Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Mercury Assessment and Potential for Bioaccumulation Study
Study Plan Section 5.7

2014 Study Implementation Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

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Abbreviation	Definition
AEA	Alaska Energy Authority
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AK-DHSS	Alaska Department of Health and Social Services
APA	Alaska Power Authority
AWQS	Alaska Water Quality Standards
CFR	Coe of Federal Regulations
CIRWG	Cook Inlet Region Working Group
Cm	Centimeter
DO	dissolved oxygen
Dw	dry weight
DNP	Denali National Park
EFDC	Environmental Fluid Dynamics Code
ELA	Experimental Lakes Area
EPA	U.S. Environmental Protection Agency
F	Female
FAMS	Florida Atmospheric Mercury Study
FERC	Federal Energy Regulatory Commission
FDA	Food and Drug Administration
g	gram
GAAR	Gates of the Arctic National Park
Hg	Mercury
HgS	Hydrogen sulfide
ILP	Integrated licensing process
ISR	Initial Study Report
Kg	Kilogram
Km^2	Square kilometer
Km^3	Cubic kilometer
LNS	longnose suckers
LOER	Lowest observed effects residue
m	male
m^2	square meters(s)
MeHg	Methylmercury
mm	Millimeters
MW	Megawatts
ng	Nanograms
ng/g	nanograms per gram
ng/l	nanograms per liter
$ng/m^2/yr.$	nanograms per square meter per year
NOAA	National Oceanic and Atmospheric Administration

Abbreviation	Definition
NOAT	Noatak National Preserve
NOER	No observed effects residue
NM	Not measured
NS	Not sampled
Project	Susitna-Watana Project
PRM	Project River Mile
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RSP	Revised Study Plan
Sp.	Species
SPD	Study Plan Determination
SQuiRTs	Screening Quick Reference Tables
THg	Total mercury
TOC	total organic carbon
µg	Microgram
µg/kg	microgram per kilogram
µg/L	micrograms per liter
USFWS	U.S. Fish and Wildlife Service
UV	Ultraviolet
USGS	U.S. Geological Survey
WACAP	Western Airborne Contaminants Assessment Project
WSENP	Wrangell-St. Elias National Park
ww	wet weight
Yr.	Year

1. INTRODUCTION

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans. Included in the Study Plan was the Mercury Assessment and Potential for Bioaccumulation Study, Section 5.7. This part of the study focuses on determining the current concentrations and methylation rates for mercury in the study area, and what changes could occur with construction of the Susitna-Watana Project (Project) reservoir.

On February 1, 2013, FERC staff issued its study determination (February 1 Study Plan Determination (SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. On April 1, 2013 FERC issued its study determination (April 1 SPD) for the remaining 14 studies; approving one study as filed and 13 with modifications. Study Plan Section 5.7 was one of the 13 approved with modifications. In its April 1 SPD, FERC recommended the following:

Use of Harris and Hutchinson and EFDC Models for Mercury Estimation

> *We recommend that AEA use the more sophisticated Phosphorus Release Model to predict peak methylmercury levels in fish tissue, regardless of the outcome of the other two models.*

Mercury Effects on Riverine Receptors

> *We recommend that AEA include likely riverine receptors (i.e., biota living downstream of the reservoir that may be exposed to elevated methylmercury concentrations produced in the reservoir and discharged to the river) as part of the predictive risk analysis. The additional study element would have a low cost (section 5.9(b)(7)) because AEA would simply add consideration of additional receptors to the existing analysis. This information is necessary to evaluate potential project effects downstream of the reservoir (section 5.9 (b)(5)).*

In accordance with the April 1 SPD, AEA has adopted the FERC requested modifications.

Following the first study season, FERC's regulations for the Integrated Licensing Process (ILP) require AEA to "prepare and file with the Commission an initial study report describing its overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)) On June 3, 2014, AEA filed with the Commission the Initial Study Report (ISR) on Mercury Assessment and Potential for Bioaccumulation in accordance with FERC's ILP regulations. The ISR details AEA's status in implementing the study, as set forth in the FERC-approved RSP as modified by FERC's April 1 SPD and the Quality Assurance Project Plan for Mercury Assessment and Potential for Bioaccumulation Study for the Susitna-Watana Hydroelectric Project (QAPP) (collectively referred to herein as the "Study Plan").

2. STUDY OBJECTIVES

Previous studies have documented increased mercury concentrations in fish and wildlife following the flooding of terrestrial areas to create hydroelectric reservoirs. The purpose of this study is to assess the potential for such an occurrence in the proposed Project area. The study objectives as established in Study Plan (Section 5.7.1) are as follows:

- Summarize available and historic mercury information for the Susitna River basin, including data collection from the 1980s Alaska Power Authority (APA) Susitna Hydroelectric Project.
- Characterize the baseline mercury concentrations of the Susitna River and tributaries. This will include collection and analyses of vegetation, soil, water, sediment pore water, sediment, piscivorous birds and mammals, and fish tissue samples for mercury.
- Utilize available geologic information to determine if a mineralogical source of mercury exists within the inundation area.
- Map mercury concentrations of soils and vegetation within the proposed inundation area and use this information to develop maps of where mercury methylation may occur.
- Use the water quality model to predict where in the reservoir conditions (pH, dissolved oxygen [DO], turnover) are likely to be conducive to methylmercury (MeHg) formation.
- Use modeling to estimate MeHg concentrations in fish.
- Assess potential pathways for MeHg to migrate to the surrounding environment.
- Coordinate study results with other study areas, including fish, instream flow, and other piscivorous bird and mammal studies.

3. STUDY AREA

As established in Study Plan Section 5.7.3, the study area begins at project river mile (PRM) 19.9 and extends upstream from the proposed reservoir to PRM 235.2 (Figure 3-1).

4. METHODS AND VARIANCES

The following section provides a brief summary of the tasks performed, the methods utilized, and any variances from the methods described in the Study Plan (Section 5.7.4 of the RSP 5.7).

4.1. Summary of Available Information

Existing literature was reviewed to summarize the current understanding of the occurrence of mercury in the environment. This review was previously presented in the study plan and the ISR Section 5.7 filed June 3, 2014. Information derived from the initial review has been carried forward here for use as a comparison to data generated as part of this study. Sources included the following:

- APA Susitna Hydroelectric Project
- Alaska Department of Environmental Conservation
- U.S. Geological Survey (Frenzel 2000)
- Western Airborne Contaminants Assessment Project (WACAP)
- Jewett and Duffy (2007)
- Geologic Data in ISR Section

4.1.1. Variances from the Study Plan

AEA implemented this portion of the plan using the methods as described in the Study Plan (Section 5.7.4 of the RSP 5.7) with no variances.

4.2. Collection and Analyses of Samples for Mercury

Samples were collected from vegetation, soil, surface water, sediment, sediment pore water, and fish tissue (Table 4.2-1). The sample methods have been detailed in the study plan and in ISR Section 5.7. The ISR also includes any variances from the study plan.

In most cases the samples were collected in 2013, however, the analytical results were received from the laboratory too late for inclusion in ISR Section 5.7. Those results are presented in this report. The following sections provide a brief description of the work performed, and any additional variances that were encountered in 2014.

4.2.1. Vegetation and Soil

Vegetation and soil samples were collected from within the proposed inundation zone in August 2013. Samples were collected from five sites at each of ten locations (Figure 4.2-1 through 4.2-11 and Table 4.2-2). The sampling methods and preliminary results were previously discussed in the ISR Section 5.7. Analytical results are presented in this report.

4.2.1.1. Variances from the Study Plan

No additional work was performed in 2014, and thus there were no variances in addition to the soil sampling method variance that occurred in 2013 as noted in the ISR Section 4.2.2.1.

4.2.2. Water

There were two types of monitoring programs used to characterize mercury concentrations in surface waters: Baseline Water Quality Monitoring (Study 5.5, Section 5.5.4.4) and Focus Area Monitoring (Study 5.5, Section 5.5.4.5). These programs were distinguished by the frequency of water sampling, the density of sampling effort in a localized area, and parameters analyzed. Sampling programs for the surface water were initiated in 2013 and carried through to 2014.

4.2.2.1. Baseline Sampling Protocols

For the baseline sampling protocols, water quality data collection occurred at various intervals from the mouth of the river to above the inundation zone (Figure 3.1 and Table 4.2-3). The sampling methods were previously discussed in the ISR Section 5.7 filed June 3, 2014. Analytical results are presented in this report.

4.2.2.2. Focus Area Sampling Protocols

The Focus Areas had a higher density of sampling locations, in contrast to the mainstem network, so that prediction of change in water quality conditions from Project operations could be made with a higher degree of resolution. These were discrete samples taken at each collection point (Figure 4.2-12 to 4.2-19 and Table 4.2-4). The sampling methods were previously discussed in the ISR Section 5.7 filed June 3, 2014. Analytical results are presented in this report.

4.2.2.3. Variances from the Study Plan

Per Section 5.7.4.2.3 of the RSP, water quality sampling for mercury was supposed to be discontinued after the March 2014 sampling if mercury concentrations did not exceed regulatory criteria or thresholds. However, additional total mercury sampling was performed in 2014 due to laboratory results that were qualified as “estimated”, and to further fine-tune a mercury model pathways analysis. This decision was detailed in ISR Section 5.7 Part C: Executive Summary and Section 7 filed June 3, 2014. This variance should enhance the results of this study.

4.2.3. Sediment and Sediment Porewater

In 2013 sediment samples were collected at four of the ten proposed sample locations at mouths of Jay, Kosina, and Goose creeks, and the Oshetna River at the downstream of islands, and in similar riverine locations in which water velocity was slowed, favoring accumulation of finer sediment along the channel bottom. As detailed in ISR Section 5.7 Part C: Executive Summary and Section 7 dated June 2014, the remaining sites could not be accessed in 2013, and were sampled in 2014. These remaining sites were from the mainstem Susitna River just above and below the proposed dam site, and at the mouths of Fog, Tsusena, Deadman, Watana, and Kosina Creeks. The analytical results of the sediment sampling in 2013 were received from the contract laboratory too late for inclusion in the ISR Section 5.7 dated June 3, 2014 and are included here along with the 2014 results. A map of all the sediment/porewater sampling locations is shown in Figure 4.2-20. Images of each sampling location can be seen in Figures 4.2-21 and 4.2-25.

4.2.3.1. Variances from the Study Plan

Sediment in the upper Susitna River was generally very coarse at accessible sample locations. At each sample location several test pits were dug to attempt to locate the finest grained sediment for sampling, however, only 30% of the samples had more than 5% fines as required in the Study Plan. This does not appear to have adversely impacted the study results because mercury concentrations in the sediments appear to be only poorly correlated with grain size, and sites with few fines had similar mercury concentrations to those with more fines.

As detailed in ISR Section 5.7 Part C: Executive Summary and Section 7 dated June 2014, sample locations for sediment, and sediment porewater sites in the Upper River were modified slightly due to lack of access (landing access for helicopters, river stage levels, property ownership, and boat availability) (ISR Section 4.2.4.1.). These minor modifications to proposed sample locations in the Upper River did not impact AEA's ability to meet the study objectives.

4.2.4. Piscivorous Birds and Mammals

The purpose of the bird and mammal surveys was to collect biological specimens (fur and feathers) and test them for mercury. An important part of this study is to collect, to the maximum extent possible, biological specimens from the immediate vicinity of the inundation area. This would allow the mercury concentrations found to be correlated with mercury concentrations observed in fish, water, sediment, soil and vegetation. Mammals and birds from other drainages may be exposed to higher or lower mercury concentrations, and data from those sources may not be relevant to this study.

The drawback of this approach is residency. If the birds and mammals are not present, or present at very low population levels, then it may not be possible to locate bird or mammal samples for sample collection.

Because of the small populations, there were concerns that lethal sampling techniques would adversely impact populations, and only non-lethal methods (salvaging feathers from nests, fur snags), and purchasing furs from commercial trappers, were utilized.

4.2.4.1. Birds

AEA submitted a discussion of this issue in the ISR Section 5.7, Part C: Executive Summary and Section 7 (June 2014). Attempts at collecting samples were unsuccessful due to the low populations of piscivorous birds in the area. In addition,

- Feathers of Bald Eagles could not be collected because the study team and the U.S. Fish and Wildlife Service (USFWS) did not possess the necessary federal permit for salvage of eagle feathers, and the permit could not be obtained in time to collect samples in the 2013 season.
- Lack of access to Cook Inlet Region Working Group (CIRWG) lands in 2013 limited the number of areas where nests could be examined; however, populations of piscivorous birds in the inundation area appear to be relatively low, and it is not clear whether access to CIRWG lands would have improved the study results.
- Opportunistic collection of feathers from some species of piscivorous birds (Belted Kingfisher and Osprey) for mercury analysis, as described in RSP Section 10.16.4.6, was unsuccessful because these species do not appear to be resident in the study area.

For these reasons, it was determined that the results from mercury analysis of wildlife tissues will not be necessary until the predictive reservoir and riverine models are complete and can provide an accurate evaluation of the potential for transfer from the aquatic environment to the terrestrial environment. The vegetation, soil, sediment, and fish tissue samples will be used to perform a pathways analysis of potential bioaccumulation of mercury and MeHg throughout the food chain. The results of the pathways analysis will help to determine the need for additional sample collection from birds. No additional work was completed on this task, and no new results were generated in 2014.

4.2.4.2. Mammals

As noted in the study plan (Section 5.7.4.4) populations of piscivorous mammals are relatively small in the study area, and sampling efforts collected few samples. Further hampering efforts was an attempt to avoid a lethal take, which would damage the relatively small populations of these species. The study plan specified that an attempt would be made to collect samples by the following means:

- Obtain fur samples from river otters and mink from animals harvested by trappers in the study area.
- Utilize data obtained in other studies on background concentrations of MeHg in natural northern environments.
- Place hair-snag "traps" at or near the mouths of tributaries near the proposed dam site, including Fog, Deadman, Watana, Tsusena, Kosina, Jay, and Goose creeks, and the Oshetna River.

4.2.4.3. Variances from the Study Plan

4.2.4.3.1. Birds

ISR Section 5.7 Part C: Executive Summary and Section 7 dated June 2014 describes the variances for the sampling. No additional variances have occurred since that report was submitted.

4.2.4.3.2. Mammals

During the aquatic furbearers study (Study 10.11) evidence of aquatic furbearers (tracks) was only observed on Kosina and Deadman Creeks. Hair snags were not placed at the remaining creeks.

In ISR Section 5.7 Part C: Executive Summary and Section 7 dated June 2014, the decision to collect additional samples from piscivorous mammals has been deferred until the pathways analysis has been completed and a determination made as to the potential for mercury to bioaccumulate in aquatic receptors. If there is a potential for mercury transfer from aquatic to the terrestrial environment, additional sampling may be performed.

4.2.5. Fish Tissue

The sampling methods and preliminary results were previously discussed in the ISR Section 5.7 dated June 3, 2014. Analytical results are presented in this report. No additional sampling or analyses was performed in 2014.

4.2.5.1. Variances from the Study Plan

Variances from the study plan were detailed in ISR Section 5.7 Part C: Executive Summary and Section 7 dated June 2014. No additional variances are noted.

4.3. Modeling

4.3.1. Harris and Hutchison Model

A detailed description of the Harrison and Hutchison model was presented in the Study Plan (Section 5.7.4 of the RSP 5.7). This model is a linear regression model based on studies of the relationship between various reservoir parameters and the resulting mercury concentrations seen in fish after reservoir construction. The model assumes that the primary source of MeHg in a new reservoir is the flooded terrain, while the primary MeHg removal mechanism is outflow/dilution. The highest MeHg concentrations in fish are therefore associated with reservoirs that flood large areas, but have low flow-through. The results are adjusted for piscivorous and non-piscivorous species of fish. The use of area in the calculation reflects an assumption that MeHg removal mechanisms other than outflow are primarily related to reservoir area (e.g., photodegradation, burial and sediment demethylation) rather than reservoir volume.

4.3.2. Phosphorous Release Model

A detailed description of the Phosphorous Release model was presented in the Study Plan (Section 5.7.4 of the RSP 5.7). This model is not necessarily more accurate than the Harrison and Hutchison model, and in fact may be slightly less accurate given the larger number of parameters necessary to perform the calculations. However, it has the added benefit of predicting when peak mercury concentrations are likely to occur after inundation, and how long they are likely to persist. The model pays special attention to flood zone characteristics, because decomposition of organic materiel after flooding is a key driver for increases in MeHg levels in new reservoirs.

The model is semi-empirical: decaying organic material releases phosphorous at a set rate (the phosphorus release curve), which controls decomposition of the organic material in the inundation zone. This turns out to be a fairly accurate measure of the bioavailability of mercury for fish, and can be used to predict mercury concentrations in muscle tissues.

Note that the predictions from this model generally tend to overestimate mercury concentrations that will occur. This situation reflects a conscious choice on the part of the developers of the formula to be conservative with their predictions.

4.3.3. Pathways Assessment

A detailed description of the pathways assessment method was presented in the Study Plan (Section 5.7.4 of the RSP 5.7). Potential for bioaccumulation of mercury in aquatic life is evaluated by reviewing water quality conditions that would increase mercury concentrations. Examples of parameters that increase mercury concentrations are: low pH, low dissolved oxygen concentrations, increased nutrients, increased temperature and several others.

The pathways assessment is intended to identify water quality characteristics that would increase mercury concentrations under different operational scenarios. Potential for bioaccumulation of mercury during post-Project scenarios will be evaluated by inserting predicted water quality conditions from the Environmental Fluid Dynamics Code (EFDC) into the pathways assessment model. A separate pathways assessment for mercury will use the predicted water quality conditions to evaluate potential for bioaccumulation during each operational scenario in the reservoir and immediately below the dam.

The pathways assessment cannot be fully completed until the modeling for the reservoir is complete (Study 5.6). However, the potential pathways assessment and impacts for existing conditions in the inundation zone is presented in this report.

4.3.3.1. Variances from the Study Plan

There were no variances to the modeling methods described in the study plan.

5. RESULTS

5.1. Summary of Available Information

The available information on the concentrations of mercury in various media in Alaska is extensive and fairly well documented. This information was summarized in the ISR Section 5.7 dated June 3, 2014. Additional information on mercury concentrations in Alaska fish has been added (USGS 2014). Information generated from the review is summarized on Tables 5.1-1 to 5.1-9, and Figures 5.1-1 to 5.1-2.

5.2. Vegetation

The vegetation found at each of the sample sites is shown on Table 5.2-1, and was previously summarized in the ISR Section 5.7. The analytical results of the vegetation analyses were received from the contract laboratory too late for inclusion in the ISR and are presented in Table 5.2-2. In summary, there was little difference in the mercury concentrations between the various sample locations inside the inundation zone. Concentrations of total mercury ranged from 7.00 to 16.1 nanograms per gram (ng/g) dw (dry weight), and 2.06 to 4.36 ng/g wet weight (ww) (Table 5.2-2). There was little correlation between plant species and mercury concentrations, which is consistent with the fact that relatively few species such as alder, willow, bog blueberry, and low bush cranberry made up a majority of the vegetative mass at most locations.

5.3. Soil

As reported in the ISR Section 5.7, the soil samples each consisted of a combination of surface moss, peat, and mineral soil (Table 5.3-1). At each sample location there was a significant fraction of organic material (moss and peat) above the mineral soil. This material is the primary potential source of mercury methylation in the reservoir after impoundment.

The analytical results of the soil analyses were received from the contract laboratory too late for inclusion in the ISR and are presented here. Total mercury concentrations in the soil ranged from 27.1 to 119 ng/g dw, with a mean of 61 ng/g dw. The highest concentration of mercury seemed to be located at SITE-3, which was also found to have the thickest accumulation of peat in all the sample areas. Peat is well known as an accumulator and concentrator of mercury in the environment (Mitchell et al. 2008).

Periodic detections of relatively high (> 1 ng/g) concentrations of MeHg were observed as well (Table 5.3-1). These elevated detection had little effect on the total mercury concentration.

There was very little difference in the reported total mercury concentrations based on the type of extraction method utilized. MeHg concentrations were generally found to be 2-3 times higher using the organic extraction method; however, detection limits were also elevated, reducing the value of this method.

