylene	<1	mg/L
LSPFDNX	5/24/2008	Total Xylene	<1	mg/L
LSPFUP	5/24/2008	Total Xylene	<1	mg/L
LSHUDN	6/1/2008	Total Xylene	<1	mg/L
LSHUUP	6/1/2008	Total Xylene	4.78	mg/L
LSPFDN	6/1/2008	Total Xylene	3.73	mg/L
LSPFDNX	6/1/2008	Total Xylene	3.31	mg/L
LSPFUP	6/1/2008	Total Xylene	3.95	mg/L



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Site	Date	Measurement	Value	Units
LSHUDN	6/8/2008	Total Xylene	<1	mg/L
LSHUUP	6/8/2008	Total Xylene	24.3	mg/L
LSPFDN	6/8/2008	Total Xylene	<1	mg/L
LSPFDNX	6/8/2008	Total Xylene	<1	mg/L
LSPFUP	6/8/2008	Total Xylene	<1	mg/L
LSHUDN	6/15/2008	Total Xylene	<1	mg/L
LSHUUP	6/15/2008	Total Xylene	<1	mg/L
LSPFDN	6/15/2008	Total Xylene	3.13	mg/L
LSPFDNX	6/15/2008	Total Xylene	2.19	mg/L
LSPFUP	6/15/2008	Total Xylene	1.34	mg/L
LSHUDN	6/21/2008	Total Xylene	<1	mg/L
LSHUUP	6/21/2008	Total Xylene	<1	mg/L
LSPFDN	6/21/2008	Total Xylene	<1	mg/L
LSPFDNX	6/21/2008	Total Xylene	1.61	mg/L
LSPFUP	6/21/2008	Total Xylene	<1	mg/L
LSHUDN	6/29/2008	Total Xylene	<1	mg/L
LSHUUP	6/29/2008	Total Xylene	<1	mg/L
LSPFDN	6/29/2008	Total Xylene	1.47	mg/L
LSPFDNX	6/29/2008	Total Xylene	1.71	mg/L
LSPFUP	6/29/2008	Total Xylene	1.64	mg/L
LSCHR	8/14/2006	Turbidity	5.5	NTU
LSEDG	8/14/2006	Turbidity	3.7	NTU
LSHUDN	8/14/2006	Turbidity	8.1	NTU
LSHUUP	8/14/2006	Turbidity	6.1	NTU
LSPFDN	8/14/2006	Turbidity	7.8	NTU
LSPFDNX	8/14/2006	Turbidity	5.3	NTU
LSPFUP	8/14/2006	Turbidity	5	NTU
LSCHR	5/14/2007	Turbidity	0.9	NTU
LSEDG	5/14/2007	Turbidity	1.1	NTU
LSHUDN	5/14/2007	Turbidity	1.5	NTU
LSHUUP	5/14/2007	Turbidity	1.5	NTU
LSPFDN	5/14/2007	Turbidity	2.7	NTU
LSPFDNX	5/14/2007	Turbidity	2.5	NTU
LSPFUP	5/14/2007	Turbidity	1.7	NTU
LSCHR	5/21/2007	Turbidity	1.6	NTU
LSEDG	5/21/2007	Turbidity	1.5	NTU
LSHUDN	5/21/2007	Turbidity	2	NTU
LSHUUP	5/21/2007	Turbidity	1.2	NTU
LSPFDN	5/21/2007	Turbidity	2	NTU
LSPFDNX	5/21/2007	Turbidity	2.1	NTU
LSPFUP	5/21/2007	Turbidity	1.8	NTU
LSCHR	6/4/2007	Turbidity	1.3	NTU
LSEDG	6/4/2007	Turbidity	1.4	NTU
LSHUDN	6/4/2007	Turbidity	1.6	NTU

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Site	Date	Measurement	Value	Units
LSHUUP	6/4/2007	Turbidity	1.6	NTU
LSPFDN	6/4/2007	Turbidity	2.5	NTU
LSPFDNX	6/4/2007	Turbidity	3	NTU
LSPFUP	6/4/2007	Turbidity	2.5	NTU
LSCHR	6/14/2007	Turbidity	3.5	NTU
LSEDG	6/14/2007	Turbidity	3.8	NTU
LSHUDN	6/14/2007	Turbidity	4.2	NTU
LSHUUP	6/14/2007	Turbidity	3.8	NTU
LSPFDN	6/14/2007	Turbidity	13	NTU
LSPFDNX	6/14/2007	Turbidity	18	NTU
LSPFUP	6/14/2007	Turbidity	5.9	NTU
LSCHR	6/20/2007	Turbidity	5.2	NTU
LSEDG	6/20/2007	Turbidity	3.6	NTU
LSHUDN	6/20/2007	Turbidity	5.4	NTU
LSHUUP	6/20/2007	Turbidity	5.6	NTU
LSPFDN	6/20/2007	Turbidity	12	NTU
LSPFDNX	6/20/2007	Turbidity	16	NTU
LSPFUP	6/20/2007	Turbidity	8.9	NTU
LSPFDN	7/23/2007	Turbidity	8	NTU
LSPFDNX	7/23/2007	Turbidity	5.5	NTU
LSPFUP	7/23/2007	Turbidity	2.5	NTU
LSHUDN	7/29/2007	Turbidity	4	NTU
LSHUUP	7/29/2007	Turbidity	4.7	NTU
LSPFDN	7/29/2007	Turbidity	7.2	NTU
LSPFDNX	7/29/2007	Turbidity	4.1	NTU
LSPFUP	7/29/2007	Turbidity	3.3	NTU
LSHUDN	8/5/2007	Turbidity	4.5	NTU
LSHUUP	8/5/2007	Turbidity	3.5	NTU
LSPFDN	8/5/2007	Turbidity	8	NTU
LSPFDNX	8/5/2007	Turbidity	7.4	NTU
LSPFUP	8/5/2007	Turbidity	7.3	NTU
LSHUDN	8/12/2007	Turbidity	3.9	NTU
LSHUUP	8/12/2007	Turbidity	4	NTU
LSPFDN	8/12/2007	Turbidity	10	NTU
LSPFDNX	8/12/2007	Turbidity	10	NTU
LSPFUP	8/12/2007	Turbidity	5.5	NTU
LSHUDN	8/19/2007	Turbidity	3.1	NTU
LSHUUP	8/19/2007	Turbidity	3.6	NTU
LSPFDN	8/19/2007	Turbidity	7.4	NTU
LSPFDNX	8/19/2007	Turbidity	7.1	NTU
LSPFUP	8/19/2007	Turbidity	7.4	NTU
LSHUDN	8/26/2007	Turbidity	4.9	NTU
LSHUUP	8/26/2007	Turbidity	3.5	NTU
LSPFDN	8/26/2007	Turbidity	5.6	NTU

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Site	Date	Measurement	Value	Units
LSPFDNX	8/26/2007	Turbidity	4.9	NTU
LSPFUP	8/26/2007	Turbidity	5.7	NTU
LSHUDN	9/2/2007	Turbidity	2.7	NTU
LSHUUP	9/2/2007	Turbidity	2.7	NTU
LSPFDN	9/2/2007	Turbidity	2.6	NTU
LSPFDNX	9/2/2007	Turbidity	2.6	NTU
LSPFUP	9/2/2007	Turbidity	2.7	NTU
LSHUDN	9/9/2007	Turbidity	43	NTU
LSHUUP	9/9/2007	Turbidity	34	NTU
LSPFDN	9/9/2007	Turbidity	4.4	NTU
LSPFDNX	9/9/2007	Turbidity	6.8	NTU
LSPFUP	9/9/2007	Turbidity	4.2	NTU
LSHUDN	9/17/2007	Turbidity	6	NTU
LSHUUP	9/17/2007	Turbidity	4.5	NTU
LSPFDN	9/17/2007	Turbidity	4	NTU
LSPFDNX	9/17/2007	Turbidity	3.8	NTU
LSPFUP	9/17/2007	Turbidity	3.1	NTU
LSHUDN	5/10/2008	Turbidity	0.06	NTU
LSHUUP	5/10/2008	Turbidity	0.38	NTU
LSPFDN	5/10/2008	Turbidity	3.89	NTU
LSPFDNX	5/10/2008	Turbidity	1.79	NTU
LSPFUP	5/10/2008	Turbidity	1.18	NTU
LSHUDN	5/18/2008	Turbidity	1.41	NTU
LSHUUP	5/18/2008	Turbidity	1.84	NTU
LSPFDN	5/18/2008	Turbidity	6.04	NTU
LSPFDNX	5/18/2008	Turbidity	6.73	NTU
LSPFUP	5/18/2008	Turbidity	2.31	NTU
LSHUDN	5/24/2008	Turbidity	1.07	NTU
LSHUUP	5/24/2008	Turbidity	0.47	NTU
LSPFDN	5/24/2008	Turbidity	6.47	NTU
LSPFDNX	5/24/2008	Turbidity	7.26	NTU
LSPFUP	5/24/2008	Turbidity	1.62	NTU
LSHUDN	6/8/2008	Turbidity	2.56	NTU
LSHUUP	6/8/2008	Turbidity	1.96	NTU
LSPFDN	6/8/2008	Turbidity	12.7	NTU
LSPFDNX	6/8/2008	Turbidity	15.3	NTU
LSPFUP	6/8/2008	Turbidity	2.03	NTU
LSHUDN	6/15/2008	Turbidity	2.58	NTU
LSHUUP	6/15/2008	Turbidity	2.07	NTU
LSPFDN	6/15/2008	Turbidity	18.1	NTU
LSPFDNX	6/15/2008	Turbidity	19.1	NTU
LSPFUP	6/15/2008	Turbidity	9.17	NTU
LSHUDN	6/21/2008	Turbidity	6.69	NTU
LSHUUP	6/21/2008	Turbidity	6.59	NTU

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<b>Site</b>	<b>Date</b>	<b>Measurement</b>	<b>Value</b>	<b>Units</b>
LSPFDN	6/21/2008	Turbidity	10.3	NTU
LSPFDNX	6/21/2008	Turbidity	11.4	NTU
LSPFUP	6/21/2008	Turbidity	8.63	NTU
LSHUDN	6/29/2008	Turbidity	2.28	NTU
LSHUUP	6/29/2008	Turbidity	0.12	NTU
LSPFDN	6/29/2008	Turbidity	3.89	NTU
LSPFDNX	6/29/2008	Turbidity	5.6	NTU
LSPFUP	6/29/2008	Turbidity	3.54	NTU

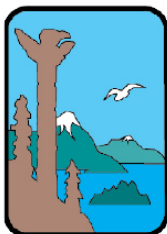
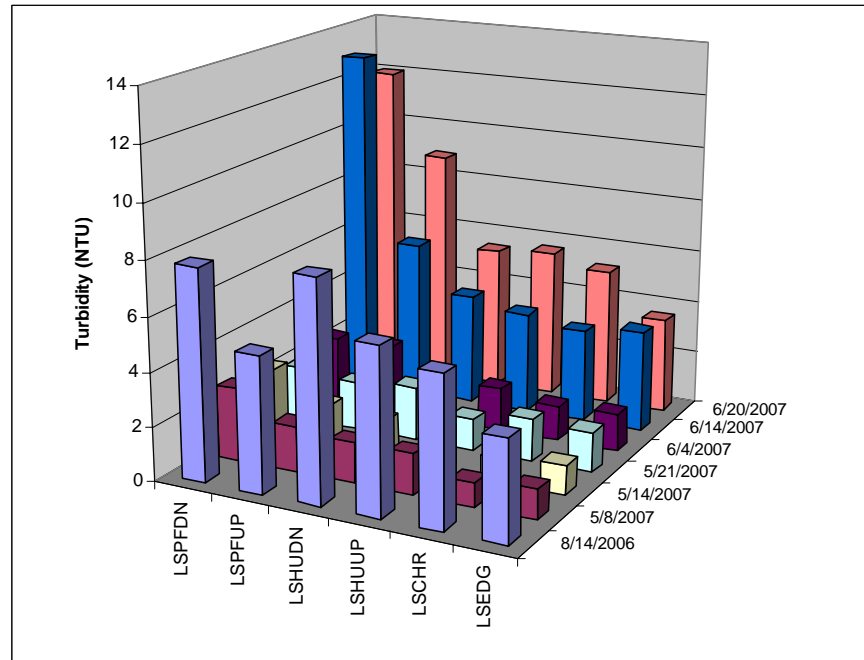
## **Appendix B. Sampling Plan and QAPP**

# Quality Assurance Project and Sampling Plan

## Water Quality Evaluation of the Lower Little Susitna River

August 2007

(Revision Number 2.0)



ALASKA  
Department of  
Environmental  
Conservation



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## **A1. Water Quality Evaluation of the Lower Little Susitna River**

### **Aquatic Restoration and Research Institute**

**Project Manager:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Quality Assurance Officer:** \_\_\_\_\_ **Date:** \_\_\_\_\_

### **Alaska Department of Environmental Conservation**

**Project Manager:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Quality Assurance Officer:** \_\_\_\_\_ **Date:** \_\_\_\_\_

Effective Date: \_\_\_\_\_



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### **A3. Distribution List**

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#### A4. Project/Task Organization

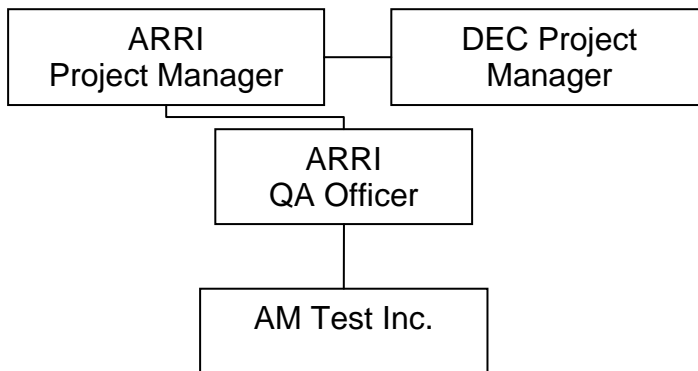
The Project Manager listed below will be responsible for all project components including data collection, entry, analyses, and reports.

Laura Eldred (DEC). DEC Project Manager. Ms. Eldred will oversee the project for DEC, provide technical support, QAPP review and approval, and the review of all quarterly reports and the final report.

Jeffrey C. Davis (ARRI): Project Manager. Mr. Davis will make sure that all field data are collected as specified in the QAPP. He will test and maintain all equipment prior to use and perform the review of data entry and analyses.

Gay A. Davis (ARRI) will act as Quality Assurance Officer. Ms. Davis will be responsible for making sure that all data are collected, replicate samples taken and analyzed, and all data entered and analyzed correctly.

AM Test Inc.—Redmond, WA. The testing laboratory will be responsible for analyzing all collected water chemistry samples.



#### A5. Problem Definition/Background

The Little Susitna River flows from the Talkeetna Mountains to Cook Inlet. The river flows through the Hatcher Pass State Recreation Area, the residential communities of Wasilla and Houston, 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. The river supports a highly popular salmon and trout fishery as well as recreational non-motorized and motorized boating. There is a relatively high degree of residential development between Edgerton Park Road and Schrock Road, adjacent to the city of Wasilla City, and the City of Houston. The lower river, from Houston to the Public Use Site, is a popular recreational area for motorized and non-motorized boating, camping and sport fishing. Potential impacts to the lower river segment are from the residential development adjacent to the

city of Houston, and recreation, primarily boat-accessed sport fishing. There are two areas of concentrated motor boat use, from Houston to Lake Creek and from 3 miles upstream of the public use site downstream to near Cook Inlet.

Recreation use also can cause an increase in sediment delivery rates and toxic hydrocarbons. Fine sediment delivery rates can increase with increasing bank failures due to the removal of bank vegetation with foot traffic. Boat waves also can increase bank failure rates and sediment delivery by eroding bank materials. Motor boats can deliver toxic hydrocarbons through fuel and oil leaks, spills or the inefficient combustion of engines, fuel spills, and bilge pumping. The objective of this study is to determine whether boat-accessed use of the Little Susitna is leading to hydrocarbon contamination of the river.

#### **A6. Project/Task Description Total Aromatic Hydrocarbons**

This project has been designed to evaluate potential hydrocarbon contamination of the Little Susitna River. This will be accomplished by collecting water samples and analyzing them for Total Aromatic Hydrocarbons (TAH). Water samples will be collected during times of heavy boat use during the recreational sport fisheries and during times of low boat use. Samples will be collected above and below high boat concentration use areas.

##### **Task 1: QAPP Revision and Sampling Plan Approval**

Start and end date: July 20 to July 31, 2007

Description: The ARRI Project Manager will develop a Quality Assurance Project Plan (QAPP) and Sampling Plan for ADEC review and approval. Previously approved QAPP and Sampling Plan will be modified for the specific project tasks. These documents will describe in detail the frequency, duration, and location of all proposed sampling. They will identify the equipment that will be used and how the equipment will be calibrated and maintained. It will describe the analytical methods that will be used and who will be handling and analyzing the water samples. The methods that will be used to determine data accuracy, precision, and completeness will be outlined. Data handling, management and reporting will be described. It will detail the responsibilities of all staff members and contractors and who will be responsible for each phase of the project. The Project Manager will coordinate with the ADEC Project Manager to address any inadequacies in the documents to prepare final approved plans. ARRI will focus on completing this task as soon as possible.

Product or deliverable: ADEC approved QAPP and Sampling Plan.

##### **Task 2: Water Chemistry Sampling and Analyses**

Start and end date: July 31, 2007 to June 30, 2008

Description: Stream water samples will be collected on 16 sampling dates at 4 different locations. Sampling locations will be upstream from Houston, below the Miller's Reach boat launch, above the Public Use Site/Boat Launch and just downstream from the Public Use Site/Boat Launch. Sampling will be conducted weekly for eight weeks from late July through the third week in August. Both areas will be sampled in the spring of 2008 from early May through June. Sampling dates will coincide with the peak Chinook and coho

salmon fisheries and low use times. During peak fisheries, sample collection will occur on weekends or holidays. Public use of the boat launch at the Public Use Site as well as boat and motor size will be obtained from State Park personnel surveys. Water samples will be analyzed for hydrocarbons, turbidity, pH, specific conductance, and dissolved oxygen. Flow data will be obtained from the U.S.G.S. gauging station, weather observations will be augmented by weather data downloaded from NOAA stations. Stream water temperature will be measured on each sampling date, and recorded continuously from temperature data loggers. Stream water samples will be collected in sample containers provided by commercial laboratories and submitted for analyses immediately following collection.

Product or deliverable: Data will be provided within the final report. Sample results will determine whether intensive boat use results in a measurable change in water chemistry, provide additional background water chemistry, and determine whether chemical results meet State Water Quality Standards. Results will be analyzed relative to changes in hydrology, location, and use surveys.

**Task 3: Juvenile Salmon Sampling and Analyses**

Start and end date: August to October 2007

Description: Sampling would be conducted to evaluate the relative catch rate of juvenile salmon. Sampling would be conducted during peak boat use during the coho sport fishery and following the sport fishery at sampling locations above and within peak use areas. Juvenile salmon would be captured in baited minnow traps. Five minnow traps would be placed along the river bank adjacent to the water chemistry sampling locations. Traps would be placed on outside bends within areas of similar depth, velocity, and cover. Traps would be removed after 8 to 12 hours soak time. All captured fish would be counted, identified, and measured. Fish would be observed for DELT (Deformities, Eroded fins, Lesions, or Tumors) anomalies per U.S.G.S. methodology.

Product or deliverable: The resulting data would be provided within the final report. Results will determine differences in juvenile fish catch rates between sites that have heavy boat use and adjacent reference sites.

**Task 4: Data Formatting for STORET**

Start and end date: November 2007 – June 2008

Description: Sampling locations, dates, methods, and resulting measurement values will be formatted for uploading into the STORET database. Data will either be transferred to ADEC or uploaded by ARRI staff.

Product or Deliverable: Project data provided in DEC required format by specified dates in grant agreement.

**Task 5: Draft and Final Water Quality Reports**

Start and end date: January 2008 – July 2008

Description: Draft and final written reports will be prepared. The draft report will be submitted to the ADEC Project Manager for review and comment. The final report will

provide background information and describe why the project is necessary the project objectives and the approach that was taken to meet the objectives. Field methods will be described and the project QAPP and sampling plan will be attached. All of the data results will be presented and described relative to the project objectives. A discussion of sources, timing and scope of petroleum hydrocarbons will be presented. We will make recommendations on further data collection if necessary and the potential causes and sources of hydrocarbon pollution. Project success will be determined based upon the completeness of data collection and on whether project objectives were accomplished.