5.4. Water

The analytical results of the water sampling were received from the contract laboratory too late for inclusion in the ISR Section 5.7 dated June 14, 2014 and are summarized on Tables 5.4-1 and 5.4-2. The complete results are available at the Susitna project data website, and the Baseline Water Quality Site Completion Report (Study 5.5). The following is a summary of the results:

- There was very little difference in mercury concentrations collected in the middle of the river to those collected at the margins, and little difference in mercury concentrations with depth, suggesting the mercury present is well mixed in the river.
- Total mercury concentrations ranged from 78.3 nanograms per liter (ng/L) to non-detect (<0.5 ng/L).
- Samples analyzed for dissolved mercury typically were one to two orders of magnitude lower concentration than total mercury. The highest dissolved concentration of mercury in water was 1.7 ng/L; however, most detections were at or below the detection limit (0.5 ng/L).
- The 2013 total mercury data should be considered an estimate. While the samples were collected and analyzed according to the Study Plan and appropriate guidance from EPA and ADEC, high concentrations of suspended solids are believed to have biased the results high. This is discussed in more detail in Water Quality Study Completion Report (Study 5.5).
- Concentrations of mercury generally decreased moving up river from Susitna Station (PRM 29.9) to Oshetna River (PRM 235.2) (see Figure 5.4-1).
- There is a strong seasonal component in the mercury concentrations, with higher concentrations noted in the spring, and diminishing in the fall and winter (Figure 5.4-2). Mercury is largely absent from the river water in the winter. This change tracks the seasonal suspended sediment concentrations in the river.
- The Deshka River has a significantly lower mercury concentration than the main stem Susitna River.
- Similar ranges of mercury concentrations were observed in the focus area samples, suggesting that the focus areas are no more prone to mercury accumulation than the main stem Susitna River.

5.5. Sediment and Sediment Porewater

5.5.1. Sediment

Figures 4.2-20 to 4.2-25 show the sampling areas selected for the study. Sediment concentrations of mercury ranged from 1.00 to 17.4 ng/g total mercury dw (Table 5.5-1). Sediment tended to be fairly coarse grained in the upper river, with little fines (Table 5.5-2).

5.5.2. Porewater

Porewater samples were co-located with sediment samples. Results ranged from non-detect (< 0.51 ng/L) to 9.54 ng/L. In general the results were fairly low, with 24 of the 30 analytical results under 2 ng/L (Table 5.5-1). This suggests that there is currently a very low primary productivity of mercury in the river.

5.6. Piscivorous Birds and Mammals

No additional attempts at sampling tissues from piscivorous birds were performed, and as detailed in the ISR Section 5.7, Part C: Executive Summary and Section 7 (June 2014), there are no plans to attempt any additional tissue sample collection.

Fur samples from river otters and mink were sought from animals harvested by trappers in the study area in 2013. However, state regulations prevent identification of trappers and harvest locations using ADF&G data. The information was discussed in the ISR Section 5.7.

One river otter pelt and two mink pelts were obtained in late winter 2014 from a trapper who harvested them near Chulitna River/Indian River (Figure 5.6-1). The exact location where the furs were trapped was not recorded. The furs had been dried, but not tanned. Both the fur and the pelt were analyzed for mercury. Concentrations were nearly identical for all three furs, ranging from 6,330 to 7,670 ng/g dw (Table 5.6-1).

Eight hair snares were set at two main locations on March 8, 2014 - four were set at three sites along Kosina Creek and four snags were set at three sites near Deadman Creek. The hair snags were checked on March 25 and April 11, 2014 with no reported collection. One additional hair snag was deployed along Kosina Creek on April 11, 2014. All snares were removed on April 23, 2014.

The effort produced only four hairs from a single river otter at one of the sites. Despite the low sample volume, the sample was analyzed for total mercury and the results indicated a mercury concentration of 417 ng/g ww. No other analyses could be performed due to the small sample size.

5.7. Fish Tissue

The following sections discuss the available data on a species by species basis. While the fish tissue samples were collected in 2013 and sampling details incorporated in the ISR Section 5.7

dated June 3, 2014, the analytical results were received from the contract laboratory too late for inclusion in the ISR and are presented here.

5.7.1. Lake Trout

Lake trout were collected from Sally Lake and Deadman Lake which would be hydrologically connected to the proposed reservoir after filling (Figure 4.2-26). Otoliths were extracted from all seven of these fish. While lake trout were present in Cushman Lake, none were caught during the study period.

Previous studies of lake trout from various lakes in the Susitna drainage and in Deadman Lake (Burr 1987) found there to be a good relationship between fish fork length and age (Figure 5.7-1). It should be noted that the relationship between lake trout length to age may be lake specific, and even small changes in lake conditions can impact growth significantly (Burr 1987). Based on otolith data extracted from the lake trout, the fish captured for this study ranged from 7 to 26 years old, which is consistent with the information from Burr (1987) (Figure 5.7-1).

The fish ranged in size from 355 to 625 millimeters (mm) fork length, and 500 to 2,200 grams (g) in weight (Table 5.7-1. As anticipated, lake trout showed the highest concentration of mercury in their tissues, and the concentration was closely related to the size of the fish (Figure 5.7-2). Concentrations ranged from 136 to 637 ng/g total mercury ww, and 592 to 2,920 ng/g dw. As anticipated, a majority, if not all, of this mercury is MeHg (Table 5.7-1).

5.7.2. Longnose Sucker

A total of seven longnose suckers (LNS) were captured from the river. Five of these fish were captured at the confluence of the Susitna and Oshetna Rivers, the remainder in the mainstem Upper Susitna River (Figure 4.2-26). The fish ranged in size from 315 to 430 mm, and in weight from 303 to 500 g (Table 5.7-2). Otoliths were successfully extracted from 5 of these fish.

Previous studies of the LNS in the Susitna Middle River (APA 1984b) found there to be a good relationship between fish fork length and age (Figure 5.7-3). Based on that relationship and the data collected in this study, the LNS captured in this study ranged from seven to over 13 years old.

Mercury concentrations in the fish tissue ranged from 33.1 to 640 ng/g ww, and 153 to 640 ng/g dw (Table 5.7-2). There appeared to be a poor correlation between fish size and mercury concentration (Figure 5.7-4), which may be due to the narrow range of fish sizes sampled. As anticipated, a majority, if not all, of this mercury is MeHg.

5.7.3. Dolly Varden

Dolly Varden were found to be rare in the inundation zone, with the only area of their occurrence being the upper Watana Creek (Figure 4.2-26). A total of seven fish were captured from this location. The fish narrowly ranged in size from 177 mm to 204 mm, and in weight from 47 g to 70 g (Table 5.7-3). Otoliths were successfully extracted from four of the fish as part of this study.

The fish were found to be essentially the same age, and had mercury concentrations ranging from 20.8 to 83.7 ng/g ww, and 88.3 to 359 ng/g dw (Table 5.7-3). Only a weak correlation was found between fish size and mercury concentration (Figure 5.7-5). This may be because of the narrow range of sizes sampled. As anticipated, a majority, if not all, of this mercury is MeHg.

5.7.4. Arctic Grayling

A total of 16 Arctic grayling were captured as part of this study. Most were captured from Kosina Creek in 2013, where the species appears to be plentiful (Figure 4.2-26). The fish ranged in size from 75 mm to 340 mm, and in weight from 12 g and 385 g (Table 5.7-4). Two fish were also captured in 2012 from Watana Creek, and one was captured from the Oshetna River. Some of the fish captured appeared to be juveniles (<2 years old), however, the field crews were directed to keep any fish accidentally killed during other studies for inclusion in this study. No otoliths were successfully extracted from Arctic grayling.

Previous studies of the Arctic grayling in the Upper Susitna River (APA 1984a) found there to be a good relationship between fish fork length and age (Figure 5.7-6). Using this data, it would appear that the fish captured in 2013 ranged from 0.5 to over 8 years old.

Mercury concentrations in the fish tissue ranged from 19.3 to 100 ng/g ww, and 78.1 to 533 ng/g dw (Table 5.7-4). There is a weak correlation between fish size and mercury concentrations (Figure 5.7-7). As anticipated, a majority, if not all, of this mercury is MeHg.

5.7.5. Burbot

A total of eight burbot were collected from the mainstem of the Upper Susitna River in the inundation zone, two were captured in 2012, and six in 2013 (Figure 4.2-26). The fish ranged narrowly in size from 390 mm to 467 mm, and in weight from 312 g to 553 g (Table 5.7-5). Two otoliths were successfully extracted from the burbot, and in both cases the fish was found to be approximately 5 years of age. For the fish collected in 2013, burbot livers were also analyzed for mercury and other metals.

Mercury concentrations in the fish tissue ranged from 39.8 to 113 ng/g ww, and 200 to 547 ng/g dw (Table 5.7-5). Mercury concentrations in liver tissue were generally lower, ranging from 14.7 to 44.2 ng/g ww, and 31.6 to 241 ng/g dw (Table 5.7-6). There is a weak correlation between fish size and mercury concentrations (Figure 5.7-8), which may be due to the narrow range of sizes sampled. As anticipated, a majority, if not all, of this mercury is MeHg.

5.7.6. Slimy Sculpin

A total of seven slimy sculpin were collected from the mainstem of the Upper Susitna River in the inundation zone in 2013 (Figure 4.2-26). Unlike the other species studied here, the analytical results of the slimy sculpin were evaluated for whole fish. The fish ranged narrowly in size from 74 mm to 100 mm, and in weight from 3.6 g to 6.6 g (Table 5.7-7). Otoliths were not sampled due to the small size of the fish. Mercury concentrations in the fish tissue ranged from 23.3 to 85.1 ng/g ww, and 104 to 387 ng/g dw (Table 5.7-7). There appears to be a poor correlation between slimy sculpin size and mercury concentration (Figure 5.7-9), however, this may be because the total mercury concentrations in the fish were nearly the same for all sizes. As anticipated, a majority, if not all, of this mercury is MeHg.

5.7.7. Whitefish sp.

A total of 13 whitefish were collected from the mainstem of the Upper Susitna River in the inundation zone in 2013 (Figure 4.2-26).

Humpback whitefish were found to be rare in the inundation zone. Only a single fish was positively identified; however, two other unidentified whitefish were also captured. The remaining 10 whitefish captured appeared to be round whitefish. The fish were captured throughout the proposed inundation zone. Otoliths were extracted from three of the fish for analyses.

Three of the whitefish captured appeared to be juveniles, but were analyzed since they had been accidentally killed in rotary screw traps. Including the juveniles, the fish ranged in size from 140 to 450 mm, and in weight from 57.1 to 470 g (Table 5.7-8).

Previous studies of the round whitefish in the Susitna Middle River (APA 1984b) found there to be a good relationship between fork length and age (Figure 5.7-10). Based on the data collected in this study the fish captured for this study ranged from 1 to 20 years. It should be noted that the Middle River is more productive than the Upper River, meaning the same size fish may be younger in the Middle River than the Upper River because there is more food available. Therefore using age data from the Middle River could underestimate age for Upper River fish.

Mercury concentrations in the fish tissue ranged from 5.68 to 102 ng/g ww, and 26.9 to 379 ng/g dw (Table 5.7-8). The concentration of mercury appeared to be reasonably correlated with fish size (Figure 5.7-11). As anticipated, a majority, if not all, of this mercury is MeHg.

5.8. Modeling

5.8.1. Harris and Hutchison

Results of the model simulation to predict peak increase factors (relative increases) for the proposed the project are shown on Table 5.8-1. These predicted relative increases are low (2.77 for non-piscivorous fish and to 4.24 for piscivorous fish) compared to what has been observed in Canadian reservoirs (Schetagne et al. 2003; Bodaly et al. 2007). The low predicted peak values were due to both low relative increases and relatively low baseline concentrations of mercury at the site.

5.8.2. Phosphorous Release Model

The phosphorous release model cannot be completed at this time because it requires inputs from the reservoir model (Study 5.6).

5.8.3. Pathways Assessment

The pathways assessment cannot be fully completed because it requires inputs from the reservoir model (Study 5.6), particularly predictions of mercury and phosphorous concentrations in water and sediment post impoundment. However, an assessment of the existing mercury pathways can be presented here.

The primary source of mercury to the reservoir will be atmospheric deposition, and degradation of mercury inside the inundation zone that is stored in vegetation, peat, and shallow soils. The existing relationship between mercury in the environment in the inundation area can be summarized as follows:

- Atmospheric deposition (336 ng/m^2/yr.) (from WACAP 2008).
- Vegetation uptake (9.16 ng/g dw)
- Concentration of vegetation in organic soils (58.25 ng/g dw)
- Transport in surface water (5 ng/L)
- Concentration in sediment/porewater (9 ng/g dw)
- Concentration in bacteria
- Concentration in invertebrates
- Concentration in non-piscivorous fish (205 ng/g dw)
- Concentration in piscivorous fish (1,088 ng/g dw) and mammals (7,000 ng/g dw)

Transferability of mercury between media (e.g., sediment to pore water) is enhanced by several environmental factors that increase methylation from sediments or in pore water or that sequesters mercury into sediments (Figure 5.8-1). The Technical Memorandum Mercury Pathways Analysis describes in detail approach and methods for conducting this pathways assessment for mercury (Appendix A). An increase in the methylation rate might be due to the following conditions:

- Presence of aquatic vegetation;
- A reducing environment (redox potential) or low oxygen concentrations;
- Increased nutrients;
- Increased temperature;
- Increased microbial respiration;
- Presence of dissolved organic carbon;
- Neutral to low pH.

A decrease in the methylation rate in sediments or pore water (Figure 5.8-1) could be a result of:

- Higher dissolved oxygen concentrations;
- Presence of sulfides or acid-volatile sulfides;
- Presence of selenium in sediments.

Mercury sequestered in sediments, entrained in pore water, or in the water column can be bound to organic matter or exist in a methylated form. The transfer process from sediment to bioaccumulation in the food chain is shown on Figure 5.8-2. Elemental mercury or mercury adsorbed to organic particles can be physically transferred in a riverine setting from sediment to pore water to surface water by moving water that re-suspends adsorbed mercury on organic particles from the sediment. The increase or decrease in MeHg in any of these compartments are dependent on factors that either enhance or diminish the methylation process.

The pathways assessment is completed in two steps: 1) determination of potential toxic concentrations in sediment or pore water and if exposure of aquatic life results in chronic or acute effects, and 2) examination of water quality factors that could enhance methylation of mercury and aquatic life are exposed to lethal concentrations.

The presence of mercury under existing conditions was evaluated for potential toxicity to aquatic life using available criteria: 1) National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) for sediments, and 2) Alaska Water Quality Standards (AWQS) for pore water and surface water. Sediment was collected from three points at each sample site with analysis for mercury described separately (Figure 5.8-3). The SQuiRT threshold for mercury in sediment is 174 ng/g dw with all observations for mercury in sediment falling well below this concentration at all sites.

Porewater was collected and analyzed for mercury at the same sites as the sediment samples. The results were compared to AWQS, and are well below the environmental thresholds for protection of aquatic life. The controlling state standard for mercury in surface water is 0.050 micrograms per liter (µg/L) or 50 ng/L and is intended to protect aquatic organisms from exposure as well as protection of potable water sources. Dissolved mercury results for porewater were less than one-quarter of the water quality standard for protection of the designated beneficial uses. Most of the porewater concentrations from tributary sediments were at or near detection limits; detection limits are shown on Figure 5.8-4.

Some factors diminish the toxic effects of MeHg. For example, the selenium in sediments will typically bind with mercury forming mercury selenide, reducing the formation of MeHg. Selenium will also reduce the toxicity of mercury inside an organism. Once uptake of Hg has occurred in aquatic organisms, the body burden of this metal does not determine toxicity, rather, a combination of the presence of selenium and mercury better represent potential toxic effects. Peterson et al. (2009) indicated that the concentration of mercury in tissues is not the critical indicator for toxicity. Instead toxicity is determined by the ratio of moles of mercury to the moles of selenium in the organism. As the molar ratio for selenium: mercury approaches or exceeds 1:1, mercury toxicity decreases.

The upper river sites had low concentrations of selenium in sediment (Figure 5.8-5) and non-detectable concentrations at several sample points (e.g., Kosina, Jay, Goose, and Oshetna Creeks). However, the concentration of selenium in sediments was typically two orders of magnitude (100 times) larger than mercury sediment concentrations from the same sample points, suggesting that the toxicity of mercury in the ecosystem is low.

Additional factors and fate processes that influence increases in mercury methylation rates include: pH, dissolved oxygen concentration, temperature, and redox potential. These factors are further examined for compliance with current water quality standards in Figure 5.8-6 through Figure 5.8-9. Field observations for these factors were within water quality standards as reported in select graphs (Figure 5.8-6 through Figure 5.8-8); the one exception was one dissolved oxygen concentration among the sample points collected from Oshetna River (Figure 5.8-8). All other results were within a range that are protective of beneficial uses, including aquatic life, and were not considered influential for increasing methylation of mercury. Individual data points for factors and fate processes, as reported in Figure 5.8-6 through Figure 5.8-9, that influence mercury methylation rates are found in Table 5.8-2.

Increased nutrients can contribute to increased mercury methylation rates. A surrogate indicator, percent TOC, was examined for nutrient content in sediment samples. TOC at all sample points represented in sediments was less than one percent, indicating a dominance of inorganic material present at all locations (Table 5.5-1).

6. DISCUSSION

6.1. Summary of Available Information

The available information on the concentrations of mercury in various media in Alaska is extensive and fairly well documented in the ISR Study Plan Section 5.7.

The following is a discussion of information on the general characteristics of mercury in the environment, the accumulation of mercury in biological organisms, and the potential impacts to ecological resources. It is included here to allow for a better understanding of the analytical data generated, and the Harris and Hutchison modeling and pathways assessment.

6.1.1. Mercury Sources

In nature, the mineral cinnabar (mercury sulfide or HgS) occurs in concentrated deposits and has been used as the primary source of commercially mined mercury. However, mercury is bound very tightly to sulfur in cinnabar, and typically weathers slowly (USGS 2013). In areas that lack the necessary mercury mineralization, the mercury concentration in parent geologic materials is typically very low, and cannot explain the mercury concentrations observed in sediment in aquatic ecosystems (Fitzgerald et al. 1998; Swain et al. 1992; Wiener et al. 2006). This is because numerous studies have shown the primary source of mercury to aquatic ecosystems is atmospheric. For example, the 1992-1996 Florida Atmospheric Mercury Study (FAMS) demonstrated that atmospheric deposition accounts for more than 95% of the mercury in the Everglades each year (Guentzel et al. 1994). Because the primary source of mercury is atmospheric, mercury can create problems in aquatic ecosystem even when a primary source of mercury is distant.

This would appear to be true for the proposed reservoir; given the rock types and mineralization in the proposed inundation zone do not appear to contain significant sources of mercury, however, this does not mean that mercury concentrations in the resulting reservoir will not be elevated over background.

The primary sources of mercury to the atmosphere are 1) Volcanic eruptions 2) Forest fires, and 3) coal burning. Volcanic eruptions cycle mercury into the atmosphere from deep in the Earth. Forest fires liberate mercury that has previously been deposited on the land, and has been absorbed by plant life. Coal is fossilized plant life, which contains the trace amounts of mercury that was present in the plants when they died and were buried. Burning coal liberates this mercury into the environment. In 2000 it was estimated that as much as two-thirds of the total anthropogenic emissions of mercury world-wide was from the combustion of fossil fuels (Pacyna et al. 2006), mostly coal. It is estimated that over the last 100 years, anthropogenic mercury has accounted for approximately 70% of the total atmospheric deposition of mercury at the location of the Upper Freemont Glacier in the western United States, with the remainder coming from other sources (Schuster et al. 2002).

WACAP (2008) observed an annual atmospheric influx of mercury of 336 ng/m^2/yr. at Wonder Lake. It is expected that a similar influx would occur at Watana. Given the reservoir will be 23,500 acres (95.1 million square meters), annual atmospheric contributions to the reservoir would be approximately 31.95 grams per year.

This influx of mercury has been incorporated into the vegetation in the inundation zone. The estimated vegetative mass per square meter at the site is 4 kg ww (derived from Mead 1998). Assuming an average concentration in the vegetation of 2.8 ng/g of mercury ww, the total mercury stored in the vegetation of the inundation zone is estimated at 11,200 ng/m^2. Viewed from another perspective, the vegetation has captured and stored approximately 33 years of atmospherically deposited mercury.

An average of 60 ng/g dw of mercury was present in the organic soils (peat) within the inundation zone. The average thickness of this layer was found to be 10 cm. Peat has a dry density of 4 g/cm^3. Therefore each square meter of soil would therefore contain 400,000 g of organic soils (dw). This equals 24,000,000 ng/m^2. Viewed from another perspective, the organic soils are storing approximately 2,143 times the amount stored in the vegetation.

This relationship between atmospheric mercury deposition, vegetation, and peat is logically consistent, in that vegetation takes many years (or decades) to grow, and peat takes hundreds, if not thousands of years, to form from the vegetation.

These calculations also clearly illustrate why mercury concentrations typically spike after inundation of a reservoir. As the vegetation and especially the fine organic soils are broken down by bacteria, the accumulated atmospheric mercury is released to the reservoir, and is available to aquatic organisms. This influx of mercury can be many times what may occur via natural atmospheric deposition. It should be noted that not all the vegetation and organic soils are susceptible to biological break down. Woody debris degrades very slowly in cold water, and organic material at the bottom of the reservoir tends to get sequestered in fine sediment, and degrades slowly, if all. Most of the biological breakdown of plants and organic soils occurs in fine organic material on the margins of the reservoir.

Previous studies have found that increases in MeHg concentrations in a reservoir after filling are not related to atmospheric deposition. Rudd (1995) has shown that only 0.3% to 3% of the mercury in a newly formed reservoir is derived from precipitation, while the remainder is from inundated fine organic soil particles. Studies have found that the primary source of mercury to a new reservoir is inundated soils (Meister et al. 1979), especially the upper organic soil horizon (Bodaly et al. 1984).

6.1.2. Mercury Bioaccumulation

As a volatile liquid, in some ways, mercury behaves much like water does as part of the hydrologic cycle (Figure 5.8-2). Under the right conditions, it evaporates from the Earth's surface, can travel as a vapor, and can be precipitated at remote locations, changing its chemical form as it moves. Ultimately, mercury is sequestered in sediments, absorbed by fish, plants, and wildlife, or evaporated back to the atmosphere by volatilization.

Mercury exposure to the ecosystem via water, sediment or soil is typically low, and concentrations of mercury in these media are often undetectable. The various forms of mercury can be converted from one to the next; most important is the conversion to MeHg, which is more toxic and hazardous because it bioaccumulates in species. In water bodies, bacteria generate MeHg as part of their metabolic processes. Bacteria pass the MeHg up the food chain, where it becomes slowly concentrated in higher organisms (Figure 5.8-2). The rate of bioaccumulation is often specific to each organism. Size, age, diet, and species greatly influence the rate of mercury bioaccumulation. In general, the longer an organism lives, the higher trophic level it occupies, the more mercury it will tend to bioaccumulate. For example, Arctic grayling may live shorter lives, and generally subsist on insects and fish eggs. Lake trout typically live longer, and feed on insects, but also on small crustaceans, and fish. Because of this, lake trout typically bioaccumulate higher concentrations of mercury in similar ecosystems than Arctic grayling.

Physical factors can also greatly influence the formation and uptake of MeHg. Ocean, lake, and stream habitats each have different physical properties that affect the input and retention of mercury in the system. In general lakes and ponds retain mercury longer than streams and rivers.

Photodegradation is a primary demethylation mechanism for MeHg, and water bodies with high levels of circulation offer greater opportunities for this mechanism to occur (Seller et al. 1996).

Water quality parameters also affect MeHg uptake rates for aqueous organisms. Wiener et al. 2006 concluded that high dissolved sulfate, low selenium, low lake water pH, and high organic carbon favored MeHg bioaccumulation. Lake temperature has also been implicated in methylation (Schindler et al. 1995; Lambertson and Nilsson 2006; Power et al. 2002). Krabbenhoft et al. (1999) showed that the density of nearby wetlands was the most important factor increasing methylation rates. The location of sampling in relation to point sources of mercury contamination also clearly has an effect on mercury levels in fish.

In general, total mercury in fish consists of > 85% MeHg, but in some species (such as pike) MeHg has been found to be is nearly 100% of the total mercury (Jewett et al. 2003). This was consistent with the results of this study. MeHg is most likely to be present in fish because it bioaccumulates in tissue, whereas elemental mercury can pass through organisms relatively quickly.

Because mercury, unlike many other contaminants, concentrates in the muscle tissue of the organism, it cannot be filleted or cooked out of consumable game fish.

Looking at the results of this study, the non-piscivorous fish (Arctic graying, whitefish, and longnose suckers) seemed to have concentrations of total mercury of around 40 to 80 ng/g ww.

Piscivorous species (lake trout) had a mean total mercury concentration of 247 ng/g ww, or approximately 4 times the concentration of the non-piscivorous species. This suggests a fairly typical mercury relationship between trophic levels (Tremblay 1999).

Slimy sculpin were analyzed as whole body. Adjusting for this factor and slimy sculpin would have similar total mercury concentrations of muscle tissue to other non-piscivorous species.

The burbot results were anomalous. While burbot are typically a piscivorous species, they typically don't begin feeding on other fish until their 5th to 6th year in the aquatic environment. All of the burbot captured during this study were below this threshold age, and are therefore considered non-piscivorous for the purposes of this study. Their mercury concentrations were largely consistent with what was observed for other non-piscivorous fish studied at the impoundment area.

6.1.3. Mercury Behavior in Reservoirs

Many studies have documented increased mercury levels in fish following the flooding of terrestrial areas to create hydroelectric reservoirs (Bodaly et al. 1984; Bodaly et al 1997; Bodaly et al 2004; Bodaly et al. 2007; Rylander et al. 2006; Lockhart et al 2005; Johnston et al. 1991; Kelly et al. 1997; Morrison 1991). These problems have been sometimes acute in hydropower projects from northern climates including Canada and Finland (Rosenberg et al. 1997). When boreal forests are flooded, substantial quantities of organic carbon and mercury stored in vegetation biomass and soils become inputs to the newly formed reservoir (Bodaly et al. 1984; Grigal 2003; Kelly et al. 1997). This flooding accelerates microbial decomposition, causing accelerated microbial methylation of mercury. Part of the MeHg produced is released into the water column where it may be transferred to fish via zooplankton. Insect larvae feeding in the top centimeters of flooded soils can assimilate the MeHg available and transfer it to fish (Figure 5.8-2). The production and transfer of MeHg is governed by the amount and type of flooded organic matter and by biological and physical factors such as bacterial activity, water temperature, oxygen content of the water, etc. of the newly formed reservoir.

Because the fine organic material that is being inundated is a finite source, and is slowly consumed by the bacteria, or sequestered under accumulating sediment, MeHg concentrations in the reservoir generally return to background concentrations. Studies have shown this increase lasts between 10 and 35 years (Hydro-Quebec 2003; Bodaly et al. 2007).

The magnitude and timing of the change in MeHg concentrations can vary significantly by trophic levels in the same reservoir. Peak MeHg concentrations first occur in the water column, in lower trophic level organisms and young fish, and later in top predators, such as lake trout (Bodaly et al. 2007; Schetagne et al. 2003). These trends are consistent with a pulse in MeHg production that peaks within a few years after inundation, and then takes time to move through the food web to top predators.

The peak MeHg concentrations in some higher tropic level fish (lake trout) species are typically 4 to 7 times greater than background levels (Bodaly et al. 2007; Schetagne et al. 2003). Lower trophic level fish species such as Arctic grayling tend to have lower concentrations and slightly lower relative increases (2 to 5 times above baseline). Increased mercury concentrations have also been noted at other trophic levels within aquatic food chains of reservoirs, such as aquatic invertebrates (Hall et al. 1998). However, it is not uncommon for concentrations at lower trophic levels to be too low to measure.

Fish mercury concentrations downstream of some reservoirs can increase as well (Schetagne et al. 2003; Anderson 2011). The distance downstream of reservoirs where increased fish MeHg levels occur depends on system-specific features. A study was performed to identify how mercury is transported downstream from reservoirs and to assess the amount of mercury being exported (Schetagne et al 2000). The results indicated that the dissolved MeHg and the suspended particulate matter are the major components by which mercury is transferred downstream of reservoirs, accounting for 64 and 33%, respectively, of the total amounts exported. Plant debris, benthic invertebrates, fish, phytoplankton, and zooplankton were found to be much less important pathways for mercury export because of their very low biomass per water volume coming out of the generating station, as opposed to the high biomass of suspended particulate matter.

In the case of the Susitna-Watana Dam downstream export appears unlikely. The river downstream of the dam will be relatively shallow and highly oxygenated. MeHg is not stable in water exposed to air and sunlight, and quickly breaks down. Lehnherr and St. Louis (2009) found that, depending on the quantity and type of radiation, up to 75% of MeHg in lakes can be demethylated by sunlight. UV radiation accounts for 58% and 79% of the photodemethylation activity in a clear and colored lake, respectively.

Chetelat et al. (2008) studied MeHg transfer to fish in high arctic lakes and found that mercury is bound to organic material rather than inorganic particles, and low organic carbon in water and sediment reduce mercury retention in lakes. The capacity of the sediment bacterial community to generate MeHg may be strongly limited by poor environmental conditions for methylation rather than the availability of inorganic mercury.

6.1.4. Potential Ecological Impacts

In fish, mercury accumulation is typically age-dependent. This was certainly found to be the case in this study (Figures 5.7-2, 5.7-5, 5.7-7, and 5.7-8). However the correlation appears to be weak with whitefish, and nonexistent with slimy sculpin (Figures 5.7-9 and 5.7-11). This difference is likely diet related. As fish get older their diet may consist of larger prey, at a steadily higher trophic level. However, round white fish feed mostly on invertebrates, such as crustaceans, insect larvae, and do not typically feed at much higher trophic levels as they get older. Slimy sculpin are very small, and have limited choices of prey as they age.

WACAP (2008) found that the increase in mercury concentrations with age generally diminished after 15 years. It has been theorized that after 15 years the highest trophic level of feeding for each species has been reached (Kidd et al. 1995; Evans et al. 2005), or that some sort of metabolic balance is achieved (Trudel and Rasmussen 1997). A third possible explanation is that mercury might increase steadily, until it eventually reaches toxic levels (WACAP 2008). As a result, only fish with fairly low starting concentrations of mercury live past 15 years. Because the source of mercury is atmospheric, the rate of mercury bioaccumulation in an ecosystem is typically not source dependent, that is to say the rate of mercury bioaccumulation is dependent on site specific conditions for the formation of MeHg. It has been documented extensively that areas can have concentrated mercury sources, but low methylation rates, and hence low concentrations of mercury in fish tissue (Bloom 1992). WACAP (2008) found that sites with elevated mercury flux in snow and sediment were found to have lower concentrations of mercury in fish, while areas with low mercury deposition were found to nonetheless have high concentrations of mercury in fish. On this basis, it appears that even though atmospheric deposition is a primary source of mercury to most ecosystems, the linkage between atmospheric deposition rates and fish concentrations is weak. These results indicate that we should not expect a direct relationship between mercury concentrations in soil, vegetation, precipitation, and fish at the project site. Indeed, the WACAP study of several Alaska National parks found there to be none.

6.2. Vegetation

The vegetation types at the site do not appear to be variable within the inundation zone, with only three to four species representing the majority of the vegetation mass. However, there was a considerable mass of organic material (moss and peat) at almost all the sample locations. Friedli et al. (2007) found there to be a significant variation in mercury concentrations between plant species, with moss, lichen, and leaf litter typically showing the highest concentrations of mercury (Table 6.1-1). These concentrations are consistent with concentrations observed in the soils at the site, as opposed to the vegetative matter. Table 5.1-8 presents the results for the lichen collected as part of the WACAP study in Alaska, and shows similar results.

There are no regulatory standards for mercury in vegetation; however, the concentrations are typically very low.

6.3. Soil

Where soils have developed on uniform parent material vegetation, cover type and cover age are important variables affecting concentration of mercury in soils (Grigal et al. 1994). This is certainly true in an upland boreal forest in the Prince Albert National Park, Saskatchewan, Canada (Friedli et al. 2007). They found that 93 to 97 percent of the mercury resided in the organic soil (peat and forest litter) above the mineral layer. They also found that periodic forest fires can “reset” the mercury concentration to a lower level, and that mercury concentrations increase slowly in the soil over time (Table 6.1-1).

Soil concentrations of mercury can be compared to the NOAA SQuiRTs. These are thresholds used as screening values for evaluation of toxics and potential effect to aquatic life in several media. It is suggested that mercury concentrations should be <100 ng/g dw in soil to protect invertebrates, and < 300 ng/g dw to protect plants. The highest concentration of mercury noted in the soil was 119 ng/g dw at SITE-3 N2, but most samples were well below this concentration (Table 5.3-1).

MeHg concentrations need to be below 1.58 ng/g dw to protect the reference species of voles used for establishing the cleanup standard. While most of the samples had MeHg concentrations below this level, a few samples significantly exceeded this concentration (Table 5.3-1).

The SQuiRT table indicates that the mean background concentration of mercury in soil nationwide is 58 ng/g dw. This is close to the mean for all the soils samples collected in the inundation zone of 61 ng/g dw. This suggests that the soils present in the inundation zone show no particular evidence of mercury accumulation above nominal background levels.

In July 2012 ADEC set the following cleanup standards for mercury in soil:

- MeHg in soil of 0.012 mg/kg (12 ng/g dw)
- Total Mercury 1.4 mg/kg (1,400 ng/g dw)

None of the soil samples were found to exceed these concentrations. Both of these cleanup levels assume that migration to groundwater (and surrounding water bodies) is the primary exposure pathway.

6.4. Water

While mercury samples were collected during studies conducted in the 1980s, it appears that the analytical methods utilized at the time were not sensitive enough to detect mercury concentrations in the water. Their detection range was <0.1 µg/L (<100 ng/L), compared to current detection limits of approximately 0.5 ng/L. Most detections of mercury reported in the 1980s were at or very near the detection limit for the analytical method (Tables 5.1-1 to 5.1-3). Such detections are often suspect, given they are close to the theoretical maximum sensitivity of the equipment.

Modern analyses by the USGS (Table 5.1-1 to 5.1-3) and in this study (Tables 5.4-1 and 5.4-2) indicate that total mercury concentrations in the water range from <0.5 to 68 ng/L, and is largely undetectable as dissolved mercury, suggesting that the majority of the mercury detected is associated with suspended sediment. As previously stated, mercury sorbs onto fine carbon, and that may be the reason for this result.

Surface water concentrations of mercury can be compared to the NOAA SQuiRT tables. NOAA recommends screening levels of 1,400 ng/L for total mercury (acute), and 770 ng/L for total mercury (chronic). AWQS (18 AAC 75.345) has set a cleanup level for surface and groundwater of 2,000 ng/L. Total mercury concentrations in the Susitna River, as expected, are well below these concentrations (Tables 5.4-1 and 5.4-2).

6.5. Sediment and Sediment Porewater

The methylation process is largely mediated by anaerobic bacteria in aquatic bed sediment (Gilmour et al. 2011; Fleming et al. 2006). Once formed, MeHg can enter the benthic food web. The purpose of the sediment and porewater sampling was to document the primary production of MeHg at the base of the food web.

Total mercury concentrations ranged more than an order of magnitude between sample locations. Concentrations of mercury in porewater and sediment from this study (1.00 to 17.4 ng/g dw in sediment and <0.5 to 12.5 ng/L in porewater) is on the low end of what has been observed in other freshwater streams (1.9 to 4,517 ng/g dw) reported in a survey of 106 streams throughout the United States (Marvin-Depasquale et al. 2009).

Concentrations of mercury in sediment also appeared to be low (Table 5.1-6) when compared to concentrations found in other freshwater streams and rivers around Cook Inlet (Frenzel 2000). Table 5.1-7 shows the partitioning of mercury in select samples from the Frenzel (2000) study. Concentrations of mercury at the site were low compared to most of the other sites, but in sediment, fish, and water. Interestingly, the one site sampled by Frenzel (2000) with similar mercury concentrations was Costello Creek, which is located north of the project site near Cantwell (Figure 5.1-2).

Sediment grain size and TOC typically exert a dominant influence on sediment mercury concentrations at most sites; however, in this study there appeared to be little correlation between TOC and mercury concentrations. It is likely the cause of the breakdown in this relationship is the overall low concentrations of TOC observed in the sediments (Table 5.5-1). Total mercury concentrations did appear to be loosely related to the sediment size, with finer grained sediments often producing higher concentrations of mercury, however this was not always the case. Overall the data suggests that there is a low primary productivity for MeHg in upper Susitna within the inundation zone.

These sediment concentrations can be compared to NOAA Squirt guidelines (Table 6.5-1). As with the soil and water results, the concentrations of mercury in sediment at the site were well below screening levels.

6.6. Piscivorous Birds and Mammals

Efforts to collect bird specimens have so far been unsuccessful. This potential problem was identified in the Study Plan and discussed with the TWG, in that it is difficult to collect non-lethal samples for animals with very low population densities in rugged terrain. Lack of access to CIRWG lands and a Bald Eagle collection permit further limited the potential for sample collection.

For the two samples of otter hair analyzed, one of the samples exhibited a very low concentration of mercury (417 ng/g ww; Table 5.6-1). It is possible that the individual hairs found in the trap may belong to a juvenile, which would explain their relatively low concentration of mercury compared to the adult sample. However, the mercury concentration in the adult fur sample also seems relatively low (1,610 ng/g ww) compared typical concentrations found in other studies (Yates et al. 2005), and these concentration are consistent with relatively low mercury concentrations found in fish, sediment, and surface water. It is also consistent with the relatively low concentrations of mercury found in the mink pelts.

Other studies have documented mercury levels in river otter fur ranging from 2,800 to 73,700 ng/g ww in Maine, with a mean of 20,700 ng/g ww (Yates et al. 2005). This compares to 417 to 1,610 ng/g ww found during this project. Concentrations of total mercury in fur samples from Nova Scotia averaged 25,000 ng/g dw, ranging from 1,400 to 137,000 ng/g dw (Spencer et al, 2011). This compares to 6,330 ng/g dw found during this project. Overall the concentrations found appear to be relatively low compared to concentrations seen elsewhere.

Studies have documented mercury levels in mink ranging from 1,780 to 68,500 ng/g ww in Maine, with a mean of 17,500 ng/g ww (Yates et al. 2005). This compares to 2,170 to 2,970 ng/g ww found in the mink samples collected as part of this study. Again, these results are consistent with the relatively low concentrations documented in the sediment, water, and fish tissues at the site.

6.7. Fish Tissue

The data indicates that mercury concentrations in trout continue to increase as the trout age (Figure 6.7-1). This is consistent with the fact that as trout age they get larger and feed at progressively higher trophic levels. This relationship was not observed as much with the non-piscivorous fish. This is especially noticeable for the Arctic grayling and whitefish (sp.) (Figure 6.7-1). Arctic grayling showed a correlation between age and mercury concentrations, but the results were more scattered, and had more exceptions. Whitefish showed only a moderate increase in mercury concentrations with age.

The burbot showed somewhat anomalous results, with relatively low concentrations for a piscivorous species (Figure 5.7-8). The feeding habits of burbot are complex, and may vary seasonally, and with life stage (Dixon and Vokoun, 2009). It is possible that burbot captured were non-piscivorous, and their close range in size suggests that all the fish captured are at the same life stage.

In general, mercury concentrations reported in fish captured inside the inundation zone were consistent with results for the same species captured elsewhere in Alaska. Comparing the results from this study to ADEC statewide results (ADEC 2012), the results for the Upper Susitna seemed to be on the low end of the average observed for the state (Table 5.1-4). Overall the mean and median were lower for all species of fish, except for longnose suckers. However, these results represent an average for ADEC sampling across the state, and ADEC tends to focus on sampling watersheds where a problem may exist. In addition, the ADEC analytical method does not follow standard EPA procedures, and results from these analyses should be considered estimates.

Table 5.1-5 presents the samples from the previous ADEC study, but only for samples from the Susitna River Drainage (Figure 5.1-1). Again, the results from this study of the Upper Susitna River appear to be slightly lower than concentrations found elsewhere in the drainage.

Comparing slimy sculpin concentrations to those found in various freshwater streams around Cook Inlet (Frenzel (2000), it appears the concentrations are consistent with what has been recorded elsewhere (Table 5.1-6, Figure 5.1-2).

The WACAP study looked at concentrations of mercury in fish in relatively pristine national parks in Alaska. Concentrations of mercury in lake trout and burbot caught in these lakes were very similar to the concentrations reported as part of this project (Table 5.1-9).

Looking through the literature, Arctic grayling appear to be the fish most commonly analyzed for mercury in Alaska. The results from multiple studies have been compared on Figure 6.7-2. The results are graphed on the basis of mean weight and mean mercury concentration per capture location, to better adjust for the increase in mercury concentrations in larger fish. In summary, the results from this study appear to reside on the lower end of mercury previously observed for Arctic grayling in Alaska.