Product or Deliverable: Draft and final Reports.

## A7. Quality Objectives and Criteria for Measurement of Data

The parameters in the Table 1 will be measured at the indicated performance level. All parameters are critical to meeting project objectives. Criteria for Measurements of Data are the performance criteria: accuracy, precision, comparability, representativeness and completeness of the tests. These criteria must be met to ensure that the data are verifiable and that project quality objectives are met.

**Table 1. Accuracy, precision, and completeness objectives for measurement parameters.**

Parameter	Method	Resolution/ Limit	Expected Range	Accuracy%	Precision %	Completeness
pH	Meter	0.01	6.5 to 8.5	95 to 105 @ 7.0	5%	90%
Turbidity (NTU)	Meter	0.1	1 to 6	75 to 125	20%	90%
Specific Conductance ( $\mu\text{S}/\text{cm}$ )	Meter	0.1	100 to 200	95 to 105 @ 100 $\mu\text{S}/\text{cm}$	5%	90%
DO (mg/L)	Meter	0.1	8 to 16	95 to 105 @ 10mg/L	5%	90%
TAH (mg/L)	EPA 624	0.001	0.001 to 0.01	75 to 125	20%	90%
Total Fecal Coliforms (cfu)	SM9222D	1	0 to 300	N/A	25%	90%
Juvenile Fish	Baited minnow traps	1.0	0 to 50	N/A	N/A	90%
Temperature ( $^{\circ}\text{C}$ )	HOBO	0.1	0 to 15	97 to 103 @ 15 $^{\circ}\text{C}$	5%	90%

### Accuracy

*Accuracy is a measure of confidence that describes how close a measurement is to its “true” value. Methods to ensure accuracy of field measurements include instrument calibration and maintenance procedures discussed in Section B of this QAPP.*

$$\text{Accuracy} = \frac{\text{MeasuredValue}}{\text{TrueValue}} \times 100$$

## **Precision**

*Precision is the degree of agreement among repeated measurements of the same characteristic, or parameter, and gives information about the consistency of methods. Precision is expressed in terms of the relative percent difference between two measurements (A and B).*

$$\text{Precision} = \frac{(A - B)}{((A + B) / 2)} \times 100$$

## **Representativeness**

*Representativeness is the extent to which measurements actually represent the true condition. Measurements that represent the environmental conditions are related to sample frequency and location relative to spatial and temporal variability of the condition one wishes to describe.*

## **Comparability**

*Comparability is the degree to which data can be compared directly to similar studies. Standardized sampling and analytical methods and units of reporting with comparable sensitivity will be used to ensure comparability.*

## **Completeness**

*Completeness is the comparison between the amounts of usable data collected versus the amounts of data called for.*

## **Quality Assurance for Measurement Parameters**

### **Accuracy and Precision**

The percent accuracy and precision for the acceptance of data is shown for each parameter in Table 1.

Water Chemistry. Accuracy will be determined for those measurements where actual values are known. For pH, conductivity, turbidity, and dissolved oxygen, measurements of commercially purchased standards within the range of expected values will be used. For dissolved oxygen, 100% saturated air will be used as a standard. Measurement accuracy will be determined for each sampling event. Contract laboratories will provide the results of accuracy measures along with chemical analytical reports. Sample analytical precision will be determined by obtaining a sample replicate at on site on all sampling dates. For aromatic hydrocarbons duplicate samples will be collected at all sampling sites on all dates.

Temperature. Accuracy for Stowaway temperature loggers has been calculated to be 0.40°C by the manufacturer, which at 15°C is 97% to 103%. Accuracy will be checked at two known temperatures, 0°C and 20°C, prior to deployment and upon retrieval.

Fish. Fish identification and counts will be assumed accurate. ARRI staff are well trained in the identification of juvenile salmon and other common fish species often captured within minnow traps. Similarly it is assumed that a repeat count of fish collected within a trap will result in the same value and precision is 0.

## **Representativeness**

The site locations, sampling frequency, and timing will ensure that the measurement parameters adequately describe and represent actual stream conditions for the sampling period. Single year data should not be interpreted to be representative of conditions over longer temporal scales. Repeated measures over multiple years are necessary to describe the variability among years. However this is beyond the scope of this project.

### **Comparability and Completeness**

The use of standard collection and analytical methods will allow for data comparisons with previous or future studies and data from other locations. We expect to collect all of the samples, ensure proper handling, and ensure that they arrive at the laboratory and that analyses are conducted. Our objective is to achieve 90% completeness for most measures. Sample collection will be repeated if problems arise such as equipment malfunction or lost samples. Due to the size of the Little Susitna River the completeness of some measures may be reduced due to high flows. These measures include substratum counts, and channel cross-section measurements.

### **A8. Special Training Requirements/Certification Listed**

Jeffrey C. Davis (Project Manager) has a B.S. degree in Biology from University of Alaska Anchorage and a M.S. degree in Aquatic Ecology from Idaho State University. He has 12 years of experience in stream research. Mr. Davis has experience in all of the assessment techniques outlined in this document. He has experience in macroinvertebrate collection pursuant to the USGS NAWQA program, the EPA Rapid bioassessment program, modification of these methodologies for Idaho and Alaska. Mr. Davis also has experience in aquatic invertebrate and vertebrate species identification.

Gay Davis (Quality Assurance Officer) has a B.S. degree In Wildlife Biology from the University of Maine. She has 16 years of experience in stream restoration and evaluation.

Chemical analyses will be conducted through AM Test Inc., in Redmond Washington. AM Test Inc., has been accredited by Washington State Department of Ecology for drinking water, waste water and solid matrix chemical analyses.

With the combined experience of these investigators, no additional training will be required to complete this project.

### **A9. Documentation and Records**

Field data including replicates measures for quality assurance will be recorded in Rite-in-the-Rain field books. Upon returning to the laboratory, the field book will be photocopied (daily or weekly). The field data book will be kept and stored by the Project Manager and the Quality Assurance Officer will store the photocopies. ARRI will maintain records indefinitely. The final data report will include as appendices photocopies of the field data book, Excel data sheets, and results of QC checks. Any sampling problems will be recorded on the data sheets and included in the field sampling report. Laboratory reporting and requested laboratory turn around times of 6 to 10 days are discussed in section B4.

The project reporting requirements are as follows:



- Quarterly Reports: Quarterly reports will be submitted to the DEC Project Manager. The reports will describe project progress, summarize field data collection, identify any problems with data collection and provide any received analytical results.
- Monitoring Data Entry. In addition to a written project report, any water quality monitoring data collected by the project will be entered into STORET or provided to DEC in accordance with guidance and templates at:  
<http://www.state.ak.us/dec/water/wqsar/storetdocumentation.htm>. The guidance and templates show the layout required for STORET compatible files and detail the valid values for various fields used in STORET (e.g. characteristics, analytic procedures, HUCs, etc). The data will be provided to DEC electronically via email, CD, diskette, or via an FTP website (to be determined). All data collected by Dec 31, 2007 will be furnished to DEC by March 31, 2008, and all data collected by the project will be furnished to DEC by July 31, 2008.
- Project Photographs. At least 3 electronic photograph(s) of the project will be submitted in a format suitable for publishing. Additional project photos are appreciated. These photos will represent all of the following: the problem the project addresses, the project in progress, and the environmental benefit of the project. At least one of these photos must be submitted with the first quarterly report; the remainder will be submitted with the final report or sooner if available. Each photo will be at least 800 x 600 pixels in size and in JPEG format or other format acceptable to the department. Included will be background information on what the photo represents and when and where it was taken. If possible, the information will be in the photo's file name, such as "Fish\_Ck\_samplesite1\_iron\_floc\_101603". Alternatively, it may be provided with a caption that states the date, location, and describes the subject: for example "MCV-023X.JPG. Taken 10-3-02, Ditch along south side of Alaska Highway that empties into Fish Creek: Note channelization." The grantee agrees that these photos may be used in publications and distributed widely as the department determines, and that it has obtained any necessary permissions of individuals that appear
- Final Report Evaluating Project Accomplishments and Benefits:  
The final report will include data presentation and discussion in tabular, graphical, and narrative formats along with QA validation and discussion. The final report will evaluate and describes the project accomplishments and their environmental benefit. These environmental benefits will be determined by determining whether the concentrations of hydrocarbons increases during the sport fishery relative to State Water Quality Standards.
- Deliverables: (at least 1 electronic and 3 hard copies of each)  
In addition to submitting the information identified in the reporting requirements, the following products will be delivered to the Department. All written products will be submitted to the department in both hard copy and electronic format.

QAPP and Sampling Plan ..... July 31, 2007  
Draft Final Report ..... June 1, 2008

## **B1. Sampling Process Design**

The sampling design consists of obtaining water samples for TAH analyses at river locations and times with heavy boat use and at locations and times with little or no boat use. Background water chemistry and water temperature will be obtained at the same time. Sampling is designed to occur during and after the coho salmon fishery in 2007 and before and during the Chinook fishery in 2008. Sampling locations are upstream of and within areas heavily used for boat-access fishing. These two areas are between Houston and Lake Creek and downstream from the Public Use Facility. The timing and intensity and type of boat use on the Little Susitna River will be obtained through survey data collected by State Park staff at the Public Use fee station and by observations during water sampling.

### **Sampling Locations**

Boat-accessed salmon fishing occurs primarily at two locations; downstream from the city of Houston and at the Public Use Facility at the end of the Little Su access Road. Water sampling will be located upstream and within these two areas.

1. Upstream of the Park's Highway. This site is located within an area closed to salmon fishing and upstream from boat launching locations in the city of Houston and at Miller's Reach.
2. Millers Reach Road. The Millers Reach site will be downstream of the Parks Highway and the city of Houston. This site is located within an area used for boat-accessed salmon fishing and is the location of an undeveloped boat launch.
3. Upstream of the Public Use Site. This site is upstream from the boat launch and although accessed by boats for the sport fishery, use is much less than downstream from the boat launch.
4. Downstream of the Public Use Site. This area is below the Public Use boat launch and within an area heavily used for boat-accessed salmon fishing.

### **Sampling Frequency**

Sampling frequency is designed to provide data during and before or after heavy use periods. Heavy use occurs during the Chinook and coho salmon fisheries. The Chinook fishery begins the first or second week in June in the lower river near the Public Use Facility and extends into the first week of July. The Chinook fishery near Houston is about one week later than in the lower river; however, run timing varies from year to year. The coho salmon fishery begins near the third week of July and extends through August in the lower river, and is approximately a week later near Houston. Sampling at both locations will occur weekly for 8 weeks during and following the 2007 coho fishery and before and during the 2008 Chinook fishery. Sampling will be conducted weekly on Saturday or Sunday. In 2007, sampling would begin on July 29 and extend through September 16. In 2008, sampling would begin on May 4 and extend through June 22.

**Sample Parameters** consist of water chemical parameters and evaluating timing and intensity of boating use (Table 2).

Water samples collected weekly from the six sampling sites will be analyzed for the following parameters.

- pH. This is a measure of hydrogen ion activity. pH is controlled by the rock weathering, buffering capacity of the water, and influenced by biotic respiration. pH will be measured using a calibrated portable meter in the ARRI laboratory (Hanna HI 9023 or equivalent).
- Turbidity (NTU). This measures the reflective properties of the water sample relative to the amount of organic and inorganic particles. Turbidity will be measured in the laboratory using a Turbidimeter (Hach Chemical Co. 16800, or equivalent).
- Specific Conductance ( $\mu\text{S}/\text{cm}$ ). Specific conductance is the inverse of electrical resistance and is relative to the concentration of ions in water. Specific conductance is used as a surrogate for Total Dissolved Solids. Specific conductance will be measured in the laboratory using a conductivity probe and meter (Sper Scientific 840039 or equivalent).
- Dissolved Oxygen (mg/L). Oxygen concentration and percent saturation will be measured using membrane electrode (YSI 550A) in the field.
- Total Aromatic Hydrocarbons (Gasoline)—Water samples will be collected by ARRI and submitted to AM Test Inc. for analyses using EPA 624 methodology. Samples will be collected using the sampler and methodology developed through the U.S. Geological Survey NAWQA program (Shelton 1997). Duplicate samples will be collected from each sampling sites on each sampling date and trip blanks will be carried and submitted with samples for analyses.
- Temperature ( $^{\circ}\text{C}$ ). Water temperature will be measured at 1 hour intervals using Stowaway data loggers (Onset Corporation). Temperature loggers will be placed at Millers Reach, and downstream from the public use site.
- Boat use. Boat use at the Public Use Facility is monitored by State Park staff at the launch fee area. They record the number of boats by date and the approximate boat length. An index of boat use from Houston to Lake Creek would be obtained by counting the number of boat trailers at the Miller's Reach Launch on each sampling date. We will request the Department of Natural Resources, Division of Parks to also recorded whether boats have 2 or 4 stroke engines. Otherwise, information on boat motor type (4 stroke or 2 stroke engines) will be obtained by direct observation on each sampling date. We will keep a log of all boats observed during sampling and note motor type based on upon cowling wording and size. If we are unsure we will attempt to ask the boat owner, or place a question mark by the notation.

### **External Data**

Discharge data will be obtained from the USGS web site ([http://nwis.waterdata.usgs.gov/ak/nwis/dv/?site\\_no=15290000&agency\\_cd=USGS](http://nwis.waterdata.usgs.gov/ak/nwis/dv/?site_no=15290000&agency_cd=USGS)) and weather data will be downloaded from the National Climate Data Center (<http://www.ncdc.noaa.gov/oa/ncdc.html>).

### **Sample Timing**

Water samples will be collected weekly on Saturday or Sunday between 12:00 and 16:00 hours.

**Table 2. Sampling frequency, location, and timing for each measurement parameter.**

<b>Parameter</b>	<b>Locations</b>	<b>Frequency/samples</b>	<b>Timing</b>	<b>Total Samples *</b>
pH, Specific Conductance, Turbidity, Dissolved Oxygen, TAH	4	Weekly for 8 Weeks in August and September 2007 and Weekly for 8 Weeks in May and June 2008/16	Mid-Day	80
Water Temperature	2	Continuous (hourly)	N/A	N/A

\* includes replicate samples for precision calculations.

## **B2. Sampling Methods Requirements**

### **Field Data Collection**

Field data collection will be conducted by ARRI staff. The latitude and longitude of sampling locations will be recorded and photographs taken. Sampling will occur on Saturday or Sunday of each week. Measures of dissolved oxygen will be conducted in the field. Samples for turbidity, pH, and specific conductance will be collected in clean sample bottles and returned to the ARRI Laboratory for analyses. Samples will be collected from a well-mixed area at each sampling site. TAH sampling will be conducted using the sampler and methods described below, and samples preserved and shipped for laboratory analyses.

### **pH, Specific Conductance, Turbidity, and Dissolved Oxygen**

Depth integrated water samples will be collected in 500 ml sample bottles. The sample bottles will be filled and emptied 3 times before a sample is retained. Water characteristics from well mixed samples will be measured using appropriate meters. Meters, pH, Hanna HI 9023, conductivity, SPER Scientific model 840039, and turbidity, HACH Chemical Co. Model 16800. Support equipment will include extra batteries and sample bottles. Clean sample bottles will be used. All meters will be tested and calibrated prior to use.

Materials Required: Data book, pencils, sharpie, 500-ml sample bottles (16 minimum), 60-ml syringe, cooler, gel-paks, pH meter with standards, dissolved oxygen meter, thermometer, extra batteries, and camera.

### **Total Aromatic Hydrocarbons (TAH)**

Samples will be collected in accordance with the USGS report “Field guide for collecting samples for analysis of volatile organic compounds in stream water for the national Water Quality Assessment Program (USGS Open File Report 97-401).” This report contains detailed instructions on sample collection procedures (Appendix A) using the USGS-designed VOC sampler distributed by Wildco. Prior to sample collection, the VOC sampler will be decontaminated in Alconox and distilled water and methanol, rinsed with distilled water and submerged in the river for four minutes to allow the copper tubes to flush completely.

Two decontamination quality control samples will be collected on separate dates as soon as a site is confirmed to have hydrocarbon contamination to ensure that cross-contamination is not occurring between sample sites. The decontamination quality control sample will be collected using the following procedure. The sampler will be used to sample at a site where sample results have shown hydrocarbon contamination. The sampler will be decontaminated following the procedure described above. The sampler will be submerged twice in a clean bucket with distilled water, once to simulate the flushing of the copper tubes at the new site and a second time to collect the decontamination quality control sample. Samples will be analyzed for TAH to ensure the decontamination procedure is adequate.

Samples will be collected in sample bottles obtained from the contract laboratory. One sample to be analyzed for TAH will be collected (2 vials) from each lowering of the sampler. Samples will be collected at least 12 cm below the water surface and away from any observable sheen. Sampling locations will be accessed by foot. The samples will be collected from adjacent to the thalweg by wading into the channel. A rope and will be attached to the sampler cables and the sampler lower into the flowing water until it rests upon the stream bottom. The attached rope will be used to keep the sampler upright. A 1:1 HCL solution will be added to each vial after sample collection for preservation and capped (~2 drops). The samples will be checked to ensure that there are no air bubbles after capping. The sample bottles will be dried, labeled using adhesive labels, placed within a cooler and shipped to the contract laboratory.

Materials Required: Amber sample bottles, labels hydrochloric acid, dropper, distilled water, Alconox, VOC sampler, rope and carabineer, gel-paks, cooler, laboratory chain-of-custody forms.

### **Temperature**

Stream water temperature data loggers will be placed within the stream at two locations. Loggers will be secured to the bank using plastic coated wire rope. Loggers will be downloaded at least monthly.

Materials Required: 4-m sections of wire rope, clamps, temperature data loggers with backup, software, base station, coupler, and shuttle.

### **B3. Sample Handling and Custody Requirements**

Water samples will be labeled in the field. Sample labels will record the date, time, location, preservation, and initials of collector. Chain of custody forms will be initiated in the field and completed each time samples are transferred to a laboratory, or other carrier. Field samples that are to be transferred to the contract laboratories will be placed within a cooler and the cooler sealed closed using plastic packing tape. Samples will be transported or shipped to the laboratory where they will be placed in a secure location until analyses are completed.

#### B4. Analytical Methods Requirements

Sample analytical methods are shown in Table 3. Field samples will be collected by ARRI staff and delivered to the commercial laboratory for subsequent analyses by the identified standard method. Dissolved oxygen will be measured in the field. Turbidity, pH, and specific conductance will be analyzed at the ARRI laboratory.

**Table 3. List of Analytical methods and detection limits for study parameters.**

Measurement	Collection/ Analyses	Method	Limits	Turnaround Time (days)
Total Aromatic Hydrocarbons	ARRI/ AM Test Inc	EPA 624	0.001 mg/L	14-21
Temperature	ARRI	Temperature logger	0.1 Degree C	Weekly Download
pH	ARRI/ARRI	Meter (Hanna HI 9023)	0.01 pH units	1
Conductivity	ARRI/ARRI	Meter (SPER 840039)	0.1 mhos (0 to 200) 1.0 mhos (>200)	1
Turbidity	ARRI/ARRI	Meter (HACH Model 16800)	0.1 NTU (0 to 10) 1.0 NTU (10 to 100)	1
Dissolved Oxygen	ARRI/ARRI	Meter (YSI Model 55)	0.01 mg/L (0 to 20)	1

#### Corrective Action

ARRI will be responsible for ensuring that all samples are collected and delivered to the laboratory. The QA officer will make sure all samples are labeled and stored correctly and that all equipment has been calibrated and accuracy tests completed as needed. The Project Manager will be informed of any errors and will be responsible for corrective action including repeating sample collection or analyses (for metered measures). If any samples are lost or are determined to be contaminated by the laboratory or if there are any laboratory problems, the Project Manager will be responsible for collecting new samples and delivering them to the laboratory.

#### B5. Quality Control Requirements

The following table (Table 4) lists the percent of field and laboratory replicates to be used for quality control (See section A7 for discussion on calculation of precision and accuracy). If accuracy and precision are not met for analyses ARRI is conducting the meters will be recalibrated and measures will be repeated or meters or probes will be replaced. Data measurements that do not meet the limits described in A7 may or may not be used in the final report depending on degree to which limits are not met. However, the report will clearly state if there are any questions regarding used data.