6.8. Modeling

After construction of a reservoir, mercury concentrations in fish typically increase several times above background levels. These fish tissue concentrations typically peak 5-15 years after flooding, and may take 2-3 decades to diminish back to background concentrations. This phenomenon is well understood and studied, and the cause of this pulse of mercury though the ecosystem is the decay of naturally occurring fine organic materiel within the inundation zone. The volume of organic soils, biological productivity, rate of breakdown of this materiel, reservoir flow through, and other factors determine the rate and amount of mercury that will accumulate in fish species. The exhaustion of the fine organic materials in the reservoir is typically what causes the mercury concentrations in fish to slowly return to background over decades.

Several models have been created to predict mercury concentrations in reservoirs post impoundment. These models have been tested against multiple reservoirs, as well as the Experimental Lakes Area (ELA)in Ontario, Canada (Bodaly et al. 2005). Two of these models have been considered as part of this study.

Schetagne et al. (2003) found a strong correlation between the ratio of flooded area, the mean annual flow through of the reservoir, and maximum mercury concentrations in fish tissue. This approach was further refined by Harris and Hutchinson (2008) to provide a predictive tool for MeHg concentrations in fish. Regression calculations using historical data from multiple reservoirs have determined the coefficients that control these equations. The drawback to these models is that they only predict peak MeHg concentrations, not when these concentrations will occur or subside. The advantage of this type of model is that it is simple, and requires relatively few input parameters. Because the input data is relatively simple to determine and calculate, this type of model is often used to screen potential impacts. This screening function is not meant to imply that the model is any less accurate than alternatives, in fact, given the model relies on easily and accurately determined parameters, it may be more accurate than more complex models.

The phosphorous release model is a more complex method of estimating MeHg impacts. It was pioneered by Messier et al. (1985) based on the work of the whole-ecosystem reservoir experiments at the ELA (Bodaly et al. 2005), and confirmed by decades-long studies of reservoirs by Hydro-Quebec (2003). The model is more complex than the Harris and Hutchison model, however, the purpose of the additional complexity is to allow for a prediction of when the peak mercury concentration would likely occur, and how long elevated mercury concentrations in fish would be likely to persist. The model pays special attention to flood zone characteristics, because decomposition after flooding is a key driver for increases in MeHg levels in new reservoirs.

6.8.1. Harris and Hutchison

The Harris and Hutchison model results are presented in Section 5.8.2 of this study report, and suggest that that inundation of the Susitna-Watana reservoir is unlikely to increase concentrations of mercury in fish to concentrations that may adverse impact human health and the environment (Table 5.8-1). The maximum predicted mean concentration for piscivorous fish species was 1,047 ng/g ww, while for non-piscivorous species it was 212 ng/g ww. It should be noted that this maximum concentration may only be present in the reservoir for a brief period, and would decline shortly thereafter.

It is difficult to precisely determine the impact of mercury in fish tissue on various species of mammal, birds, as well as humans. This is because the sensitivity of these receptors varies with species, as well as feeding habits and frequency.

For human health risk, muscle mercury concentrations can be compared to fish consumption guidelines recommended by the Alaska Department of Health and Social Services (AK-DHSS) to protect women who are or can become pregnant, nursing mothers, and young children (Verbrugge 2007). These consumption guidelines suggest the following:

0 to 150 ng/g ww – unlimited fish consumption.

150 to 320 ng/g ww – limit to 4 meals per week.

320 to 400 ng/g ww – limit to 3 meals per week.

400 to 640 ng/g ww – limit to 2 meals per week.

640 to 1,230 ng/g ww – limit to 1 meal per week.

>1,230 ng/g ww fish should not be routinely consumed.

These numbers are considered to be fairly conservative, given they were calculated based on the most vulnerable parts of our population. Based on the Harris and Hutchison model, it would appear that mercury concentrations in fish at the proposed reservoir may cause a need to place certain catch limits and consumption guidelines during the period of time when mercury concentrations peak in the fish, however, these restrictions would not appear to be significant, and would likely last only a brief period of time.

While muscle tissue results best represents potential exposure to humans, whole body results more accurately estimate ecosystem exposures. These muscle tissue results can be converted to whole body concentrations in order to assess the toxicological risks of mercury to wildlife (Peterson et al. 2005). The whole body fish concentrations for piscivorous fish (lake trout) would be 281 ng/g ww, and 67 ng/g ww for non-piscivorous fish.

To assess potential toxicological effects of mercury to fish, the estimates of whole-body mercury can be compared to a no-observed-effects-residue (NOER) of 200 ng/g ww (Beckvar et al. 2005) and a lowest-observed-effects-residue (LOER) of 300 ng/g ww (Sandheinrich et al. 2011). Fish with whole body mercury concentrations less than the NOER benchmark are not commonly associated with altered behavioral, development, growth, or reproduction. Fish with whole body mercury concentrations greater than the LOER benchmark have been consistently associated with sublethal effects, including changes in reproductive health.

Based on these criteria, concentrations of mercury in non-piscivorous fish are unlikely to ever exceed the NOER, and concentrations in piscivorous fish are unlikely to exceed LOER. Overall it appears unlikely the concentrations of peak mercury will have significant or noticeable impact on fish populations.

For piscivorous birds, whole-body mercury concentrations can be compared to toxicological benchmarks representing risks to sensitive species. A review of field and laboratory studies on mercury toxicity in common loons found that mercury concentrations greater than 180 ng/g ww whole body in prey fish were associated with significant reductions in reproductive success (Depew et al. 2012). The non-piscivorous fish would appear to be well below this standard, however, the piscivorous fish may exceed this standard. Given that the piscivorous birds would be unlikely to feed exclusively on one species of fish (lake trout), it appears unlikely that adverse impacts would occur.

Another method to evaluate these results is to compare them to other reservoirs in Alaska. If similar concentrations of mercury were present in other Alaska reservoirs without adverse impacts human health and the ecosystem, it would be unlikely to do so in the case of this project.

Unfortunately mercury accumulation in reservoir fish has not be previously studied in Alaska, and no baseline data exists for actual (versus predicted) mercury accumulation rates. However, the same Harrison and Hutchison linear model can be applied to other constructed reservoirs in Alaska. This comparison can be seen on Table 6.8-1. Significant ecological and human health impacts from mercury have not been observed in these older reservoirs, and it appears that this project would have similar impacts.

6.8.2. Phosphorous Release Model

Because of its greater complexity, the phosphorous release model requires more data inputs. Some of these inputs, such as phosphorous concentrations in the reservoir water after inundation, will be generated by the EFDC modeling being performed under Study 5.6. Until that modeling is done, the phosphorus release model cannot be completed.

6.8.3. Pathways Assessment

Several factors can affect the potential for bioavailability of mercury in the aquatic environment. Factors affecting bioavailability are described in Figure 5.8-1 and the processes of circulation in the ecosystem (e.g., sediments, surface water, biotic) in Figure 5.8-2. Fate processes and factors that increase methylation of mercury or decrease the chance for methylation to occur were the focus for evaluation of existing conditions immediately below and in the proposed reservoir area.

The procedure for evaluating potential pathways where risk for bioavailability of mercury occurs under existing conditions is the following:

- Identify factors and fate processes that increase potential exposure of aquatic life;

- Determine if factors (fate processes) are within water quality standards; and
- Interpret potential for mercury transfer between media and aquatic life at risk from exposure resulting from this transfer.

An evaluation of factors and fate processes with a focus on potential increases of methylation of mercury are reported in Table 5.8-2. Examination of how each factor contributes to increases in methylation of mercury and an assessment of data describing existing conditions at each sample site informed on potential for exposure from this bioavailable form. Low concentrations of mercury in sediments from the sites and absence of critical factors or fate processes that would contribute to methylation of mercury are evidence that risk of exposure to aquatic life is low (Table 5.8-2).

This evaluation will be revised when the EFDC model for the reservoir is complete (Study 5.6).

7. COMPLETING THE STUDY

Significant progress has been made since June 2014 in meeting the objectives of the Mercury Study. Sample collection efforts have met all the objectives outlined in Section 2 of the ISR. No additional field work is planned or would appear to be necessary at this time.

The remaining tasks for this study include:

- Phosphorous release modeling for evaluating potential mercury concentrations in fish after reservoir development. Completion of this modeling is dependent on completion of the EFDC modeling (Study 5.6) for the surface water.
- Update of the pathways assessment to include information generated from EFDC modeling (Study 5.6) for the surface water.
- A decision on additional terrestrial biological sampling (mammals and birds) will be made based on the results of the two previous bullet items. Based on the results of the Harris and Hutchison modeling, as well as all the currently available information, additional sampling of terrestrial tissues is unlikely to be necessary, given the concentrations of mercury in fish are unlikely to exceed levels of concern.

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9. TABLES

Table 4.2-1. Sampling Parameters and Media

Parameter	Media							
	Vegetation	Soil	Surface Water	Sediment	Sediment Porewater	Piscivorous Birds and Mammals	Fish Tissue	
							Filet	Liver
TOC			X	X				
Mercury	Total	Total	Total, Dissolved	Total	Dissolved	Total	Total	Total
Methyl Mercury	X			X		X	X	X
Sediment Size				X				
Total Solids				X				

See ISR Section 5.5 for additional parameters collected for Baseline Monthly and Focus Area Water Quality Sampling

Table 4.2-2. Vegetation and Soil Sample Locations

Sample Site	Latitude	Longitude	Nearest PRM
Site 1 N1	62.8206	-148.1557	200.3
Site 1 N2	62.8207	-148.1560	200.3
Site 1 N3	62.8206	-148.1553	200.3
Site1 N4	62.8207	-148.1562	200.3
Site1 N5	62.8206	-148.1552	200.3
Site 2 N1	62.7976	-148.0707	203.8
Site 2 N2	62.7975	-148.0706	203.8
Site 2 N3	62.7974	-148.0704	203.8
Site 2 N4	62.7976	-148.0708	203.8
Site 2 N5	62.7973	-148.0703	203.8
Site 2 N6	62.7973	-148.0703	203.8
Site 3 N1	62.7895	-148.0556	208.0
Site 3 N2	62.7895	-148.0561	208.0
Site 3 N3	62.7897	-148.0551	208.0
Site 3 N4	62.7896	-148.0563	208.0
Site 3 N5	62.7898	-148.0552	208.0
Site 3 N6	62.7898	-148.0552	208.0
Site 4S alt1	62.7884	-148.0074	206.2
Site 4S alt2	62.7883	-148.0077	206.2
Site 4S alt3	62.7883	-148.0071	206.2
Site 4S alt4	62.7883	-148.0079	206.2
Site 4S alt5	62.7883	-148.0068	206.2
Site 4S alt6	62.7883	-148.0068	206.2
Site 5S 1	62.7842	-147.9521	208.2
Site 5S 2	62.7845	-147.9521	208.2
Site 5S 3	62.7842	-147.9520	208.2
Site 5S 4	62.7846	-147.9524	208.2
Site 5S 5	62.7840	-147.9519	208.2

Site 6S-1	62.7790	-147.9189	209.8
Site 6S-2	62.7789	-147.9195	209.8
Site 6S-3	62.7790	-147.9185	209.8
Site 6S-4	62.7788	-147.9198	209.8
Site 6S-5	62.7792	-147.9183	209.8
Site 7 N1	62.7784	-147.8787	211.5
Site 7 N2	62.7784	-147.8787	211.5
Site 7 N3	62.7786	-147.8787	211.5
Site 7 N4	62.7782	-147.8789	211.5
Site 7 N5	62.7787	-147.8789	211.5
Site 7 N6	62.7787	-147.8789	211.5
Site 8 S1	62.7728	-147.8483	212.5
Site 8 S2	62.7729	-147.8481	212.5
Site 8 S3	62.7725	-147.8484	212.5
Site 8 S4	62.7731	-147.8480	212.5
Site 8 S5	62.7724	-147.8486	212.5
Site 9 N1	62.8509	-148.2314	NA
Site 9 N2	62.8508	-148.2316	NA
Site 9 N3	62.8509	-148.2311	NA
Site 9 N4	62.8510	-148.2317	NA
Site 9 N5	62.8507	-148.2310	NA
Site 9 N6	62.8507	-148.2310	NA
Site 10 N1	62.8577	-148.2133	NA
Site 10 N2	62.8574	-148.2131	NA
Site 10 N3	62.8572	-148.2134	NA
Site 10 N4	62.8576	-148.2129	NA
Site 10 N5	62.8571	-148.2136	NA

Samples collected from August 6 to 7, 2013.

Table 4.2-3. Baseline Water Quality Monitoring Sites

PRM	Description	Latitude	Longitude	Location Rationale
29.9	Susitna Station	61.544280	-150.515560	Influence of upstream tributary
32.5	Yentna River	61.587604	-150.483017	Major tributary
33.6	Susitna above Yentna	61.575950	-150.427410	Above major tributary
45.1	Deshka River	61.710142	-150.324700	Major tributary
59.9	Susitna	61.862200	-150.184630	Above major tributary
87.8	Susitna at Parks Highway East	62.174531	-150.173677	Mainstem river site
102.8	Talkeetna River	62.342430	-150.112660	Major tributary
107	Talkeetna	62.397240	-150.137280	Upstream of existing townsite; Historic (1980s) monitoring site
118.6	Chulitna River	62.567703	-150.237828	Major tributary
124.2	Curry Fishwheel Camp	62.617830	-150.013730	Important side channel habitat
140.1	Gold Creek	62.767892	-149.689781	Major tributary
142.2	Indian River	62.78635	-149.658780	Major tributary
142.3	Susitna above Indian River	62.785776	-149.648900	Historic (1980s) monitoring site
152.2	Susitna below Portage Creek	62.830397	-149.382743	Downstream of major tributary
152.3	Portage Creek	62.830379	-149.380289	Major tributary
152.7	Susitna above Portage Creek	62.827002	-149. 827002	Historic (1980s) monitoring site
187.2	Susitna at Watana Dam site	62.822600	-148.553000	Boundary condition between the reservoir and riverine models
235.2	Oshetna River	62.639610	-147.383109	Uppermost tributary in the Project area

PRM = project river mile

Table 4.2-4. Focus Area Water Monitoring Sites

Focus Area	PRM	Latitude	Longitude
Whiskers Slough	104	62.3729	-150.1572
Oxbow I	113	62.5015	-150.1027
Slough 6A	115	62.5142	-150.1115
Slough 8A	128	62.6605	-149.9193
Gold Creek	138	62.7657	-149.7079
Indian River	141	62.7856	-149.6459
Slough 21	144	62.8110	-149.5898

PRM = project river mile

Table 5.1-1. Historic Mercury Concentrations at Gold Creek (PRM 140.1)

Date	Mercury in water (filtered, µg/L)	Mercury in water (unfiltered, µg/L)	Mercury in suspended sediment (µg/kg)
6/14/77	NS	<0.5	NS
8/10/77	NS	<0.5	NS
10/4/77	NS	0.2	NS
6/23/81	NS	0.4	0.4
7/21/81	0.2	0.3	0.1
3/30/82	<0.1	<0.1	NS
7/1/82	<0.1	0.2	NS
9/16/82	<0.1	0.2	NS
3/18/83	<0.1	<0.1	NS
6/28/83	<0.1	0.1	NS
7/28/83	<0.1	0.3	NS
6/27/84	<0.1	0.1	NS
7/25/84	0.2	3.0	NS
6/27/85	0.2	0.0	NS
7/24/85	<0.1	<0.1	0.1
8/28/85	<0.1	<0.1	NS
3/24/86	<0.1	0.1	NS
6/25/86	<0.1	<0.1	NS
7/30/86	0.2	0.1	NS
8/25/86	0.8	0.5	NS
6/6/12	<0.005	0.007	NS
8/15/12	<0.005	0.008	NS
6/6/13	<0.005	0.023	NS

NS = not sampled
< = detection limit
µg/L = micrograms per liter
µg/kg = micrograms per kilogram

Table 5.1-2. Historic Mercury Concentrations at Susitna at Parks Highway East (PRM 87.8)

Date	Mercury in water (filtered, µg/L)	Mercury in water (unfiltered, µg/L)	Mercury in suspended sediment (µg/kg)
6/15/77	NS	<0.5	NS
8/10/77	NS	<0.5	NS
10/4/77	NS	<0.10	NS
3/25/81	0.10	0.1	0.0
6/25/81	0.00	0.6	0.6
7/23/81	0.10	0.3	0.2
7/2/82	<0.10	0.2	NS
9/15/82	0.10	0.2	0.1
10/13/82	0.10	0.1	0.0
1/20/83	<0.10	NS	NS
3/17/83	<0.10	<0.10	NS
6/24/83	<0.10	0.2	NS
7/27/83	<0.10	0.3	NS
6/14/84	<0.10	0.9	NS
7/19/85	<0.10	0.1	NS
1/10/85	<0.10	<0.10	NS
6/25/85	<0.10	0.1	NS
7/23/85	<0.10	<0.10	NS
8/27/85	<0.10	<0.10	NS
3/18/86	<0.10	<0.10	NS
6/25/86	<0.10	<0.10	NS
6/5/12	<0.005	0.015	NS
8/13/12	<0.005	0.023	NS
6/3/13	<0.005	0.035	NS

NS = not sampled
< = detection limit
µg/L = micrograms per liter
µg/kg = micrograms per kilogram

Table 5.1-3. Historic Mercury at Susitna Station (PRM 29.9)

Date	Mercury in water (filtered, µg/L)	Mercury in water (unfiltered, µg/L)	Mercury in suspended sediment (µg/kg)
1/20/75	<0.5	<0.5	0.0
5/23/75	<0.5	<0.5	0.0
8/27/75	<0.5	<0.5	0.0
10/3/75	<0.5	<0.5	0.0
3/17/76	<0.5	<0.5	0.0
5/28/76	<0.5	<0.5	0.0
7/26/76	<0.5	<0.5	0.3
10/6/76	<0.5	<0.5	0.0
3/9/77	<0.5	<0.5	NS
5/23/77	<0.5	<0.5	0.0
8/19/77	<0.5	<0.5	0.2
12/13/77	<0.1	<0.1	0.0
4/5/78	<0.1	<0.1	0.0
5/24/78	<0.1	<0.1	0.1
7/17/78	<0.1	0.2	0.1
1/15/79	<0.1	<0.1	0.1
5/14/79	<0.1	0.2	0.2
6/19/79	<0.1	<0.1	0.1
9/17/79	<0.1	<0.1	0.1
3/12/80	0.0	0.1	0.1
6/16/80	0.0	0.1	0.1
7/30/80	0.1	0.1	0.0
4/9/81	0.0	0.1	0.1
6/12/81	0.0	0.3	0.3
7/15/81	0.2	0.8	0.6
4/9/82	<0.1	<0.1	NS
5/19/82	<0.1	0.1	NS
7/14/82	0.2	0.2	0.0
10/5/82	0.1	NS	NS
4/5/83	<0.1	NS	NS
6/22/83	0.1	NS	NS
7/27/83	<0.1	NS	NS
9/30/83	<0.1	NS	NS
4/6/84	<0.1	NS	NS
5/18/84	<0.1	NS	NS
7/18/84	<0.1	NS	NS
9/20/84	<0.1	NS	NS
3/27/85	0.1	NS	NS
5/24/85	<0.1	NS	NS
7/18/85	0.2	NS	NS

Date	Mercury in water (filtered, µg/L)	Mercury in water (unfiltered, µg/L)	Mercury in suspended sediment (µg/kg)
9/19/85	<0.1	NS	NS
12/4/85	0.1	NS	NS
7/29/86	0.1	NS	NS
9/25/86	3.0	NS	NS
5/30/13	<0.005	NS	NS

NS= not sampled
< = detection limit
µg/L = micrograms per liter; µg/kg = micrograms per kilogram

Table 5.1-4. ADEC Mercury Statewide Data Compared to Susitna-Watana

Species	Date source	Tissue	Number	Mean and Std. Dev. (ng/g ww)	Median (ng/g ww)	Range (ng/g ww)
Lake trout	ADEC	Fillet	53	360 ± 180	320	64-740
	Susitna-Watana	Fillet	9	247± 171	173	136-637
Arctic grayling	ADEC	Fillet	48	87 ± 34	82	33-180
	Susitna-Watana	Fillet	16	44 ± 24	37	19-100
Dolly Varden	ADEC	Fillet	22	120 ± 160	58	11-550
	Susitna-Watana	Fillet	7	43 ± 24	47	17-84
Humpback whitefish	ADEC	Fillet	98	67 ± 32	66	8-18
Round whitefish	ADEC	Fillet	12	75 ± 56	68	8-200
	Susitna-Watana	Fillet	13	57± 29	55	6-102
Burbot	ADEC	Fillet	27	330 ± 280	250	ND–850
	Susitna-Watana	Fillet	8	68 ± 27	64	36-113
Longnose sucker	ADEC	Fillet	3	71 ± 12	73	59-82
	Susitna-Watana	Fillet	7	77 ± 42	68	33-138

All results are total mercury
ADEC = Alaska Department of Environmental Conservation
ng/g ww = nanograms per gram wet weight.
Susitna-Watana results are from this study. ADEC results are from ADEC (2012)

Table 5.1-5. ADEC Mercury Data from Susitna Watershed

Species	Site Name	Fish Length (mm)	Fish Weight (g)	Age	Sex	Hg (ng/g dw)
Lake trout	Lakes near Tyone Creek	600	2,939	NM	M	130
	Lakes near Tyone Creek	610	3,089	NM	M	270
	Lakes near Tyone Creek	730	5,294	NM	F	740
Arctic grayling	Lake Louise	288	200	4.5	M	110
	Lake Louise	290	230	4	M	110
	Lakes near Tyone Creek	200	NM	2	NM	95
	Lakes near Tyone Creek	201	NM	2	NM	91
	Lakes near Tyone Creek	330	340	5	F	180
	Lakes near Tyone Creek	278	200	<1	F	160
	Lakes near Tyone Creek	220	110	2	M	110
	Lakes near Tyone Creek	270	190	3.5	F	80
	Lakes near Tyone Creek	290	230	4	NM	80
	Finger Lake	370	460	7	M	67
	Fishook Lake	310	310	4	F	77
	Fishook Lake	370	160	7	F	100
	Fishook Lake	320	350	5	M	130
	Upper Talkeetna River	360	420	6.5	NM	93
	Upper Talkeetna River	370	430	7	M	51
	Christianson Lake	260	160	3.5	F	120
	Christianson Lake	204	10	2.5	NM	130
	Christianson Lake	272	190	3.5	F	59
Burbot	Big Lake	579	1,038	9	NM	94
Round whitefish	Knob Lake	390	490	20	F	120
	Knob Lake	360	310	7	F	200
	Knob Lake	340	220	8	F	78
	Knob Lake	320	230	6	M	58
	Knob Lake	280	150	1	M	90
	Coal Creek Lake	330	290	12	M	140
	Coal Creek Lake	310	220	13	F	79

mm = millimeters, g = grams, NM = not measured, M=male, F = female
ng/g dw = nanograms per gram dry weight
All results are from ADEC (2012)

Table 5.1-6. Mercury in Cook Inlet Freshwater Sediments and Slimy Sculpin Tissue

Site Name	Sediment Hg (ng/g dw)	Slimy Sculpin Hg (ng/g dw)
Susitna-Watana (this study)	6.7 (mean)	178 (mean)
Ninilchik River	50	150
Kenai River at Soldotna	30	200
South Fork Campbell Creek	30	210
Chester Creek	180	100
Talkeetna River	40	80
Deshka River	460	110
Moose Creek	200	160
Kamishak River	40	90
Johnson River	130	NS
Kenai River Below Russian	70	120
Kenai River at Jim's Landing	90	140
Kenai River below Skilak Lake Outlet	70	150
Colorado Creek	180	NS
Costelllo Creek	230	80
National mean	60	NA

National mean is derived from Gilliom et al (1998)
Fish and sediment data for Cook Inlet freshwater is derived from Frenzel (2000)
ng/g dw = nanograms per gram dry weight

Table 5.1-7. Mercury Partitioning in Cook Inlet Freshwater Sediments and Fish

Site Name	Total Hg in Sediment (ng/g dw)	MeHg in Sediment (ng/g dw)	Total Hg in Fish (ng/g dw)	Total Hg in Water (ng/L)	MeHg in water (ng/L)
Susitna-Watana at Dam site (This Study)	6.7 (mean)	NS	178 Slimy Sculpin (mean)	3.53[1]	NS
			183 Dolly Varden (mean)		
South Fork Campbell Creek	200	0.67	292 Slimy Sculpin	2.50	0.02
			429 Dolly Varden		
Chester Creek	109	0.38	152 Slimy Sculpin	2.96	0.02
			ND Dolly Varden		
Deshka River	21	5.10	246 Slimy Sculpin	NS	NS
Johnson River	50	0.01	NS	9.78	0.02
Costellio Creek	169	0.04	ND Slimy Sculpin	4.97	0.02
			101 Dolly Varden		

ND = not detected. NS = not sampled.
Fish and sediment data for Cook Inlet freshwater is derived from Frenzel (2000)
[1] = as measured at dam site July 2014.

Table 5.1-8. WACAP Data for Lichen Samples

Site Name	Species	Number	Median Hg (ng/g ww)
NOAT	*Masonhalea richardsonii*	3	17
NOAT	*Flavocetraria cucullata*	2	23
GAAR	*Masonhalea richardsonii*	2	22
GAAR	*Flavocetraria cucullata*	4	26
DNP	*Masonhalea richardsonii*	6	12
DNP	*Flavocetraria cucullata*	6	21

NOAT = Noatak National Preserve; GAAR = Gates of the Arctic National Park; and DNP = Denali National Park
ng/g ww = nanograms per gram wet weight
Data from WACAP (2008)

Table 5.1-9. WACAP sand USGS Data for Alaska Fish

Site Name	Species	Number	Mean Age	Mean Hg (ng/g ww)
Susitna-Watana (This Study)	Lake trout	9	12	173
Susitna-Watana (This Study)	Burbot	8	5	64
Susitna-Watana (This Study)	Arctic grayling	16	4	44
NOAT Burial Lake	Lake trout	10	20	130
GAAR Matcharak Lake	Lake trout	10	18	218
DNP Wonder Lake	Lake trout	10	17	113
DNP McLeod Lake	Burbot	4	4	58
WSENP Copper Lake	Lake trout	15	13	145
WSENP Grizzly Lake	Burbot	15	11	41
WSENP Tanada lake	Lake trout	15	14	372
WSENP Tanada lake	Burbot	13	11	383
WSENP Tanada lake	Arctic Grayling	10	11	109

Results are for whole body samples.
NOAT = Noatak National Preserve; GAAR = Gates of the Arctic National Park; DNP = Denali National Park; WSENP = Wrangell St. Elias National Park
ng/g ww = nanograms per gram wet weight.
Data from WACAP (2008) and USGS (2014)

Table 5.2-1. Plant Species Observed and Collected at Each Sample Site

Species	Site-1	Site-2	Site-3	Site-4	Site-5	Site-6	Site-7	Site-8	Site-9	Site-10
Alder (*Alnus* spp.)	X	X	X	X	X			X	X	X
Willow (*Salix* spp.)	X	X	O	X	X	X	X	X	X	X
Bog Blueberry (*Vaccinium uliginosum*)	X	X	X	X	X	X	X	X	X	X
Low-bush Cranberry (*Vaccinium vitus-idaea*)	X	X	X	X	X		X	O	X	X
Salmonberry (*Rubus spectabilis*)	X		X							
Prickly Rose (*Rosa acicularis*)		X	O		X		O		X	X
Crowberry (*Empetrum nigrum*)		X	X	O				O	X	O
American Red Currant (*Ribes triste*)					X					
Clover (*Trifolium* sp.)					X					
Spruce (*Picea* sp.)					X	O	O			
Sweet Gale (*Myrica gale*)						X	O			
Arctic Coltsfoot (*Petasites frigidus*)	O	O		O			X		X	X
Horsetail (*Equisetum* sp.)	O	O		O	O	O		O	O	O
Bog Birch (*Betula glandulosa*)	O	O	O	O	O	O	O	O	O	
Bush Cinquefoil (*Dasiphora fruticosa*)	O		O	O		O		O	O	
Common Labrador Tea (*Ledum groenlandicum*)	O	O	O	O	O		O	O	O	O
Cloudberry (*Rubus chamaemorus*)	O						O		O	
Wintergreen (*Pyrola* sp.)		O	O		O					
Dwarf Dogwood (*Cornus canadensis*)			O		O					O
Soapberry (*Shepherdia canadensis*)			O							
Twisted Stalk (*Streptopus amplexifolius*)					O					
Fireweed (*Chamerion angustifolium*)					O					
Marsh Five-finger (*Comarum palustre*)						O				
Red Bearberry (*Arctostaphylos rubra*)	O		O	O					O	O

X are plants included in the sampling. O are plants observed, but not included due to low vegetative mass.

Table 5.2-2. Vegetation Results

Location	Latitude	Longitude	PRM	% solids	Total Hg (ng/g dw)	Total Hg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
SITE-1 N1	62.8206	-148.1557	200.3	29.10	8.61	2.51	<3.42	<1.00
SITE-1 N2	62.8207	-148.1560	200.3	39.11	7.00	2.74	<2.54	<0.99
SITE-1 N3	62.8206	-148.1553	200.3	25.52	10.1	2.59	<3.73	<0.95
SITE-1 N4	62.8207	-148.1562	200.3	31.94	8.63	2.75	<3.08	<0.99
SITE-1 N5	62.8206	-148.1552	200.3	33.60	7.79	2.62	<2.90	<0.98
SITE-2 N1	62.7976	-148.0707	203.8	35.50	7.46	2.65	<2.73	<0.97
SITE-2 N2	62.7975	-148.0706	203.8	36.32	7.31	2.66	<2.54	<0.92
SITE-2 N3	62.7974	-148.0704	203.8	35.72	8.04	2.87	<2.61	<0.93
SITE-2 N4	62.7976	-148.0708	203.8	30.30	9.54	2.89	<3.18	<0.96
SITE-2 N5	62.7973	-148.0703	203.8	36.63	7.39	2.71	<2.55	<0.93
SITE-2 N6	62.7973	-148.0703	203.8	37.52	7.48	2.81	<2.57	<0.96
SITE-3 N1	62.7895	-148.0556	208.0	32.63	13.3	4.32	<2.93	<0.96
SITE-3 N2	62.7895	-148.0561	208.0	33.63	13.0	4.36	<2.75	<0.92
SITE-3 N3	62.7897	-148.0551	208.0	34.53	8.15	2.82	<2.65	<0.91
SITE-3 N4	62.7896	-148.0563	208.0	34.73	9.23	3.20	<2.75	<0.95
SITE-3 N5	62.7898	-148.0552	208.0	36.62	8.97	3.29	<2.68	<0.98
SITE-3 N6	62.7898	-148.0552	208.0	31.86	10.7	3.40	<3.06	<0.97
SITE-4S alt1	62.7884	-148.0074	206.2	37.09	7.98	2.96	<2.68	<0.99
SITE-4S alt2	62.7883	-148.0077	206.2	32.04	9.04	2.9	<2.96	<0.95
SITE-4S alt3	62.7883	-148.0071	206.2	31.84	9.01	2.87	<3.07	<0.98
SITE-4S alt4	62.7883	-148.0079	206.2	28.84	8.08	2.33	<3.24	<0.93
SITE-4S alt5	62.7883	-148.0068	206.2	33.01	8.39	2.77	<2.81	<0.93
SITE-4S alt6	62.7883	-148.0068	206.2	30.62	6.71	2.06	<3.08	<0.94
SITE-5S 1	62.7842	-147.9521	208.2	27.77	7.56	2.10	<3.44	<0.96
SITE-5S 2	62.7845	-147.9521	208.2	24.23	9.80	2.38	<3.87	<0.94
SITE-5S 3	62.7842	-147.9520	208.2	31.16	11.2	3.49	<3.06	<0.95
SITE-5S 4	62.7846	-147.9524	208.2	21.11	16.1	3.39	<4.77	<1.01
SITE-5S 5	62.7840	-147.9519	208.2	29.13	8.75	2.55	<3.23	<0.94
SITE-6S-1	62.7790	-147.9189	209.8	33.38	7.19	2.4	<2.97	<0.99
SITE-6S-2	62.7789	-147.9195	209.8	35.96	8.92	3.21	<2.69	<0.97
SITE-6S-3	62.7790	-147.9185	209.8	33.73	7.00	2.36	<2.96	<1.00
SITE-6S-4	62.7788	-147.9198	209.8	35.50	11.2	3.99	<2.60	<0.92
SITE-6S-5	62.7792	-147.9183	209.8	31.42	7.88	2.48	<3.13	<0.98
SITE-7 N1	62.7784	-147.8787	211.5	22.39	10.3	2.32	<4.28	<0.96
SITE-7 N2	62.7784	-147.8787	211.5	29.17	9.16	2.67	<3.23	<0.94
SITE-7 N3	62.7786	-147.8787	211.5	26.71	12.2	3.26	<3.68	<0.98
SITE-7 N4	62.7782	-147.8789	211.5	27.57	12.3	3.38	<3.32	<0.91
SITE-7 N5	62.7787	-147.8789	211.5	18.70	11.4	2.14	<5.15	<0.96
SITE-7 N6	62.7787	-147.8789	211.5	20.47	10.5	2.14	<4.93	<1.01
SITE-8 S1	62.7728	-147.8483	212.5	31.62	7.45	2.35	<3.03	<0.96
SITE-8 S2	62.7729	-147.8481	212.5	29.63	8.56	2.54	<3.36	<1.00

Location	Latitude	Longitude	PRM	% solids	Total Hg (ng/g dw)	Total Hg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
SITE-8 S3	62.7725	-147.8484	212.5	24.31	11.4	2.77	<3.82	<0.93
SITE-8 S4	62.7731	-147.8480	212.5	30.33	9.36	2.84	<3.22	<0.98
SITE-8 S5	62.7724	-147.8486	212.5	27.78	7.57	2.10	<3.48	<0.97
SITE-9 N1	62.8509	-148.2314	NA	31.71	7.45	2.36	<2.95	<0.93
SITE-9 N2	62.8508	-148.2316	NA	31.14	7.91	2.46	<3.17	<0.99
SITE-9 N3	62.8509	-148.2311	NA	31.26	7.89	2.47	<3.13	<0.98
SITE-9 N4	62.8510	-148.2317	NA	29.11	9.02	2.63	<3.27	<0.95
SITE-9 N5	62.8507	-148.2310	NA	34.55	7.79	2.69	<2.85	<0.99
SITE-9 N6	62.8507	-148.2310	NA	32.96	8.27	2.73	<2.85	<0.94
SITE-10 N1	62.8577	-148.2133	NA	27.93	10.7	3.00	<3.28	0.92
SITE-10 N2	62.8574	-148.2131	NA	31.02	8.78	2.7	<3.03	<0.94
SITE-10 N3	62.8572	-148.2134	NA	32.11	10.7	3.42	<3.05	<0.98
SITE-10 N4	62.8576	-148.2129	NA	32.11	7.79	2.5	<2.94	<0.95
SITE-10 N5	62.8571	-148.2136	NA	30.20	9.60	2.9	<3.09	<0.93

ng/g dw = nanograms per gram dry weight
ng/g ww = nanograms per gram wet weight

Hg= mercury
MeHg = methylated mercury

Table 5.3-1. Soil Results

										EPA Method 1631 (Sed./Soil)		EPA Method 1631 (Organic)	
Location	Sample Number	Latitude	Longitude	PRM	Soil Description	Moss (cm)	Peat (cm)	Total organics (cm)	% Total Solids	Total Hg (ng/g dw)	Total MeHg (ng/g dw)	Total Hg (ng/g dw)	Total MeHg (ng/g dw)
SITE-1	N-1	62.8206	-148.1557	200.3	Silt with clay	4.50	9.5	14.0	25.05	64.6	0.570	59.0	<3.90
SITE-1	N-2	62.8207	-148.1560	200.3	Silt with clay	6.50	18.0	24.5	19.59	60.8	1.30	50.0	<4.70
SITE-1	N-3	62.8206	-148.1553	200.3	Silt with clay	5.00	13.0	18.0	20.68	50.7	0.283	51.6	<4.74
SITE-1	N-4	62.8207	-148.1562	200.3	Silt with clay	3.50	6.5	10.0	21.23	59.6	2.62	57.1	<4.69
SITE-1	N-5	62.8206	-148.1552	200.3	Silt with Clay	4.00	14.5	18.5	41.76	43.9	0.224	39.0	<2.28
SITE-2	N-1	62.7976	-148.0707	203.8	Silt	4.50	8.9	13.4	27.19	59.1	0.365	58.6	<3.50
SITE-2	N-2	62.7975	-148.0706	203.8	Silt	3.60	15.0	18.6	23.69	77.9	0.341	80.5	<4.11
SITE-2	N-3	62.7974	-148.0704	203.8	Clayey silt	8.50	13.0	21.5	27.93	68.3	0.247	59.2	<3.34
SITE-2	N-4	62.7976	-148.0708	203.8	Silt	4.80	19.0	23.8	31.25	68.5	0.214	65.7	<3.07
SITE-2	N-5	62.7973	-148.0703	203.8	Clayey silt	3.80	9.2	13.0	23.55	63.9	0.188	54.5	<4.16
SITE-2	N-6	62.7973	-148.0703	203.8	Clayey silt	3.80	9.2	13.0	19.65	67.0	0.371	51.4	<5.06
SITE-3	N-1	62.7895	-148.0556	208.0	Clayey silt	4.50	28.5	33.0	26.12	64.2	0.469	61.8	<3.76
SITE-3	N-2	62.7895	-148.0561	208.0	Clayey silt	4.50	20.5	25.0	26.02	119	0.210	129	<3.51
SITE-3	N-3	62.7897	-148.0551	208.0	Clayey silt	4.50	15.3	19.8	28.30	107	0.225	89.6	<3.30
SITE-3	N-4	62.7896	-148.0563	208.0	Clayey silt	3.50	9.0	12.5	28.01	105	0.135	106	<3.47
SITE-3	N-5	62.7898	-148.0552	208.0	Clayey silt	7.00	5.0	12.0	27.28	70.1	0.384	64.2	<3.50
SITE-3	N-6	62.7898	-148.0552	208.0	Clayey silt	7.00	5.0	12.0	25.91	73.6	0.280	64.2	<3.66
SITE-4S	alt 1	62.7884	-148.0074	206.2	Silt	3.80	6.2	10.0	19.25	48.0	0.424	45.7	<4.98
SITE-4S	alt 2	62.7883	-148.0077	206.2	Silt	12.50	4.2	16.7	22.44	48.1	0.213	45.8	<4.60
SITE-4S	alt 3	62.7883	-148.0071	206.2	Silt	4.20	8.2	12.4	26.26	58.2	0.228	54.6	<3.48
SITE-4S	alt 4	62.7883	-148.0079	206.2	Silt	1.90	0.0	1.9	20.32	50.5	0.325	53.8	<5.37
SITE-4S	alt 5	62.7883	-148.0068	206.2	Silt	8.20	6.2	14.4	25.60	46.2	0.257	43.8	<3.71
SITE-4S	alt 6	62.7883	-148.0068	206.2	Silt	8.20	6.2	14.4	26.42	43.0	0.102	38.7	<3.61
SITE-5S	1	62.7842	-147.9521	208.2	Silty sand	4.00	4.0	8.0	38.09	60.2	0.267	54.1	<2.73
SITE-5S	2	62.7845	-147.9521	208.2	Clayey silt sand	5.00	8.0	13.0	33.27	40.2	0.159	39.6	<3.27