**Table 4. Field and laboratory replicates for quality control.**

Parameter	Field Replicates	Laboratory Replicates	Comments
pH, Specific Conductivity, Turbidity, Dissolved Oxygen	25 %	25%	Replicate measurements one of every 4 samples.
TAH	25 %	10%	Duplicate sample collected at one of the sites every sampling event.
Temperature	1%	None	Water temperature will be measured on each sampling event with meters and compared with temperature logger readings. Loggers will be placed in the same location for 24 hours and reading compared.

### **B6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements**

Instruments and meters will be tested for proper operation as outlined in respective operating manuals. Inspections and calibration will occur prior to use at each site. Equipment that does not calibrate or is not operating correctly will not be used. For most parameters (temperature, conductivity, and pH), duplicate instruments and meters are available. In the case of complete equipment failure, new equipment will be purchased. The VOC sampler is on loan from the State of Alaska. The sampler is of simple and sturdy construction. If damaged we will first, attempt to repair the sampler, second, attempt to borrow a second sampler from the State, and if none are available, purchase a new sampler. The Project Manager will be responsible for calibrating, testing and storing equipment and completing log sheets. All calibrating, testing and storage will follow the manufacturer's recommendations. The QA Officer will inspect the log sheets. Spare batteries and repair equipment will be taken during field sampling events.

### **B7. Instrument Calibration and Frequency**

The pH meter, conductivity meter, dissolved oxygen, and turbidity meter will be calibrated in accordance to instructions in the manufacturer's operations manual by the Project Manager prior to each use and a log will be maintained documenting calibration. Standards are required for pH, and turbidity and conductivity.

### **B8. Inspection/Acceptance Requirements for Supplies and Consumables**

Sample containers will be obtained from AM Test Inc. Any needed standards for equipment calibration will be purchased directly from the equipment manufacturer if possible or from a well established chemical company. The QA officer will be responsible for ensuring that standards are not outdated and for the purchase of replacements. The date and source of all purchased materials will be recorded within a separate file for each piece of equipment and kept on file by ARRI along with equipment calibration records.

## **B9. Data Acquisition Requirements for Non-Direct Measurements**

Discharge data will be obtained from the USGS web site ([http://nwis.waterdata.usgs.gov/ak/nwis/dv/?site\\_no=15290000&agency\\_cd=USGS](http://nwis.waterdata.usgs.gov/ak/nwis/dv/?site_no=15290000&agency_cd=USGS)) and weather data will be downloaded from the National Climate Data Center (<http://www.ncdc.noaa.gov/oa/ncdc.html>). Data from both of these sources will be assumed accurate.

## **B10. Data Management**

Field data will be entered onto rite-in-the-rain books. The Quality Assurance Officer will copy the field books and review the data to ensure that it is complete and check for any errors. Field and laboratory data sheets will be given to the Project Manager. The Project Manager will enter data into Excel spreadsheets. The Quality Assurance Officer will compare approximately 10% of the field and laboratory data sheets with the Excel files. If any errors are found they will be corrected and the Project Manager will check all of the field and laboratory data sheets with the Excel files. The Quality Assurance Officer will then verify correct entry by comparing another 10% of the sheets. This process will be repeated until all errors are eliminated. The Project Manager will then summarize and compare the data. The Quality Assurance officer will review any statistical or other comparisons made. Any errors will be corrected. The Project Manager will write the final report, which will be proofed by the Quality Assurance officer and submitted to the DEC Project Manager.

Water quality data will be provided to DEC in a modernized STORET compatible format. Data will be formatted into STORET compatible files as described at the following DEC web site (<https://www.dec.state.ak.us/water/wqsar/storetdocumentation.htm>).

## **C1. Assessments and Response Actions**

Project assessment will primarily be conducted through the preparation of reports for DEC by the Project Manager. Section A6 contains more information on the type and date of each required report. At that time the Project Manager will review all of the tasks accomplished against the approved workplan to ensure that all tasks are being completed. The Project Manager will review all data sheets and entered data to make sure that data collection is complete. If necessary, data collection processes or data entry will be modified as necessary. Any modifications of the data collection methods will be reviewed against the processes described within the QAPP to determine whether the document needs to be updated.

The Quality Assurance Officer will check on contractor's laboratory practices to ensure that samples are handled correctly and consistently. The final report will contain an appendix that will detail all of the QA procedures showing precision and accuracy. Representativeness, completeness, and comparability will be discussed in the body of the report. Any QA problems will be outlined and discussed relative to the validity of the conclusions in the report. Any corrective actions will be discussed as well as any actions that were not correctable, if any.



The QA officer will report to ARRI management any consistent problems in data collection, analyses, or entry identified either internally or through a 3<sup>rd</sup> party audit. ARRI management will be responsible for developing and implementing a course of action to correct these problems. Where consistent problems may have affected project validity, these will be identified and reported to the DEC Project Manager directly and included in project reports as directed.

## **C2. Reports to Management**

Quarterly Reports will be prepared by the ARRI Project Manager and distributed to the Department of Environmental Conservation Project Manager. Reports will update the status of the project relative to the schedule and tasks of the work plan. Reports include Quarterly Reports, Draft Final Report, and Final Report. The Project Manager will prepare the draft and final reports. The final report also will be submitted in electronic format. Any potential problems with data due to QA will be identified and reported in all submitted reports.

### **D1. Data Review, Validation, and Verification**

The Project Manager and the Quality Assurance Officer will conduct data review and validation. This process for data review is described under section B10 and A7. Data that are obtained using equipment that has been stored and calibrated correctly and that meets the accuracy and precision limits will be used. Data that does not meet the accuracy and precision limits may be used; however, we will clearly identify these data and indicate the limitations.

### **D2. Validation and Verification Methods**

The Project Manager and the Quality Assurance Officer will conduct data validation and verification. The Project Manager will enter all data from laboratory and field data sheets into Excel worksheets. The Project Manager will double-check all entries to ensure that they are correct. The Quality Assurance Officer will compare 10% of the laboratory and field data sheets with the Excel worksheets. The Project Manager will enter all formulas for calculation of parameters and basic statistics. All of these formulas will be checked by the Quality Assurance Officer. If any errors are found, the Project Manager will correct the errors and then check all entries. The Quality Assurance Officer will then repeat a check of 10% of the data entry and all of the formulas and statistics. This process will be repeated until any errors are eliminated. The Project Manager will organize and write the final report. The Quality Assurance Officer will check the results in the report and associated statistical error (i.e. standard deviation and confidence interval) against those calculated with computer programs. Any errors found will be corrected by the Project Manger.

### **D3. Reconciliation with User Requirements**

The project results and associated variability, accuracy, precision, and completeness will be compared with project objectives. If results do not meet criteria established at the beginning of the project, this will be explicitly stated in the final report. Based upon data accuracy some data may be discarded. If so the problems associated with data collection and analysis, or

completeness, reasons data were discarded, and potential ways to correct sampling problems will be reported. In some cases accuracy project criteria may be modified. In this case the justification for modification, problems associated with collecting and analyzing data, as well as potential solutions will be reported.

Water Quality Evaluation of the Lower Little Susitna River  
August 2007  
Revision 2.0

## **Literature Cited**

Shelton, L.R. 1997. Field guide for collecting samples for analysis of volatile organic compounds in stream water for the National Water-Quality Assessment Program. U.S. Geological Survey, Open File Report 97-401.

Water Quality Evaluation of the Lower Little Susitna River  
August 2007  
Revision 2.0

## **Appendix A. USGS Open File Report 97- 401**

**FIELD GUIDE FOR COLLECTING SAMPLES FOR  
ANALYSIS OF VOLATILE ORGANIC  
COMPOUNDS IN STREAM WATER FOR THE NATIONAL  
WATER-QUALITY ASSESSMENT PROGRAM**

*By* Larry R. Shelton

U.S. GEOLOGICAL SURVEY  
Open-File Report 97-401

Sacramento, California  
1997

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U.S. DEPARTMENT OF THE INTERIOR  
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY  
Gorden P. Eaton, Director

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**CONVERSION FACTORS, ABBREVIATIONS, AND ACRONYMS**

**Conversion Factors**

Multiply	By	To obtain
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
inch (in.)	25.4	millimeter

Temperature is given in degrees Celsius (C), which can be converted to degrees Fahrenheit (F) by the following equation:  $F=1.8(C)+32$

**Abbreviations**

L, liter

mg/L, microgram per liter

mL, milliliter

lb, pound

ASR, analytical services request

DIW, deionized water

FS, field spike

FSR, field-spike replicate

HCL, hydrochloric acid

ID, identification

QA, quality assurance  
QC, quality control  
VBW, pesticide/volatile blank water  
VG, VOC grade blank  
VOC, volatile organic compound

### **Acronyms**

NAWQA, National Water-Quality Assessment  
NWQL, National Water Quality Laboratory  
USGS, U.S. Geological Survey  
WRD, Water Resources Division

### **GLOSSARY**

Environmental Setting -- Land areas characterized by a unique, homogeneous combination of natural and human-related factors, such as row-crop cultivation on glacial-till soils.

Gaging station -- A fixed site on a stream or river where hydrologic and environmental data are collected.

Indicator Sites -- Stream sampling sites located at outlets of drainage basins with relatively homogeneous land use and physiographic conditions. Basins are as large and representative as possible, but still encompassing primarily one Environmental Setting (typically 50 to 500\(\times\))1km<sup>2</sup>).

Integrator Site -- Stream sampling sites located downstream from drainage basins that are large and complex and commonly contain multiple Environmental Settings. Most Integrator Sites are on major streams with drainage basins that include a substantial portion of the Study Unit area (typically, 10 to 100 percent).

Point sample -- A sample collected at a single point in the stream cross section and at a single point in the stream vertical.

Study Unit -- A major hydrologic system of the United States in which NAWQA studies are focused. NAWQA Study Units are geographically defined by a combination of ground- and surface-water features and usually encompass more than 10,000 km<sup>2</sup> of land area. The NAWQA design is based on assessment of these Study Units, which collectively cover a large part of the Nation, encompass the majority of population and water use, and include diverse hydrologic systems that differ widely in natural and human factors that affect water quality.

Water-Column Studies -- Assessment of physical and chemical characteristics of stream water, including suspended sediment, dissolved solids, major ions and metals, nutrients, organic carbon, and dissolved pesticides, in relation to hydrologic conditions, sources, and transport.

## **Field Guide For Collecting Samples For Analysis of Volatile Organic Compounds In Stream Water For The National Water-quality Assessment Program**

By Larry R. Shelton

### **Abstract**

For many years, stream samples for analysis of volatile organic compounds have been collected without specific guidelines or a sampler designed to avoid analyte loss. In 1996, the U.S. Geological Survey's National Water-Quality Assessment Program began aggressively monitoring urban stream-water for volatile organic compounds. To assure representative samples and consistency in collection procedures, a specific sampler was designed to collect samples for analysis of volatile organic compounds in stream water. This sampler, and the collection procedures, were tested in the laboratory and in the field for compound loss, contamination, sample reproducibility, and functional capabilities. This report describes that sampler and its use, and outlines field procedures specifically designed to provide contaminant-free, reproducible volatile organic compound data from stream-water samples.

These guidelines and the equipment described represent a significant change in U.S. Geological Survey instructions for collecting and processing stream-water samples for analysis of volatile organic compounds. They are intended to produce data that are both defensible and interpretable, particularly for concentrations below the microgram-per-liter level. The guidelines also contain detailed recommendations for quality-control samples.

### **INTRODUCTION**

One of the goals of the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS) (Hirsch and others, 1988) is to establish a network of comprehensive and integrated urban water-quality studies to develop an understanding of the occurrence, significance, sources, movement, and fate of environmental chemicals in urbanized hydrologic systems (Lopes and Price, 1997; Squillace and Price, 1996). The occurrence of many contaminants, including volatile compounds, are being assessed in urban areas. For the information to be comparable among studies in different parts of the Nation, consistent procedures and equipment specifically designed to produce contaminant-free, reproducible volatile organic compound (VOC) data from stream-water samples are critical.

The assessment of VOCs in stream water is part of the Water-Column Studies (Gilliom and others, 1995), which focus on assessing the occurrence, concentrations and seasonal distribution of VOCs (Lopes and Price, 1997). The purpose of this report is to describe the equipment used to sample VOCs in streams and the procedures for using the VOC sampler. Companion reports by Koterba and others (1996) outline the procedures used for collecting VOC samples in ground-water, and Majewski and Capel (1995) discuss sampling of pesticides in the atmosphere.

The glossary at the front of this report includes brief definitions of some terms used in this report. Key terms used to describe the NAWQA Program are capitalized. Trade names used in connection with equipment or supplies do not constitute an endorsement of the product.



## **OVERVIEW**

The sampling designs for stream-water studies rely on coordinated sampling of varying intensity and scope at two general types of sites, Integrator Sites and Indicator Sites. Integrator Sites are chosen to represent water-quality conditions of streams and rivers in the large basins affected by complex combinations of land-use settings, point sources, and natural influences. Indicator Sites, in contrast, are chosen to represent water-quality conditions of streams with relatively homogeneous land use and, usually, are associated with smaller basins in specific Environmental Settings. Most, but not all VOC samples will be collected at urban Indicator Sites located in residential and commercial areas. Site selection and sampling strategies for urban Indicator Sites are described in Lopes and Price (1997).

Two primary sampling strategies are used at the selected Integrator and Indicator Sites: (1) fixed interval sampling (usually monthly) characterizes the spatial and temporal distribution of contaminants in relation to hydrologic conditions and contaminant sources, and (2) intensive sampling characterizes seasonal and short-term temporal variability of contaminant transport during high flows and at more frequent fixed intervals.

Most VOCs are man-made compounds that are components of gasoline, by-products of chlorinating drinking water, or solvents. Laboratory analysis is done by the purge-and-trap technique to separate the VOCs from the water matrix, and the quantitation is done by capillary-column gas chromatography/mass spectrometry. Results are reported in micrograms per liter. The USGS National Water Quality Laboratory (NWQL) VOC analysis schedule 2020 will be used. The analytes are summarized in table 1.

## **PREPARATION FOR SAMPLE COLLECTION**

### **Site Selection**

All VOC sampling sites should be at or near streamflow gaging stations because stream discharges associated with contaminant concentrations are needed to evaluate relations between streamflow and water-quality characteristics (Gilliom and others, 1995; Lopes and Price, 1997). The sample collection site should not be more than a few hundred feet from the station.

Collection sites should be located in relatively straight channel reaches where the flow is uniform. Collecting samples directly in a ripple, or from ponded or sluggish water, should be avoided. Sites directly upstream or downstream of confluences or direct sources of contamination also should be avoided to minimize problems caused by backwater effects or poorly mixed flows. In addition, samples collected downstream from a bridge can be contaminated by runoff from the road surface. Proper field judgement is crucial to achieve a sample representative of the typical environmental conditions.

Samples should be collected at the centroid of the stream in the same cross section throughout the project. This will eliminate many of the potential problems that might arise during the interpretation of the data. This does not mean that the same section used during the low-water wading stage must be used during higher stages that require the use of a bridge or cableway.

However, the flow characteristics at different cross sections can result in incomparable data if the cross sections are not located near each other or in the same flow regime. Rapidly changing stage, discharge, and constituent concentrations dictate that sampling schemes and techniques be planned carefully in advance to ensure that representative samples are obtained.

**Table 1.** List of volatile organic compound analytes for the National Water-Quality Assessment Program.

[CAS, Chemical Abstract Service number; PCODE, USGS Parameter Code]

Laboratory analyses: Schedule Number 2020		
CAS number	PCODE	Compound
Halogenated Alkanes		
630-20-6	77562	1,1,1,2-Tetrachloroethane
71-55-6	34506	1,1,1-Trichloroethane
79-34-5	34516	1,1,2,2-Tetrachloroethane
76-13-1	77652	1,1,2-Trichloro-1,2,2-trifluoroethane
79-00-5	34511	1,1,2-Trichloroethane
75-34-3	34496	1,1-Dichloroethane
96-18-4	77443	1,2,3-Trichloropropane
96-12-8	82625	1,2-Dibromo-3-chloropropane
106-93-4	77651	1,2-Dibromoethane
107-06-2	32103	1,2-Dichloroethane
78-87-5	34541	1,2-Dichloropropane
142-28-9	77173	1,3-Dichloropropane
594-20-7	77170	2,2-Dichloropropane
74-97-5	77297	Bromochloromethane
75-27-4	32101	Bromodichloromethane
74-83-9	34413	Bromomethane
124-48-1	32105	Chlorodibromomethane
75-00-3	34311	Chloroethane
74-87-3	34418	Chloromethane
74-95-3	30217	Dibromomethane
75-71-8	34668	Dichlorodifluoromethane
75-09-2	34423	Dichloromethane
67-72-1	34396	Hexachloroethane
74-88-4	77424	Iodomethane
56-23-5	32102	Tetrachloromethane
75-25-2	32104	Tribromomethane
75-69-4	34488	Trichlorofluoromethane
67-66-3	32106	Trichloromethane
Halogenated Alkenes		
75-35-4	34501	1,1-Dichloroethene
563-58-6	77168	1,1-Dichloropropene
107-05-1	78109	3-Chloro-1-propene
593-60-2	50002	Bromoethene

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75-01-4	39175	Chloroethene
87-68-3	39702	Hexachlorobutadiene
127-18-4	34475	Tetrachloroethene
79-01-6	39180	Trichloroethene
156-59-2	77093	cis-1,2-Dichloroethene
10061-01-5	34704	cis-1,3-Dichloropropene
156-60-5	34546	trans-1,2-Dichloroethene
10061-02-6	34699	trans-1,3-Dichloropropene
110-57-6	73547	trans-1,4-Dichloro-2-butene

Aromatic Hydrocarbons

71-43-2	34030	Benzene
91-20-3	34696	Naphthalene
100-42-5	77128	Styrene

Alkyl Benzenes

488-23-3	49999	1,2,3,4-Tetramethylbenzene
527-53-7	50000	1,2,3,5-Tetramethylbenzene
526-73-8	77221	1,2,3-Trimethylbenzene
95-63-6	77222	1,2,4-Trimethylbenzene
95-47-6	77135	1,2-Dimethylbenzene
108-67-8	77226	1,3,5-Trimethylbenzene
108-38-3	85795	1,3-Dimethylbenzene
106-42-3	---	1,4-Dimethylbenzene
611-14-3	77220	2-Ethyltoluene
100-41-4	34371	Ethylbenzene
98-82-8	77223	Isopropylbenzene
108-88-3	34010	Methylbenzene
104-51-8	77342	n-Butylbenzene
103-65-1	77224	n-Propylbenzene
99-87-6	77356	p-Isopropyltoluene
135-98-8	77350	sec-Butylbenzene
98-06-6	77353	tert-Butylbenzene

Halogenated Aromatics

87-61-6	77613	1,2,3-Trichlorobenzene
120-82-1	34551	1,2,4-Trichlorobenzene
95-50-1	34536	1,2-Dichlorobenzene
541-73-1	34566	1,3-Dichlorobenzene
106-46-7	34571	1,4-Dichlorobenzene
95-49-8	77275	2-Chlorotoluene
106-43-4	77277	4-Chlorotoluene
108-86-1	81555	Bromobenzene
108-90-7	34301	Chlorobenzene

Ethers and other Oxygenated Compounds

78-93-3	81595	2-Butanone
591-78-6	77103	2-Hexanone
108-10-1	78133	4-Methyl-2-pentanone
67-64-1	81552	Acetone

60-29-7	81576	Diethyl ether
108-20-3	81577	Diisopropyl ether
637-92-3	50004	Ethyl tert-butyl ether
1634-04-4	78032	Methyl tert-butyl ether
109-99-9	81607	Tetrahydrofuran
994-05-8	50005	tert-Amyl methyl ether

Others

107-02-8	34210	2-Propenal
107-13-1	34215	2-Propenenitrile
75-15-0	77041	Carbon disulfide
97-63-2	73570	Ethyl methacrylate
96-33-3	49991	Methyl acrylate
126-98-7	81593	Methyl acrylonitrile
80-62-6	81597	Methyl methacrylate

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## Sampling Equipment

### Sampler

Obtaining representative VOC samples in flowing streams is a difficult task. Of critical importance is the design and operation of the equipment and the sampling procedure (Brown and others, 1970). Samplers must be designed to collect an unbiased sample of environmental conditions. One important process is to flush atmospheric gases from the sampler before collecting a stream sample (Kilpatrick and others, 1989).