										EPA Method 1631 (Sed./Soil)		EPA Method 1631 (Organic)	
Location	Sample Number	Latitude	Longitude	PRM	Soil Description	Moss (cm)	Peat (cm)	Total organics (cm)	% Total Solids	Total Hg (ng/g dw)	Total MeHg (ng/g dw)	Total Hg (ng/g dw)	Total MeHg (ng/g dw)
SITE-5S	3	62.7842	-147.9520	208.2	Silty sand	4.50	15.0	19.5	35.95	47.7	0.198	49.8	<2.87
SITE-5S	4	62.7846	-147.9524	208.2	Clayey silty sand	3.80	8.1	11.9	44.67	37.8	0.136	37.3	<2.34
SITE-5S	5	62.7840	-147.9519	208.2	Clayey silt	4.30	2.5	6.8	23.48	74.8	0.171	75.2	<4.33
SITE-6S	1	62.7790	-147.9189	209.8	Silty sand	3.50	1.0	4.5	30.25	37.3	2.55	34.3	8.80
SITE-6S	2	62.7789	-147.9195	209.8	Silty sand	2.50	0.0	2.5	54.53	27.1	0.305	33.3	<1.88
SITE-6S	3	62.7790	-147.9185	209.8	Silt	5.50	2.0	7.5	28.91	35.3	3.97	36.9	8.03
SITE-6S	4	62.7788	-147.9198	209.8	Silty sand	2.00	0.0	2.0	29.87	27.3	0.192	26.8	<3.43
SITE-6S	5	62.7792	-147.9183	209.8	Clayey silt	6.00	10.0	16.0	23.90	33.7	4.34	35.8	6.51
SITE-7	N-1	62.7784	-147.8787	211.5	Silt	4.30	0.0	4.3	18.44	45.2	0.137	49.2	<4.91
SITE-7	N-2	62.7784	-147.8787	211.5	Silt	3.50	0.0	3.5	19.47	60.4	0.252	61.9	<5.34
SITE-7	N-3	62.7786	-147.8787	211.5	Silt	6.00	0.0	6.0	20.71	70.1	0.190	71.0	<5.05
SITE-7	N-4	62.7782	-147.8789	211.5	Silt	4.50	5.0	9.5	23.41	100	0.508	100	<4.22
SITE-7	N-5	62.7787	-147.8789	211.5	Silt	3.80	0.0	3.8	23.61	72.8	0.266	75.6	4.05
SITE-7	N-6	62.7787	-147.8789	211.5	Silt	3.80	0.0	3.8	19.50	48.9	0.157	51.3	<5.07
SITE-8	S-1	62.7728	-147.8483	212.5	Silt	3.50	0.0	3.5	37.62	42.4	1.10	42.7	2.67
SITE-8	S-2	62.7729	-147.8481	212.5	Silt	4.00	0.0	4.0	26.54	77.8	0.349	65.6	<3.63
SITE-8	S-3	62.7725	-147.8484	212.5	Silt	4.00	0.0	4.0	42.70	44.8	0.681	48.0	<2.48
SITE-8	S-4	62.7731	-147.8480	212.5	Clayey Silt	3.80	0.0	3.8	28.67	52.6	0.193	54.9	3.62
SITE-8	S-5	62.7724	-147.8486	212.5	Clayey silt	3.50	0.0	3.5	35.36	59.8	2.37	59.3	2.99
SITE-9	N-1	62.85085	-148.2314	NA	Clayey silt	3.50	7.5	11.0	27.66	44.9	0.096	44.5	<3.40
SITE-9	N-2	62.85083	-148.2316	NA	Silt	3.00	6.5	9.5	32.48	106	0.218	109	<2.81
SITE-9	N-3	62.85089	-148.2311	NA	Silt	3.50	11.5	15.0	17.51	30.6	0.189	36.5	<5.22
SITE-9	N-4	62.85104	-148.2317	NA	Clayey silt	4.00	9.5	13.5	25.17	49.8	0.205	40.0	<3.85
SITE-9	N-5	62.85074	-148.2310	NA	Clayey silt	6.00	7.5	13.5	30.99	42.3	0.182	47.3	<3.09
SITE-9	N-6	62.85074	-148.2310	NA	Clayey Silt	6.00	7.5	13.5	26.73	49.9	0.193	53.7	<3.69

										EPA Method 1631 (Sed./Soil)		EPA Method 1631 (Organic)	
Location	**Sample Number**	**Latitude**	**Longitude**	**PRM**	**Soil Description**	**Moss (cm)**	**Peat (cm)**	**Total organics (cm)**	**% Total Solids**	**Total Hg (ng/g dw)**	**Total MeHg (ng/g dw)**	**Total Hg (ng/g dw)**	**Total MeHg (ng/g dw)**
SITE-10	N-1	62.8577	-148.2133	NA	Clayey Silt	7.00	6.5	13.5	27.14	97.4	1.67	67.1	<3.47
SITE-10	N-2	62.8574	-148.2131	NA	Clayey silt	5.50	7.5	13.0	27.85	69.6	0.539	67.7	<3.43
SITE-10	N-3	62.8572	-148.2134	NA	Clayey silt	4.50	6.8	11.3	29.75	84.5	0.843	76.3	<3.08
SITE-10	N-4	62.8576	-148.2129	NA	Clayey silt	4.50	6.5	11.0	25.24	81.7	0.321	75.5	<3.83
SITE-10	N-5	62.8571	-148.2136	NA	Clayey silt	2.5	1.5	4.0	23.98	55.0	0.689	53.3	<4.14

NA = not applicable - site is inside inundation zone, but equidistant from more than one part of the river.
PRM = project river mile
cm = centimeter
ng/g dw = nanograms per gram dry weight

Table 5.4-1 Surface Water Results Baseline Water Quality

Location	PRM	Month	N	Min Total Hg (ng/L)	Max Total Hg (ng/L)	Mean Total Hg (ng/L)	Min Dissolved Hg (ng/L)	Max Dissolved Hg (ng/L)	Mean Dissolved Hg (ng/L)
Susitna Station	29.9	June 2013	6	22.6	29.1	25.9	<0.5	0.642	<0.5
		July 2013	6	27.4	32.1	29.1	All samples <0.5		
		August 2013	6	15.9	26.5	21.4	All samples <0.5		
		September 2013	6	6.90	16.3	12.7	0.799	1.48	0.989
		January 2014	1	2.26	2.26	2.26	1.19	1.19	1.19
		March 2014	2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
		June 2014	1	18.7	18.7	18.7	NA	NA	NA
		July 2014	1	14.1	14.1	14.1	NA	NA	NA
		August 2014	1	25.1	25.1	25.1	NA	NA	NA
		September 2014	1	6.09	6.09	6.09	NA	NA	NA
Yentna River	32.5	June 2013	4	30.6	27.2	28.7	0.523	0.874	0.729
		July 2013	6	27.1	33.6	29.4	<0.5	0.680	<0.5
		August 2013	6	14.4	21.5	17.8	All samples <0.5		
		September 2013	6	14.0	19.2	15.3	0.581	0.809	0.683
		June 2014	1	13.6	13.6	13.6	NA	NA	NA
		July 2014	1	8.43	8.43	8.43	NA	NA	NA
		August 2014	1	31.4	31.4	31.4	NA	NA	NA
		September 2014	1	10.6	10.6	10.6	NA	NA	NA
Susitna above Yentna	33.6	June 2013	6	37.5	44.9	41.5	0.712	1.23	0.866
		July 2013	6	56.3	66.6	60.7	0.653	0.743	0.696
		August 2013	6	25.3	33.7	29.3	<0.5	1.59	0.517
		September 2013	6	9.82	60.5	19.7	<0.5	0.720	0.513
		June 2014	1	8.37	8.37	8.37	NA	NA	NA
		July 2014	1	13.6	13.6	13.6	NA	NA	NA
		August 2014	1	13.4	13.4	13.4	NA	NA	NA
		September 2014	1	3.18	3.18	3.18	NA	NA	NA
Deshka River	45.1	June 2013	6	1.00	1.64	1.22	0.713	0.838	0.810
		July 2013	5	1.11	1.54	1.25	1.00	1.34	1.25
		August 2013	5	0.923	1.31	1.13	0.650	1.31	0.783
		September 2013	5	3.75	4.17	3.98	2.91	3.36	3.14
		June 2014	1	1.09	1.09	1.09	NA	NA	NA

Location	PRM	Month	N	Min Total Hg (ng/L)	Max Total Hg (ng/L)	Mean Total Hg (ng/L)	Min Dissolved Hg (ng/L)	Max Dissolved Hg (ng/L)	Mean Dissolved Hg (ng/L)
		July 2014	1	1.26	1.26	1.26	NA	NA	NA
		August 2014	1	0.58	0.58	0.58	NA	NA	NA
		September 2014	1	0.99	0.99	0.99	NA	NA	NA
Susitna	59.9	June 2013	5	51.7	58.7	55.8	<0.5	0.892	0.632
		July 2013	5	28.0	34.3	30.8	<0.5	0.674	<0.5
		August 2013	5	24.8	28.7	27.6	<0.5	2.15	0.630
		September 2013	5	6.48	7.55	6.88	All samples <0.5		
		June 2014	1	10.4	10.4	10.4	NA	NA	NA
		July 2014	1	10.8	10.8	10.8	NA	NA	NA
		August 2014	1	13.3	13.3	13.3	NA	NA	NA
		September 2014	1	2.75	2.75	2.75	NA	NA	NA
Susitna at Parks Highway East	87.8	June 2013	5	51.0	80.1	66.8	<0.5	0.815	0.5
		July 2013	5	33.4	60.2	39.9	<0.5	0.558	<0.5
		August 2013	5	26.5	32.4	29.3	<0.5	1.54	0.618
		September 2013	6	12.3	22.4	18.4	0.599	0.762	0.700
		January 2014	1	1.18	1.18	1.18	0.636	0.636	0.636
		March 2014	1	All samples <0.5			All samples <0.5		
		June 2014	1	21.1	21.1	21.1	NA	NA	NA
		July 2014	1	5.8	5.8	5.8	NA	NA	NA
		August 2014	1	14.8	14.8	14.8	NA	NA	NA
		September 2014	1	3.49	3.49	3.49	NA	NA	NA
Talkeetna River	102.8	June 2013	4	40.6	67.3	51.1	1.07	1.15	1.12
		July 2013	3	NS	NS	NS	0.912	2.54	1.48
		August 2013	3	57.4	78.3	67.9	0.509	0.855	0.709
		September 2013	4	4.3	28.4	13.0	0.768	1.06	0.880
		June 2014	1	2.64	2.64	2.64	NA	NA	NA
		July 2014	1	18.5	18.5	18.5	NA	NA	NA
		August 2014	1	23.0	23.0	23.0	NA	NA	NA
		September 2014	1	2.66	2.66	2.66	NA	NA	NA
		June 2013	6	13.2	17.9	14.8	<0.5	1.21	0.640

Location	PRM	Month	N	Min Total Hg (ng/L)	Max Total Hg (ng/L)	Mean Total Hg (ng/L)	Min Dissolved Hg (ng/L)	Max Dissolved Hg (ng/L)	Mean Dissolved Hg (ng/L)
Talkeetna	107.0	July 2013	5	12.2	13.1	12.8	<0.5	0.819	<0.5
		August 2013	5	18.3	25.3	19.2	<0.5	1.11	0.511
		September 2013	6	11.0	14.7	12.9	<0.5	0.668	0.524
		June 2014	1	2.39	2.39	2.39	NA	NA	NA
		July 2014	1	3.65	3.65	3.65	NA	NA	NA
		August 2014	1	2.36	2.36	2.36	NA	NA	NA
		September 2014	1	1.02	1.02	1.02	NA	NA	NA
Chulitna River	118.6	June 2013	6	38.8	54.5	47.1	0.563	0.874	0.660
		July 2013	6	35.3	52.4	41.0	<0.5	1.57	0.549
		August 2013	6	32.4	45.3	38.3	<0.5	3.54	0.798
		September 2013	6	19.1	39.1	29.7	0.632	0.898	0.779
		June 2014	1	24.6	24.6	24.6	NA	NA	NA
		July 2014	1	23.2	23.2	23.2	NA	NA	NA
		August 2014	1	27.1	27.1	27.1	NA	NA	NA
		September 2014	1	4.95	4.95	4.95	NA	NA	NA
Curry Fishwheel Camp	124.2	June 2013	6	11.1	15.8	12.9	<0.5	0.612	<0.5
		July 2013	6	12.7	16.0	14.2	<0.5	2.28	1.39
		August 2013	6	15.2	18.5	17.1	<0.5	0.521	<0.5
		September 2013	6	4.84	6.04	5.25	<0.5	0.669	<0.5
		June 2014	1	3.41	3.41	3.41	NA	NA	NA
		July 2014	1	4.98	4.98	4.98	NA	NA	NA
		August 2014	1	2.81	2.81	2.81	NA	NA	NA
		September 2014	1	1.09	1.09	1.09	NA	NA	NA
Gold Creek	140.1	June 2013	6	14.3	21.1	18.1	<0.5	0.631	<0.5
		July 2013	5	10.5	12.3	11.2	0.501	0.815	0.576
		August 2013	6	15.3	16.7	16.0	<0.5	0.664	<0.5
		September 2013	5	3.41	8.54	5.30	<0.5	0.637	<0.5
		January 2014	3	0.57	1.04	0.763	<0.5	0.524	<0.5
		March 2014	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Location	PRM	Month	N	Min Total Hg (ng/L)	Max Total Hg (ng/L)	Mean Total Hg (ng/L)	Min Dissolved Hg (ng/L)	Max Dissolved Hg (ng/L)	Mean Dissolved Hg (ng/L)
		June 2014	1	3.72	3.72	3.72	NA	NA	NA
		July 2014	1	5.08	5.08	5.08	NA	NA	NA
		August 2014	1	2.36	2.36	2.36	NA	NA	NA
		September 2014	1	1.53	1.53	1.53	NA	NA	NA
Indian River	142.2	June 2013	6	15.8	25.0	20.8	<0.5	0.658	0.536
		July 2013	6	9.09	10.9	10.2	<0.5	0.704	<0.5
		August 2013	5	17.9	21.3	19.8	<0.5	0.949	<0.5
		September 2013	6	3.34	9.75	5.52	0.513	4.02	1.16
		June 2014	1	3.78	3.78	3.78	NA	NA	NA
		July 2014	1	9.69	9.69	9.69	NA	NA	NA
		August 2014	1	2.07	2.07	2.07	NA	NA	NA
		September 2014	1	1.69	1.69	1.69	NA	NA	NA
Susitna above Indian River	142.3	June 2013	5	11.9	15.6	13.4	<0.5	0.683	0.538
		July 2013	4	7.74	8.74	8.15	<0.5	1.01	0.511
		August 2013	5	19.0	23.1	20.7	<0.5	0.851	0.602
		September 2013	6	3.22	5.37	4.06	0.521	0.699	0.594
		June 2014	1	3.31	3.31	3.31	NA	NA	NA
		July 2014	1	4.50	4.50	4.50	NA	NA	NA
		August 2014	1	3.44	3.44	3.44	NA	NA	NA
		September 2014	1	1.92	1.92	1.92	NA	NA	NA
Portage Creek	152.3	July 2013	6	17.8	23.0	20.5	All samples <0.5		
		August 2013	6	3.69	30.6	19.7	<0.5	0.583	<0.5
		September 2013	6	1.75	4.84	3.68	0.723	2.20	1.29
		June 2014	1	3.86	3.86	3.86	NA	NA	NA
		July 2014	1	3.74	3.74	3.74	NA	NA	NA
		August 2014	1	1.76	1.76	1.76	NA	NA	NA
		September 2014	1	1.77	1.77	1.77	NA	NA	NA
Susitna above Portage	152.7	July 2013	6	19.6	22.9	21.9	All samples <0.5		
		August 2013	6	23.2	25.8	24.4	<0.5	0.672	<0.5

Location	PRM	Month	N	Min Total Hg (ng/L)	Max Total Hg (ng/L)	Mean Total Hg (ng/L)	Min Dissolved Hg (ng/L)	Max Dissolved Hg (ng/L)	Mean Dissolved Hg (ng/L)
		September 2013	6	4.23	5.50	4.88	0.801	0.958	0.871
		June 2014	1	5.20	5.20	5.20	NA	NA	NA
		July 2014	1	6.39	6.39	6.39	NA	NA	NA
		August 2014	1	3.32	3.32	3.32	NA	NA	NA
		September 2014	1	2.94	2.94	2.94	NA	NA	NA
Susitna	174.0	August 2014	2	2.32	10.0	6.16	All samples <0.5		
		September 2014	1	2.99	2.99	2.99	1.70	1.70	1.70
Susitna at Watana Dam	187.2	June 2013	1	22.0	22.0	22.0	All samples <0.5		
		July 2013	1	12.6	12.6	12.6	0.722	0.722	0.722
		August 2013	2	11.3	12.6	11.7	<0.5	1.17	0.629
		September 2013	1	3.31	3.31	3.31	1.46	1.46	1.46
	185.0[1]	January 2014	1	0.784	0.784	0.784	All samples <0.5		
		March 2014	1	0.536	0.536	0.536	All samples <0.5		
	187.2	June 2014	1	3.40	3.40	3.40	NA	NA	NA
		July 2014	1	3.53	3.53	3.53	NA	NA	NA
		August 2014	1	2.81	2.81	2.81	NA	NA	NA
		September 2014	1	0.83	0.83	0.83	NA	NA	NA
Oshetna River	235.2	June 2013	1	22.2	22.2	22.2	0.762	0.762	0.762
		July 2013	1	15.6	15.6	15.6	0.971	0.971	0.971
		August 2013	1	3.43	3.43	3.43	<0.5	<0.5	<0.5
		September 2013	1	3.15	3.15	3.15	1.57	1.57	1.57
	225.0[1]	January 2014	1	0.705	0.705	0.705	0.525	0.525	0.525
		March 2014	1	All samples <0.5			All samples <0.5		
	235.2	June 2014	1	2.94	2.94	2.94	NA	NA	NA
		July 2014	1	3.16	3.16	3.16	NA	NA	NA
		August 2014	1	0.99	0.99	0.99	NA	NA	NA
		September 2014	1	3.09	3.09	3.09	NA	NA	NA

[1] alternate winter sample location based on limited site access

Table 5.4-2. Surface Water Results Focus Areas

Location	PRM	Month	N	Min Total Hg (ng/L)	Max Total Hg (ng/L)	Mean Total Hg (ng/L)	Min Dissolved MeHg (ng/L)	Max Dissolved MeHg (ng/L)	Mean Dissolved MeHg (ng/L)
Whiskers Slough	104	July 28, 2013	14	11.3	14.5	12.2	<0.020	<0.020	<0.020
		August 11 2013	14	5.8	19.4	10.1	<0.020	<0.020	<0.020
		August 30, 2013	14	13.4	24.7	17.9	<0.020	0.08	<0.020
		July 24, 2014	6	1.94	4.05	2.86	NS	NS	NS
		September 17, 2014	6	3.88	5.03	4.51	NS	NS	NS
Oxbow 1	113	July 27, 2013	8	11.5	13.9	12.5	<0.020	<0.020	<0.020
		August 10, 2013	8	8.76	14.9	12.4	<0.020	<0.020	<0.020
		August 20, 2013	8	18.2	23.0	20.2	<0.020	<0.020	<0.020
		July 17, 2014	3	3.69	4.21	3.96	NS	NS	NS
		September 16, 2014	3	<0.10	<0.10	<0.10	NS	NS	NS
Lane Creek	115	July 26, 2013	14	11.4	20.8	13.5	<0.020	0.025	<0.020
		August 9, 2013	14	11.9	14.4	12.7	<0.020	<0.020	<0.020
		August 24, 2013	14	7.07	14.9	9.5	<0.020	<0.020	<0.020
		July 17, 2014	6	3.63	4.63	4.21	NS	NS	NS
		September 6, 2014	6	3.06	3.38	3.21	NS	NS	NS
Skull Creek Complex	128	July 25, 2013	11	11.1	15.0	12.3	<0.020	<0.020	<0.020
		August 8, 2013	11	8.49	12.0	10.1	<0.020	<0.020	<0.020
		August 25, 2013	11	6.54	11.4	7.90	<0.020	<0.020	<0.020
		July 17, 2014	5	4.19	5.31	4.85	NS	NS	NS
		September 16, 2014	5	0.89	1.22	1.02	NS	NS	NS
Gold Creek	138	July 24, 2013	6	10.5	14.8	12.4	<0.020	<0.020	<0.020
		August 7, 2013	6	9.83	10.5	10.2	<0.020	<0.020	<0.020
		August 23, 2013	6	4.92	5.60	5.30	<0.020	<0.020	<0.020
		July 16, 2014	2	3.6	15.3	9.45	NS	NS	NS
		September 14, 2014	2	0.83	1.43	1.13	NS	NS	NS
Indian River	141	July 23, 2013	9	10.9	13.4	12.3	<0.020	<0.020	<0.020
		August 6, 2013	9	9.33	12.9	11.4	<0.020	<0.020	<0.020
		August 22, 2013	9	25.5	84.3	47.2	<0.020	<0.020	<0.020
		July 15, 2014	3	7.05	9.87	8.13	NS	NS	NS
		September 10, 2014	3	1.23	1.35	1.28	NS	NS	NS

Location	PRM	Month	N	Min Total Hg (ng/L)	Max Total Hg (ng/L)	Mean Total Hg (ng/L)	Min Dissolved MeHg (ng/L)	Max Dissolved MeHg (ng/L)	Mean Dissolved MeHg (ng/L)
Side Channel 21	144	July 22, 2013	10	13.8	25.5	16.3	<0.020	<0.020	<0.020
		August 5, 2013	10	13.9	15.7	14.6	<0.020	<0.020	<0.020
		August 21, 2013	10	15.3	47.2	26.2	<0.020	0.085	<0.020
		July 15, 2014	3	6.72	8.46	7.51	NS	NS	NS
		September 10, 2014	3	0.95	1.21	1.04	NS	NS	NS

PRM = project river mile
N = number of samples
Hg = mercury
MeHg = methylmercury
ng/L = nanograms per liter
< = detection limit
Max = maximum
Min = minimum
NS = not sampled

Table 5.5-1. Sediment and Porewater Results

Location	Latitude	Longitude	PRM	% solids	Total Hg Sediment (ng/g dw)	TOC Sediment (% dry)	Total Hg Porewater (ng/L)	TOC Porewater (mg/L)
Fog Creek	62.77542	-148.71762	179.3	78.1	14.1	<0.05	0.58	1.87
	62.77553	-148.71740	179.3	80.7	8.59	<0.05	0.54	1.60
	62.77583	-148.71697	179.3	82.1	11.8	<0.05	0.55	1.54
Tsusena Creek	62.82242	-148.61498	184.6	79.9	1.71	<0.05	0.82	0.777
	62.82315	-148.61578	184.6	79.8	1.75	<0.05	<0.51	0.726
	62.82335	-148.61630	184.6	77.9	4.32	0.092	4.49	0.713
Below Dam Site	62.82177	-148.57805	187.1	78.3	5.34	0.141	<0.51	1.7
	62.82193	-148.57743	187.1	81.1	5.60	0.188	4.99	8.37
	62.82220	-148.57653	187.1	82.3	5.16	0.138	0.73	1.23
Above Dam Site	62.82300	-148.53540	187.3	80.9	17.4	0.072	0.70	3.68
	62.82320	-148.53567	187.3	80.0	4.10	0.094	0.99	5.93
	62.82317	-148.53640	187.3	80.1	3.73	0.084	1.90	4.54
Deadman Creek	62.82942	-148.47590	189.3	82.6	1.00	<0.05	0.66	1.36
	62.82942	-148.47643	189.3	82.0	1.31	<0.05	<0.51	1.37
	62.82930	-148.47867	189.3	84.3	1.08	<0.05	0.65	1.14
Watana Creek	62.82923	-148.25803	196.8	80.6	6.86	<0.05	0.63	1.70
	62.82943	-148.25895	196.8	77.4	8.49	0.053	<0.51	2.04
	62.82953	-148.25927	196.8	80.1	12.1	0.364	<0.51	1.64
Kosina Creek	62.78349	-147.94318	209.1	70.9	13.6	0.215	<0.50	1.92
	62.78342	-147.94299	209.1	78.3	2.09	0.058	0.529	1.73
	62.78288	-147.94221	209.1	82.8	1.82	0.027	0.814	2.38
Jay Creek	62.77716	-147.88979	211.0	77.5	7.10	0.156	0.527	1.92
	62.77729	-147.88992	211.0	75.6	10.1	0.145	0.607	1.73
	62.77743	-147.89046	211.0	75.6	14.7	0.145	<0.5	2.38
Goose Creek	62.64403	-147.43614	232.6	72.1	12.2	0.785	1.17	4.53
	62.64426	-147.43553	232.6	74.3	8.56	0.144	1.32	4.44
	62.64451	-147.43544	232.6	79.4	5.62	0.158	0.886	9.18
Oshetna River	62.63880	-147.38757	235.2	80.5	6.75	0.057	8.69	26.5
	62.63852	-147.38806	235.2	85.8	6.59	0.024	9.54	24.9
	62.63992	-147.38428	235.2	85.7	5.21	0.046	12.5	1.82

PRM = project river mile. ng/g = nanograms per gram. ng/L = nanograms per liter. mg/L = milligrams per liter. Hg = mercury. TOC = Total organic carbon. dw = dry weight

Table 5.5-2. Sediment and Porewater Results

Location	Latitude	Longitude	PRM	Soil Type	Sieve Results (% passing)						
					#4	#10	#20	#40	#60	#100	#200
Fog Creek	62.77542	-148.71762	179.3	SP	100	100	100	97	61	8	0.8
	62.77553	-148.71740	179.3	SP	99	88	53	20	6	1	0.6
	62.77583	-148.71697	179.3	SP	96	82	46	7	1	0	0.1
Tsusena Creek	62.82242	-148.61498	184.6	SP	85	73	38	8	2	1	0.8
	62.82315	-148.61578	184.6	SP	93	92	70	22	6	2	0.5
	62.82335	-148.61630	184.6	SM	100	100	95	82	44	29	15.3
Below Dam Site	62.82177	-148.57805	187.1	SP	100	100	99	71	37	10	0.5
	62.82193	-148.57743	187.1	SP	100	100	95	65	33	16	2.3
	62.82220	-148.57653	187.1	SP	99	96	88	70	45	21	3.1
Above Dam Site	62.82300	-148.53540	187.3	SP	98	98	91	36	8	3	2.7
	62.82320	-148.53567	187.3	SP-SM	100	100	100	98	74	28	6.3
	62.82317	-148.53640	187.3	SP	100	100	100	96	66	13	1.4
Deadman Creek	62.82942	-148.47590	189.3	SP	100	99	59	11	2	0	0.2
	62.82942	-148.47643	189.3	SP	99	97	78	36	10	2	0.7
	62.82930	-148.47867	189.3	SP	84	82	69	26	8	3	1.0
Watana Creek	62.82923	-148.25803	196.8	GP	44	36	27	16	7	3	1.2
	62.82943	-148.25895	196.8	SP	100	99	95	80	32	7	1.6
	62.82953	-148.25927	196.8	ML	96	95	93	89	83	71	50.5
Kosina Creek	62.78349	-147.94318	209.1	SP-SM	81	77	68	48	30	17	5.2
	62.78342	-147.94299	209.1	SP	87	76	48	19	9	6	3.1
	62.78288	-147.94221	209.1	SP	66	45	24	12	7	2	0.6
Jay Creek	62.77716	-147.88979	211.0	SM	88	83	78	76	71	55	21.2
	62.77729	-147.88992	211.0	SM	99	94	88	80	70	58	28.9
	62.77743	-147.89046	211.0	SM	100	100	99	97	95	78	25.7
Goose Creek	62.64403	-147.43614	232.6	SM	92	91	68	71	57	37	16.9
	62.64426	-147.43553	232.6	SM	78	73	68	66	64	52	26.5
	62.64451	-147.43544	232.6	SP-SM	96	95	81	45	25	15	6.0
Oshetna River	62.63880	-147.38757	235.2	SP	63	46	34	27	14	6	2.8
	62.63852	-147.38806	235.2	SW	62	35	23	15	6	2	1.4
	62.63992	-147.38428	235.2	GP	40	27	15	8	4	2	1.2

PRM = project river mile.

Table 5.6-1 Results for Mammal Samples

Mammal	% Solids	Total Hg (ng/g dw)	Total Hg (ng/g ww)
Mink Fur 1	28.22	7,670	2,170
Mink Fur 2	47.23	6,530	2,970
Otter Fur 1	24.48	6,330	1,610
Otter Fur 2 (4 strands)	28.84	NA	417

NA = not analyzed
ng/g = nanograms per gram
dw = dry weight
ww = wet weight
Hg = mercury

Table 5.7-1. Lake Trout Analytical Results

Drainage	Latitude	Longitude	PRM	Sample Date	Fish Fork Length (mm)	Fish Weight (g)	Estimated Age (yr.)	% Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Sally Lake	62.8381	-148.1907	194.1	8/5/2012	510	1806	14	22.08	912	201	1000	222
					430	1082	8	28.66	633	181	631	181
Deadman Lake	63.0076	-148.2364	NA	09/20/13	625	2200	26	21.83	2920	637	2860	624
					450	1000	9	25.94	609	158	603	156
					460	1000	9	27.29	633	173	548	149
					590	1600	22	20.12	2140	431	2140	430
					455	800	9	22.63	747	169	907	205
					355	1300	6	22.39	612	137	645	145
					380	500	7	22.91	592	136	563	129

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram. ww= wet weight. dw = dry weight.

Table 5.7-2. LNS Analytical Results

Drainage	Latitude	Longitude	PRM	Sample Date	Fish Length (mm)	Fish Weight (g)	Estimated Age (yr.)	% Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Oshetna River	62.639	-147.382	235.2	8/13/2013	350	500	9	23.50	295	67.9	313	72.1
					430	380	>10	24.15	471	114	420	101
					340	370	8	18.00	579	104	546	98.3
					315	350	7	22.43	188	42.2	167	37.5
				8/14/2013	350	355	9	21.48	640	138	644	138
Upper Susitna	62.834	-148.301	195.5	8/9/2013	320	303	7	22.65	161	36.4	152	34.4
Upper Susitna	62.754	-147.720	217.1	9/12/2013	330	371	8	21.63	153	33.1	137	29.7

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram, ww= wet weight. dw = dry weight

Table 5.7-3. Dolly Varden Analytical Results

Drainage	Latitude	Longitude	Sample Date	Fish Length (mm)	Fish Weight (g)	Estimated Age (yr.)	% Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Upper Watana Creek	62.9107	-147.9714	9/18/2013	187	55	4	23.59	88.3	20.8	82.3	19.0
				204	70	4	20.78	120	24.9	107	22.3
		-147.8966	10/3/2013	195	64	4	23.33	359	83.7	360	83.9
		-147.9349	10/3/2013	194	68	3	24.35	255	62.0	214	52.2
				186	57	4	21.94	218	47.9	222	48.6
				196	69	4	27.18	172	46.7	139	37.8

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram; ww = wet weight; dw = dry weight

Table 5.7-4. Arctic Grayling Analytical Results

Drainage	Latitude	Longitude	PRM	Sample Date	Fish Length (mm)	Fish Weight (g)	Est. Age (yr.)	% Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Watana Creek	62.9034	-148.1185	194.1	8/11/2012	248	148	4	24.72	78.1	19.3	102	25.1
	62.9034	-148.1185	194.1	8/11/2012	340	385	8	26.54	143	38.1	117	31.0
Kosina Creek	62.8921	-148.1365	209.2	6/25/2013	160	102	2	19.76	126	24.9	101	19.9
	62.8921	-148.1365	209.2	6/25/2013	225	233	3	21.45	142	30.5	107	22.9
	62.8921	-148.1365	209.2	6/25/2013	155	84	1.5	21.38	97.0	20.7	79.6	17.0
	62.8921	-148.1365	209.2	6/25/2013	185	125	2.5	19.34	142	27.4	113	21.8
	62.8921	-148.1365	209.2	6/25/2013	220	250	2.5	20.99	176	37.1	145	30.4
	62.8921	-148.1365	209.2	6/25/2013	180	119	2.5	23.22	125	29.0	86.4	20.1
	62.8921	-148.1365	209.2	6/25/2013	170	106	2	21.38	126	27.0	92.0	19.7
	62.8921	-148.1365	209.2	6/25/2013	215	221	3	22.68	215	48.8	158	35.8
	62.8921	-148.1365	209.2	6/25/2013	215	241	3	22.49	272	61.3	213	47.8
	62.8921	-148.1365	209.2	6/25/2013	235	269	4	20.62	185	38.1	159	32.9
	62.7827	-147.9417	209.2	8/4/2013	300	300	6	21.87	326	71.4	334	73.1
	62.7560	-147.9552	209.2	8/4/2013	330	320	8	20.67	421	87.1	395	81.7
	62.7560	-147.9552	209.2	8/4/2013	310	251	7	18.79	533	100	452	84.9
Oshetna River	62.6394	-147.3813	235.2	6/25/2013	75	12	0.5	20.98	180	37.7	139	29.2

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram; dw= dry weight; ww = wet weight.

Table 5.7-5. Burbot Muscle Tissue Analytical Results

Drainage	Latitude	Longitude	PRM	Sample Date	Fish Length (mm)	Fish Weight (g)	Est. Age (yr.)	% Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Upper Susitna	62.8308	-148.4666	186.8	8/5/2012	410	553	5	19.85	200	39.6	207	41.1
	62.8346	-148.3017	192.6	8/3/2012	410	553	5	18.56	297	54.7	321	59.5
	62.8246	-148.4226	195.3	8/9/2013	443	541	5	22.13	338	74.7	298	66.0
	62.8284	-148.3713	193.1	8/28/2013	454	503	5	19.26	311	59.9	239	46.1
	62.6966	-147.5645	224.3	8/16/2013	467	470	4	20.72	547	113	474	98.3
	62.7528	-147.7208	217.1	8/17/2013	390	362	3.5	20.78	324	67.3	242	50.2
	62.7608	-147.7938	214.7	10/4/2013	451	437	4	19.58	513	100	461	90.3
	62.7608	-147.7938	214.7	10/4/2013	417	312	3	18.84	498	93.8	423	79.7

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram; dw = dry weight; ww = wet weight

Table 5.7-6. Burbot Liver Analytical Results

Drainage	Latitude	Longitude	PRM	Sample Date	Fish Length (mm)	Fish Weight (g)	Est. Age (yr.)	% Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Upper Susitna	62.8246	-148.4226	195.3	8/9/2013	443	541	5	38.72	44.3	17.1	43.5	16.8
	62.8284	-148.3713	193.1	8/28/2013	454	503	5	46.39	31.6	14.7	31.1	14.4
	62.6966	-147.5645	224.3	8/16/2013	467	470	4	46.97	47.1	22.1	34.4	16.1
	62.7528	-147.7208	217.1	8/17/2013	390	362	3.5	30.88	106	32.6	94.0	29.0
	62.7608	-147.7938	214.7	10/4/2013	451	437	4	18.39	241	44.2	199	36.6
	62.7608	-147.7938	214.7	10/4/2013	417	312	3	17.91	200	35.9	170	30.5

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram; dw = dry weight; ww = wet weight

Table 5.7-7. Slimy Sculpin (Whole Body) Analytical Results

Drainage	Latitude	Longitude	PRM	Sample Date	Fish Length (mm)	Fish Weight (g)	% Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Upper Susitna	62.7302	-147.6672	219.5	9/12/2013	85	5	24.02	165	39.7	137	33.0
	62.7302	-147.6672	219.5	9/12/2013	86	5	22.01	387	85.1	248	54.5
	62.7302	-147.6672	219.5	9/12/2013	87	5.3	23.05	158	36.4	102	23.4
	62.8006	-148.1006	202.7	9/16/2013	100	6.6	23.81	159	37.9	220	52.3
	62.8006	-148.1006	202.7	9/16/2013	87	5.4	22.39	104	23.3	121	27.0
	62.8006	-148.1006	202.7	9/16/2013	92	6.9	22.71	125	28.3	117	26.5
	62.8330	-148.3018	195.5	9/18/2013	74	3.4	25.71	149	38.3	146	37.5

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram; dw = dry weight; ww = wet weight

Table 5.7-8. Whitefish (sp.) Analytical Results

Drainage	Latitude	Longitude	PRM	Sample Date	Fish Length (mm)	Fish Weight (g)	Est. Age (yr.)	% Total Solids	THg (ng/g dw)	THg (ng/g ww)	MeHg (ng/g dw)	MeHg (ng/g ww)
Watana Creek	62.861	-148.200	194.1	8/30/2013	278	155	4	25.54	150	38.3	136	34.8
Upper Susitna	62.826	-148.442	190.7	8/29/2013	309	258	6	24.94	177	44.2	175	43.6
	62.730	-147.668	219.5	8/16/2013	450	415	20	26.39	262	69.1	225	59.4
	62.775	-147.857	212.3	8/18/2013	372	495	10	30.68	332	102	258	79.3
	62.781	-147.922	209.9	8/18/2013	317	310	6	28.56	137	39.2	116	33.2
	62.645	-147.405	233.9	9/10/2013	140	256	1	23.40	350	81.8	279	65.4
	62.645	-147.405	233.9	9/10/2013	175	263	1.5	26.53	208	55.3	167	44.2
	62.645	-147.405	233.9	9/10/2013	342	365	8	27.98	171	47.9	131	36.6
	62.782	-148.049	205.1	9/16/2013	355	470	9	27.64	201	55.6	219	60.5
Kosina Creek	62.756	-147.996	209.2	8/14/2013	365[b]	340	10	23.97	379	90.8	269	64.5
Oshetna River	62.640	-147.383	235.2	8/13/2013	190[b]	57.1	1	23.95	76.5	18.3	126	30.2
	62.640	-147.383	235.2	8/13/2013	340[a]	370	8	31.74	273	86.6	281	89.2
	62.639	-147.381	235.2	6/26/2013	130	55	1	21.10	26.9	5.68	25.2	5.31

All fish are round whitefish with the exception of a (humpback whitefish) and b (whitefish species unknown).

PRM = project river mile; NA = not applicable; mm = millimeters; g = grams; yr. = year; THg = total mercury; MeHg = methylmercury, ng/g = nanograms per gram; dw = dry weight; ww = wet weight

Table 5.8-1. Predicted Peak MeHg Concentrations in Fish

Species	N	Predicted peak increase factor (relative increase)	Current Mean Total Hg in fish tissue (ng/g ww)	Predicted Peak Mean Total Hg in fish tissue (ng/g ww)
Lake Trout	9	4.25	247	1,047
Arctic Grayling	16	2.75	44	121
Dolly Varden	7	2.75	43	119
Slimy Sculpin	7	2.75	41	114
Round Whitefish	14	2.75	57	157
Burbot	6	4.25	68	289
Longnose Sucker	7	2.75	77	212

Calculation performed using formula from Harris and Hutchison (2008)
MeHg = methylmercury
N = sample number
Hg = mercury
ng/g ww = nanograms per gram wet weight

Table 5.8-2. Factors that Influence Potential Bioavailability of MeHg

Fate Processes Affecting Methylation of Mercury	Evaluating Potential for Bioavailability of Mercury under Existing Conditions	Likelihood of Increasing Methylation under Existing Conditions and Potential for Bioavailability		
		Low Risk	Moderate Risk	High Risk
Selenium (in sediment)	Presence of selenium in sediments reduce potential for toxic effects of mercury by complexing. Mercury selenide (HgSe) is formed and reduces toxic effects of mercury, when present. Selenium is present and in higher concentrations than mercury in sediment. Formation of HgSe is likely and will reduce potential for bioavailability.	X		
Dissolved Oxygen	Anaerobic conditions enhance microbial respiration that increases the rate of mercury methylation. Anaerobic conditions are characterized by low pH and low dissolved oxygen concentrations. Oxygen concentrations at the sediment/surface water interface are within water quality standards. The exception was at a single sample point on Oshetna River.	X		
pH	Mobilization of mercury from sediments tends to occur in the presence of surface water conditions with low pH. Adsorption of bioavailable mercury (dissolved) in the water column to organic particles is minimized under conditions with low pH. All pH readings at the surface water sediment interface were within water quality standards and unlikely have an effect on release of mercury from sediments.	X		
Temperature	Rate of microbial respiration may be enhanced with increased water temperature. Warmer water temperatures promote lower dissolved oxygen concentrations. Water temperatures at the sediment/surface water interface were consistently below the water quality standard at these Upper River sampling sites.	X		
Redox Potential	Redox potential is primarily a function of oxides or sulfides present in sediments which is, in turn, a function of the oxygen concentration in the overlying water (Chapman et al. 2003). Surface water redox potential near the sediment was high at all sample points. The potential for bioavailable mercury is low under existing conditions.	X		

Table 6.1-1 Mercury in Soil and Vegetation

Media	Hg (ng/g, dw) 39 year old stand	Hg (ng/g, dw) 133 year old stand	Hg (ng/g dw) 180 year old stand
Moss	94.5	108	90.6
Aspen leaves	NS	8	NS
Spruce needles	9.9	NS	NS
Aspen bark	NS	15.9	NS
Jack pine bark	38.6	NS	NS
Lichen	30.6	74	227.1
Leaf litter	68.3	NS	127.1
Aspen wood	NS	2.08	NS
White spruce wood	1.86	NS	NS
Organic soil	100-160	120 - 300	160-250
Mineral soil	9.2	8.8	25.2

Hg = mercury
ng/g dw = nanograms per gram dry weight
Information from Friedli et al. 2007

Table 6.5-1 Mercury SQuiRT Standards in Sediment

NOAA SQuiRT (ng/g)						Maximum concentration Observed on Site (ng/g)
Background	TEC	TEL	LEL	PEC	SEL	
4-51	189	174	200	1060	2000	17.4

from NOAA (2015).

TEL = Threshold Effects Level: A chemical concentration in some item (dose) that is ingested by an organism, above which some effect (or response) will be produced and below which it will not. This item is usually food, but can also be soil, sediment, or surface water that is incidentally (accidentally) ingested as well.

TEC = Threshold Effects Concentration: A concentration in media (surface water, sediment, soil) to which a plant or animal is exposed, above which some effect (or response) will be produced and below which it will not

LEL = Lowest Effect Level. The lowest level of a chemical stressor evaluated in a toxicity test that shows harmful effects on a plant or animal.