A newly developed VOC sampler designed by the USGS and built by Wildco (fig. 1) will be used to collect stream-water samples for VOC analysis. This sampler has been tested for analyte loss, reproducibility, and carryover contamination in the laboratory and in field settings. The sampler, which is made of noncontaminating materials (stainless steel and refrigeration-grade copper) that will not sorb the analytes of interest, can collect a sample representative of environment conditions in most streams. An important function of the sampler design is to evacuate air and other gases from the sampler before collecting a sample. The VOC sampler weighs 11 lb and can be suspended, by hand, from a short rope or chain while wading a stream. However, when sampling during periods of high flow, 10-lb weights can be added to keep the sampler vertical when it is suspended from a bridge or cableway.

The sampler is designed to collect a sample at a single point in the stream. The stainless-steel sampler holds four 40-mL vials. Copper tubes extend to the bottom of each vial from the inlet ports on top of the sampler. The vials fill and overflow into the sampler body, displacing the air in the vials and in the sampler through the exhaust tube. The total volume of the sampler is eight times larger than the vials; therefore, the vials are flushed seven times (removing the air) before the final volume is retained in the vial. The small (1/16-in. inside diameter) copper inlet ports results in a slow (3 to 4 minutes) filling time. This important design feature helps to produce a representative sample and allows sufficient time to place the sampler at the desired depth. The sampler begins to fill as soon as it enters the stream; however, the final sample is retained in the

vial during the last 15 to 20 seconds of the filling process. A cover over the inlet ports prevents contamination from surface oil and debris when the sampler is removed from the stream.

**Figure 1.** Schematic of volatile organic compound (VOC) sampler. The sampler body is made of stainless steel, weighs 11 pounds and is 6 inches high. It has an air exhaust tube extending above the sampler, and four copper inlet tubes that extend into four 40-milliliter sample vials.

### Support Equipment

Field vehicles are commonly used for more than one purpose (such as streamflow measurements, gaging station maintenance, construction, stream sampling, and sample processing). Sample contamination is more likely to occur when these multiuse vehicles are used to collect and process water samples. Glues and adhesives used in vehicles, and the cabinet construction, can contaminate samples for VOCs. Therefore, it is important that the processing area be free of contaminants, plastics, dirt, fumes, and oil residue. Samples should be removed from the sampler, processed, and capped streamside to avoid possible contaminants in the vehicles. Each vehicle should have a separate storage area for the VOC sampling equipment and supplies. A complete equipment list is given in table 2.

**Table 2.** List of equipment and supplies for collecting and processing stream-water volatile organic compound (VOC) samples.

*[Sources for some items are listed to maintain quality standards. OCALA, USGS Water-Quality Service Unit at Ocala, Florida; NWQL, National Water Quality Laboratory; VG, VOC grade blank; VBW, pesticide/volatile blank water]*

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### Sampling equipment and supplies

Volatile organic compound (VOC) sampler (Wildco 990-J98)  
Vial, glass, amber septum, 40 milliliter (NWQL and OCALA 333FLD)  
Rope, nylon, 1/4-inch diameter (OCALA 84FLD)

### Cleaning and storing equipment and supplies

Gloves, vinyl, powderless (OCALA 155HWS)  
Detergent, phosphate free, 0.2 percent by volume (OCALA 62FLD)  
Methanol, pesticide grade  
Deionized water  
VOC grade blank water (VG or VBW) (NWQL)  
Bottles, wash, plastic, for detergent (OCALA 357FLD)  
Bottles, wash, Teflon, for VG water (OCALA 377FLD)  
Bottles, wash, Teflon, for methanol (OCALA 377FLD)  
Basins, wash, plastic (2)  
Brush, scrub, soft metallic  
Bag, plastic, sealable, medium (OCALA 23FLD)  
Storage container, sealable, 8 inches x 8 inches x 12 inches  
Foil, aluminum, heavy duty  
Container, waste, solvent, 5 gallons

## Processing equipment and supplies

Cannister, stainless steel, 8 quarts with cover (for field blanks)  
Flask tongs  
Gloves, vinyl, powderless (OCALA 155HWS)  
Hydrochloric acid 1:1 acid, in Teflon vials (NWQL)  
Kit, matrix spike (NWQL)  
pH paper (alkacid test ribbon)  
Bottle labels (OCALA 84FLD)  
Sleeves, foam (OCALA 358FLD)  
Coolers, shipping, 1 gallon  
Coolers, shipping, 5 gallons  
Bags, plastic, 5 gallons  
Ice

## Miscellaneous equipment and supplies

Boots, hip  
Waders, chest  
Tools  
First aid kit  
Highway emergency kit  
Forms, field documentation (OCALA)  
Forms, analytical request (NWQL)  
Tissues, laboratory  
Pens, marking, permanent, (OCALA 77FLD)  
Field meters, conductance, pH, dissolved oxygen  
Supplies for field measurements

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## EQUIPMENT CLEANING

All equipment that will come in contact with the sample should be soaked in a dilute phosphate-free detergent solution; rinsed with tap water, VOC grade blank (VG) water, and methanol; and then air dried prior to each field trip and between sites (Shelton, 1994). Detergents and methanol should be used with care to avoid the possibility of the residue contaminating the sample. A thorough native-water rinse is required at each field site before sampling to remove any remaining cleaning agents and to equilibrate the equipment to the sampling conditions. A list of the supplies needed for equipment cleaning is given in table 2, and detailed procedures for cleaning the VOC sampler are outlined below.

1. Open sampler.
2. Submerge top and base in a 0.2-percent solution of phosphate-free detergent. Scrub the sampler thoroughly with a nylon brush. Use a small squeeze bottle, filled with the detergent, to flush the copper tubing.
3. Rinse the sampler thoroughly with warm tap water or deionized water (DIW) to remove all soap residue.

4. Using a Teflon squeeze bottle, rinse with a minimum amount of methanol. Place the used methanol in a waste container for proper disposal (see Water Resources Division [WRD] memorandum 94.07, Appendix).
5. Allow to air dry (cover loosely with aluminum foil to avoid airborne contamination). If complete air drying is not possible, rinse three times with VG water.
6. Wearing vinyl gloves, reassemble the sampler.
7. Wrap areas that will come in contact with the sample with aluminum foil, and place in a sealable plastic bag. Use a large sealed container to protect the sampler in storage and during transport.
8. Rinse the sampler (without the vials) with 2 to 3 L of native water prior to sampling.

## **SAMPLE COLLECTION PROCEDURES**

### **Preparation**

The timing of the VOC sampling should be planned to avoid possible contamination by other collection and processing activities (such as procedures and equipment that use methanol). Before beginning any other activity collect and process the VOC samples at the site. The entire sampling and processing procedure (removing it from the storage container, loading the sampler, sampling, and acidifying the sample) should be done at streamside, well away from other processing activities.

### **Routine Sampling**

VOC samples should be collected where the stream velocity represents the average flow, which is typically near mid-channel in the cross section. The following procedure is designed to produce a single-vertical point sample. When collecting samples for VOC analyses, special care must be taken to avoid contamination from any oily film and debris floating on the stream surface. The samples should be collected directly into the prebaked 40-mL amber-glass vials as follows:

1. Reclean the sampler, if necessary (see 'Equipment Cleaning' section).
2. Transport the sampler to the collection site and rinse three times with native water or submerge it in the stream for several minutes.
3. In a protected area, away from any direct source of contamination and wearing vinyl gloves, uncap four 40-mL unlabeled vials and place them in the sampler. Secure and lock the sampler top in position. Store the vial caps in a protected area.
4. Lower the sampler into the stream near mid-channel to about one half of the total depth at that vertical. Add weights if the stream velocity is great enough to pull the sampler downstream.

5. Collect a sample by holding the sampler in one position until the sampler is full. Air bubbles will rise to the surface while the sampler is being filled, but may be difficult to see. This takes about 3 to 4 minutes. The sample will be retained in the vial during the last 15 to 20 seconds of sampling.
6. Remove the sampler when bubbles are no longer present or after about 5 minutes, and return to a protected area at the side of the stream for processing.

### **Dip Sampling**

In very shallow streams where the VOC sampler cannot be submerged, a representative sample usually can be obtained manually by immersing an open vial (dip sample) near the centroid of flow. Wearing vinyl gloves, lower a 40-mL vial to about one half of the stream depth. Point the vial into the stream current, remove the cap, allow the vial to fill, then slowly bring it to the surface. Add hydrochloric acid (HCL), carefully cap the vial, and check for air bubbles that may be trapped in the vial. A dip sample should never be taken when it is possible to use the sampler. Consistent procedures will avoid the possibility of a sampling bias.

### **SAMPLE PROCESSING PROCEDURES**

Biodegradation and chemical reactions, such as oxidation and volatilization, can change many of the compounds present in natural waters before analyses in a laboratory. Therefore, samples must be preserved as soon as possible after collection. The method of preserving VOCs includes the addition of 1:1 HCL and refrigeration to 4°C to arrest microbiological activity and to minimize volatilization. Great care must be exercised in the field to prevent compound loss or sample contamination. Because exhaust fumes and adhesives in field vehicles may be a source of contamination, processing samples streamside can best prevent contamination. Evaluate trip and field blanks to confirm that the processing area is appropriate.

To preserve the samples, add 1:1 HCL to lower the pH to 2 or less, and immediately place the vials on ice. To determine the volume of acid to add, collect a hand dipped test sample in a used 40-mL vial. Add HCL to the test sample to lower the sample pH to less than 2.0. Two drops of HCL should be adequate for most conditions; however, some environmental samples may require additional HCL. At no time should you use more than six drops of HCL. Alkacid test ribbons can be used to estimate the pH.

By following this sequence for sample preservation, the risk of contaminating a sample is reduced. Acid should be stored and transported properly (see WRD memorandum 94.06, Appendix). These procedures are summarized below.

1. Wearing vinyl gloves, open the sampler carefully at streamside.
2. Using metal tongs, slowly lift each vial from the sampler reservoir. Do this carefully to avoid losing the convex meniscus.
3. Add drops (usually two, but no more than six) of 1:1 HCL to lower the pH to less than 2, and cap the vial.



4. Agitate the vial and check for air bubbles. Discard if bubbles are present.
5. Three vials from the same sampler set are required for one complete sample. Resample completely, if necessary.
6. Label the samples, wrap each with a foam sleeve, and place them on ice.
7. Clean the sampler and store it properly (see 'Equipment Cleaning' section).

The minimum information required on each vial is the site identification (ID) number, date and time sampled, preservation, and schedule number, as shown on the example below:

09498500  
04-24-1997 @ 1200  
HCL to

## **FIELD MEASUREMENTS**

Water temperature, specific conductance, pH, dissolved oxygen, and alkalinity could change dramatically within minutes or hours after sample collection. Immediate analysis in the field is required if the results are to be representative of in-stream conditions.

Water temperature and dissolved oxygen should be measured directly from the stream, and several readings are required in the cross section to obtain a stream average. A composite stream sample should be collected for specific conductance, pH, and alkalinity. A single field meter that measures specific conductance, water temperature, pH, and dissolved oxygen directly in the stream may be used. Detailed information on the procedures, equipment, and supplies necessary for the field analyses is presented in reports by Shelton (1994) and Wilde and Radtke (in press).

## **QUALITY ASSURANCE AND QUALITY CONTROL**

The sources of variability and bias introduced by sample collection and processing affect the interpretation of water-quality data. Quality-assurance (QA) plans ensure that the data collected are compatible and of sufficient quality to meet program objectives. These guidelines and the Study Unit design guidelines for NAWQA should be used when preparing QA plans. Specific details for QA plans are described by Shampine and others (1992).

Investigators in each Study Unit must document the quality of their data by collecting quality-control (QC) samples. A series of QC samples (blanks, replicates, and spikes) must be obtained during VOC investigations because the quality of the data collected, and the validity of any interpretation, cannot be evaluated without QC data. Detailed procedures for preparing QC samples for VOCs, and the recommended frequencies, are described in Mueller and others (1997).

### **Field Blanks**

Field blanks are used to determine whether (1) equipment-cleaning protocols adequately remove residual contamination from previous use, (2) sampling and sample-processing procedures result

in contamination, and (3) equipment handling and transport periods of sample collection do not introduce contamination. Field blanks for VOCs are collected immediately before processing a routine environmental sample. Load four 40-mL vials into the sampler. Pour VG water into a clean (see 'Equipment Cleaning' section) stainless-steel cannister, and then collect two 40-mL vials from the cannister for the cannister-blank sample. Submerge the sampler containing four 40-mL vials in the cannister and allow to fill. Remove the vials and process the field and cannister blanks in the same manner as the environmental sample. Process the samples using the NWQL analytical schedule for environmental samples. If analytical results indicate carryover of residues, perform additional field tests to determine the source of the contamination. A more rigorous cleaning procedure might be necessary. Field blanks produce the most valuable QC data to evaluate potential contamination.

### **Trip Blanks**

Trip blanks are used to determine whether external VOCs from bottle handling and analytical processes, independent of the field sample processing scheme, are contaminating the samples. Trip blanks are provided upon request and are prepared and distributed to each Study Unit by the NWQL. These trip blanks bottles should be stored and transported with the other bottles used for collecting the environmental sample, and then submitted for analysis in the same manner. Trip blanks should never be opened in the field. If analytical results indicate that samples have been contaminated, additional blanks should be processed to identify the source. Trip blanks should only be prepared with field blanks.

### **Field-Matrix Spikes**

Field-matrix spikes are designed to (1) assess recoveries from field matrices and (2) assist in evaluating the precision of results for the range of target analytes in different matrices. Biases and interferences can result from sample matrices and from other processes that occur from the time the sample vial is preserved in the field to the time the vial is analyzed in the laboratory. After collecting the environmental sample, immediately collect a second set of four vials for the field-matrix spikes and preserve each using HCL. Add a standard spike solution using a microliter gas-tight syringe. Matrix-spike kits (solution and syringe) with instructions are available from the NWQL. Label two vials 'FS' (field spike) and two vials 'FSR' (field-spike replicate). Record the lot number and volume of the spike solution on the field notes and on the NWQL analytical services request (ASR) form. Send each set of vials-two FS and two FSR-as separate sample sets, including the environmental sample, to the laboratory for analyses.

### **Replicate Samples**

Sample replicates are designed to provide information needed to (1) estimate the precision of concentration values determined from the combined sample-processing and analytical method and (2) evaluate the consistency of identifying target analytes for VOCs. Each replicate sample is an aliquot of the environmental sample collected in the same sampler, processed at the same time, and stored and shipped in the same way. Compare the analytical results to determine if accurate, consistent data can be reproduced.

## **DOCUMENTATION**

All field activities and site information should be documented on standard surface-water-quality field notes (Shelton, 1994). A complete documentation will aid in future analyses of the collected information.

Field notes should include the following information:

1. Station name and number.
2. Date and time (1 minute earlier than environmental sample).
3. Gage height, discharge, or both; stage conditions.
4. Type of sample (single-vertical point sample).
5. Sampler (VOC sampler).
6. Sampling method (bridge, cableway, wading).
7. Depth and width of stream at sampling location.
8. Location within the cross section (midstream).
9. Depth of sampling (mid depth).
10. Field analyses and calibration (temperature, conductance, pH, alkalinity, oxygen).
11. Detailed alkalinity titration.
12. Type of samples collected (VOC, major ions, quality control, and others).
13. Name of sample collector(s).
14. Site information: color and odor of the stream, weather conditions, and others.

## **SAMPLE IDENTIFICATION**

Consistent specific identification of samples is essential for national data aggregation. For this reason, a data-coding strategy has been developed for the NAWQA Program. Use the following instructions for coding information onto the water quality field notes and on the NWQL ASR forms. The most critical codes for proper sample identification are the station ID number, sample medium, and sample type. Different sample-time coding is specified to distinguish among multiple samples collected during the same site visit. VOC samples will have a time 1 minute earlier than all other environmental samples to segregate the VOC analytical results from other analyses. For QC samples, the time codes are used to establish a rationale for associating the necessary sample codes with each individual sample. Do not use fictitious station ID numbers for routine QC samples.

### **VOC Environmental Sample**

STATION ID - Same as other environmental sample  
DATE - Same as other environmental sample  
TIME - One minute earlier than the other environmental samples  
SAMPLE MEDIUM - `9' (surface water)  
SAMPLE TYPE - `9' (regular)  
Parameter 71999 (Sample purpose) - `15' (NAWQA)  
Parameter 99111 (QA data with sample) - `10' (blank)

### **Field Blank**

STATION ID - Same as environmental sample  
DATE - Same as environmental sample  
TIME - Exact time of preparation (different from other blanks)  
SAMPLE MEDIUM - `Q' (QA sample, artificial)  
SAMPLE TYPE - `2' (blank)  
COMMENTS - `PREVIOUS SAMPLE AT:' station ID, date/time  
Parameter 71999 (Sample purpose) - `15' (NAWQA)  
Parameter 99102 (Type of blank sample) - `100' (field)  
Parameter 99104 (Blank lot number) - Enter first five digits  
Parameter 99101 (Source of blank solution) - `10' (NWQL)

### **Cannister Blank**

STATION ID - Same as environmental sample  
DATE - Same as environmental sample  
TIME - One minute earlier than field blank (different from other blanks)  
SAMPLE MEDIUM - `Q' (QA sample, artificial)  
SAMPLE TYPE - `B' (other)  
COMMENTS - `CANNISTER BLANK'  
Parameter 71999 (Sample purpose) - `15' (NAWQA)  
Parameter 99102 (Type of blank sample) - `100' (field)  
Parameter 99104 (Blank lot number) - Enter first five digits  
Parameter 99101 (Source of blank solution) - `10' (NWQL)

### **Trip Blank**

STATION ID - Same as environmental sample  
DATE - Same as environmental sample  
TIME - Exact time of preparation (end of trip)  
SAMPLE MEDIUM - `Q' (QA sample, artificial)  
SAMPLE TYPE - `2' (blank)  
Parameter 71999 (Sample purpose) - `15' (NAWQA)  
Parameter 99102 (Type of blank sample) - `30' (trip)  
Parameter 99101 (Source of blank solution) - `10' (NWQL)  
Parameter 99109 (Start date YMMDD) - Date blanks received from NWQL  
Parameter 99110 (End date YMMDD) - Date trip blanks shipped to NWQL

### **Field-Matrix Spike**

STATION ID - Same as environmental sample  
DATE - Same as environmental sample  
TIME - `SPIKE (FS)' 6 minutes later than environmental sample (HH:X6)  
`SPIKE REPLICATE (FSR)' 7 minutes later than environmental sample (HH:X7)  
SAMPLE MEDIUM - `R' (QA surface water)  
SAMPLE TYPE - `1' (spike)  
COMMENTS - `FS or FSR', `SCH 9090 spike lot number\_\_\_\_\_'  
Parameter 71999 (Sample purpose) - `15' (NAWQA)  
Parameter 99104 (Spike lot number) - Enter first five digits  
Parameter 99105 (Replicate type) - `10' (concurrent)  
Parameter 99106 (Spike type) - `10' (field)  
Parameter 99107 (Spike source) - `10' (NWQL)  
Parameter 99108 (Spike volume) - volume used, in milliliters

### **Replicate Samples**

STATION ID - Same as environmental sample  
DATE - Same as environmental sample  
TIME - Same as VOC environmental sample  
SAMPLE MEDIUM - `9' (surface water)  
SAMPLE TYPE - `7' (replicate)  
Parameter 99111 (QA data with sample) - `30' (replicate sample)  
Parameter 99105 (Replicate type) - `10' (concurrent)  
Parameter 71999 (Sample purpose) - `15' (NAWQA)

### **SHIPPING**

Samples should be shipped by overnight express mail to the NWQL the same day of collection. A NWQL ASR form must be included with each sample. Place all glass vials in padded sleeves or pack in some other suitable manner to prevent breakage during shipment. Insulated water coolers (1 or 5 gal in volume) make good shipping containers. Chill with an adequate amount of ice to maintain the sample temperature between 0 and 4°C. The amount of ice needed depends on the length of time in transit from field to laboratory and on the season of the year. Ice should be placed inside a double plastic bag in the shipping container. Protect the NWQL ASR form and return labels from the ice by placing them in a sealable plastic bag and fastened it to the inside of the cooler lid with tape. Detailed guidelines on shipping samples are discussed in NWQL memorandum 95.04 (Appendix).

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## **APPENDIX-SELECTED TECHNICAL MEMORANDUMS**

These Water Resources Division (WRD) and National Water Quality Laboratory (NWQL) memorandums are available in U.S. Geological Survey offices, nationwide:

WRD 94.06 SAFETY: Storage, transport, handling, and disposal of hydrochloric acid

WRD 94.07 SAFETY: Storage, transport, handling and disposal of methyl alcohol

NWQL 95.04 OPERATIONS: Shipping to the National Water Quality Laboratory

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