PEC = Probable Effects Concentration: The level of a concentration in the media to which a plant or animal is directly exposed that is likely to cause an adverse effect.

PEL= Probable Effects Level: A chemical concentration in some item (dose) prey that is ingested by an organism, which is likely to cause an adverse effect. The ingested item is usually food, but can be soil, sediment, or surface water that is incidentally (accidentally) ingested.

SEL = Severe Effect Level: is that at which pronounced disturbance of the sediment-dwelling community can be expected. This is the concentration that would be detrimental to the majority of the benthic community.

ng/g = nanograms per gram

Table 6.8.1. Comparison Between Predicted Peak MeHg Concentrations in Fish

Facility	Capacity (MW)	Area Flooded (km^2)	Area Total (km^2)	Mean Annual Flow (km^3/yr.)	Predicted piscivorous fish peak increase factor (times background)	Predicted non-piscivorous fish increase factor (times background)
Susitna-Watana	600	86.74	103.38	7.23	4.24	2.77
Bradley Lake	126	10.43	15.46	0.62	4.27	2.99
Solomon Gulch	12	2.08	2.49	0.11	4.81	3.39
Swan Lake	22.4	1.82	6.07	0.39	2.69	1.67
Terror Lake	20	2.99	4.13	0.22	4.18	2.82

MeHg = methylmercury
MW = megawatts
Km^2 = square kilometers
Km^3 = cubic kilometers

10. FIGURES

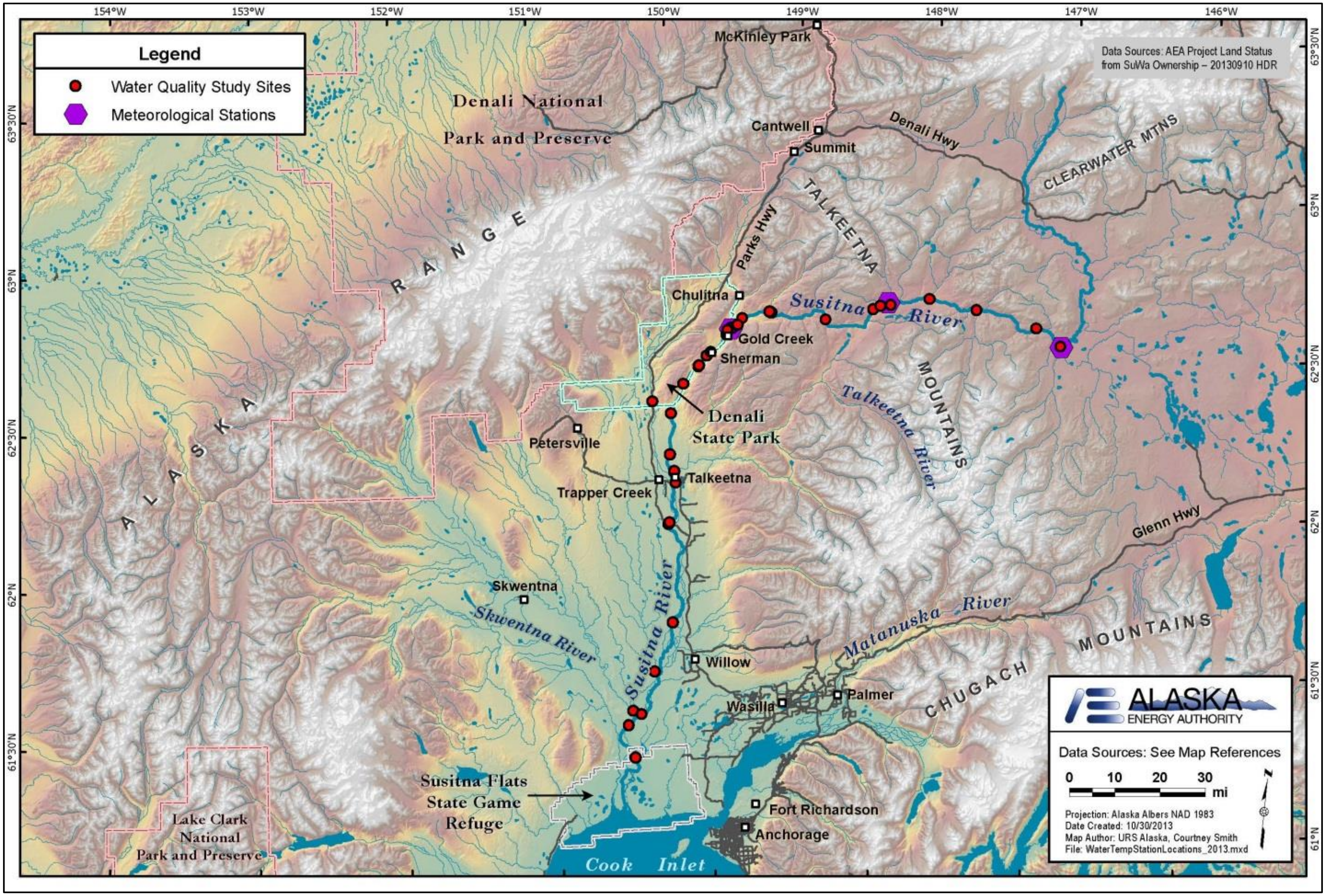


Figure 3.1. Water Quality Sample Locations

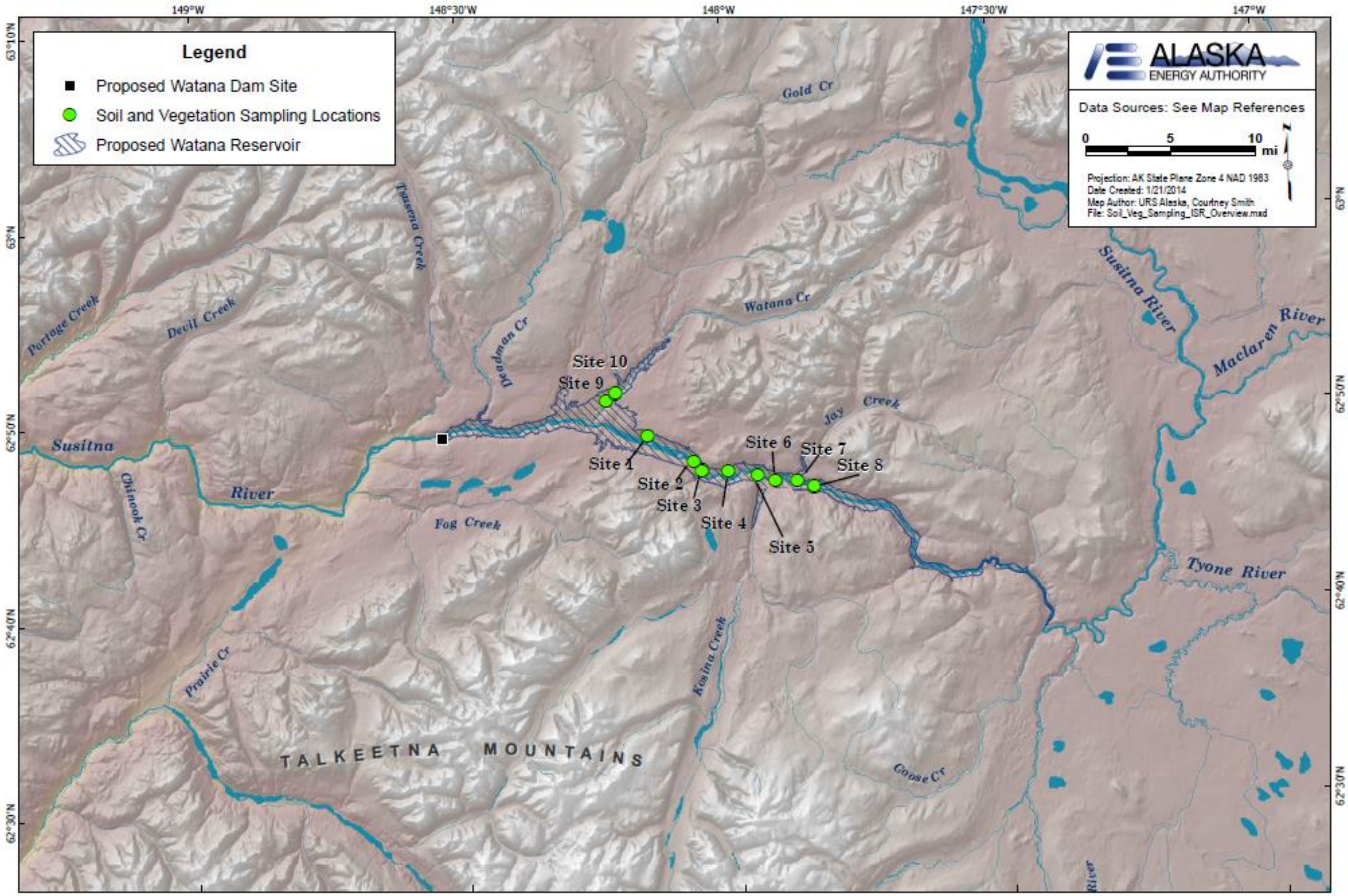


Figure 4.2-1. Vegetation and Soil Sampling Locations

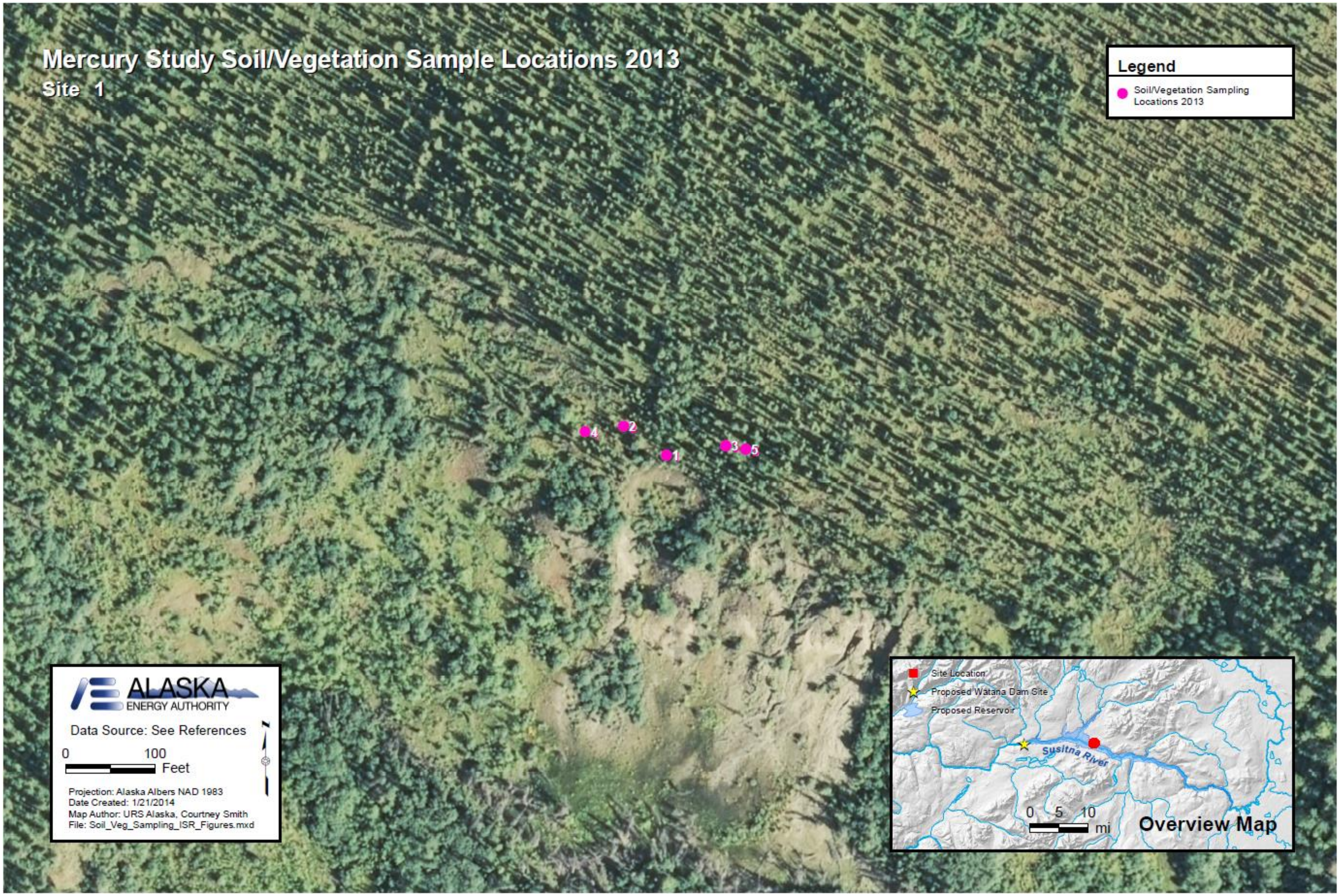


Figure 4.2-2. Vegetation and Soil Sample Location: Site 1

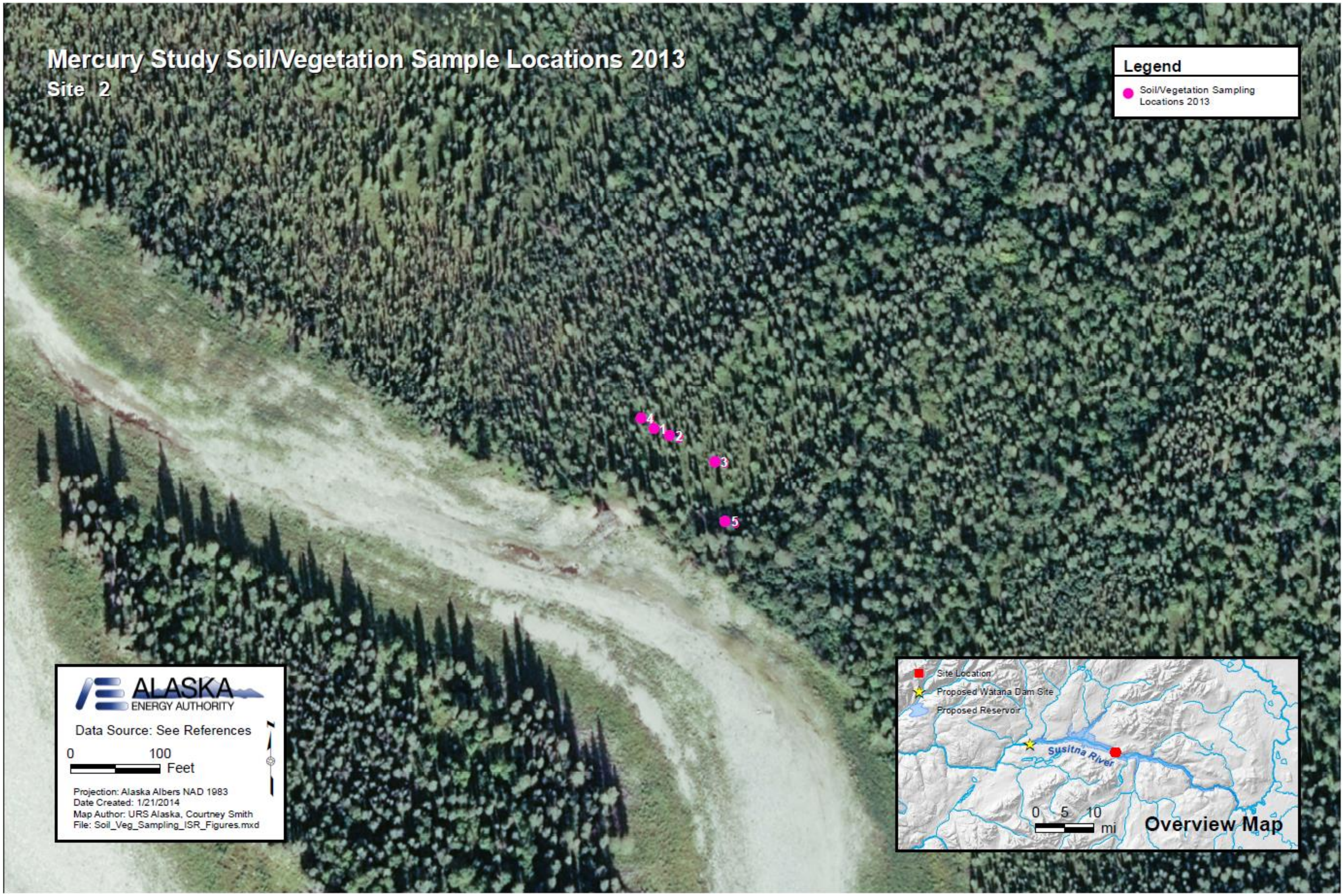


Figure 4.2-3. Vegetation and Soil Sample Location: Site 2

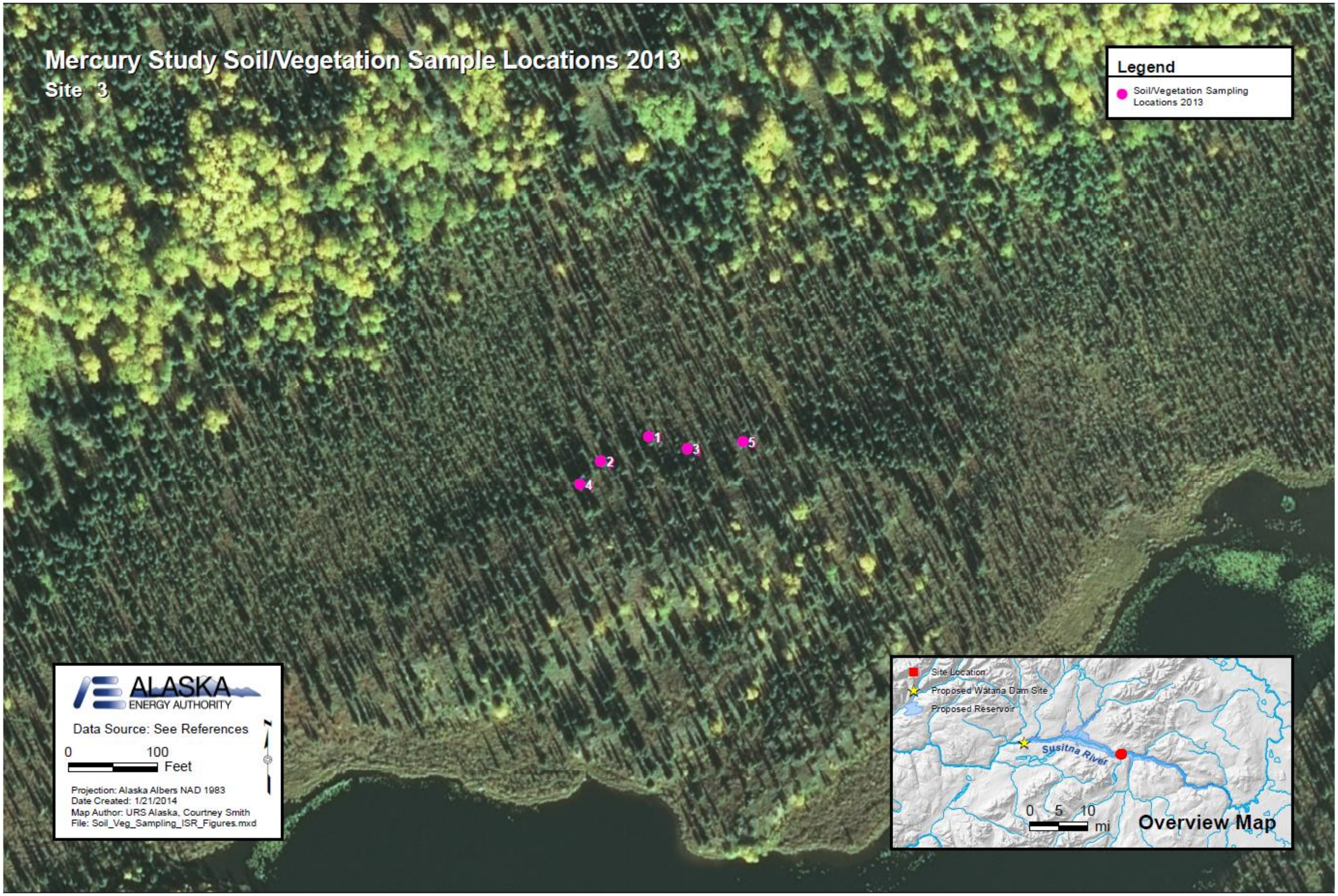


Figure 4.2-4. Vegetation and Soil Sample Location: Site 3

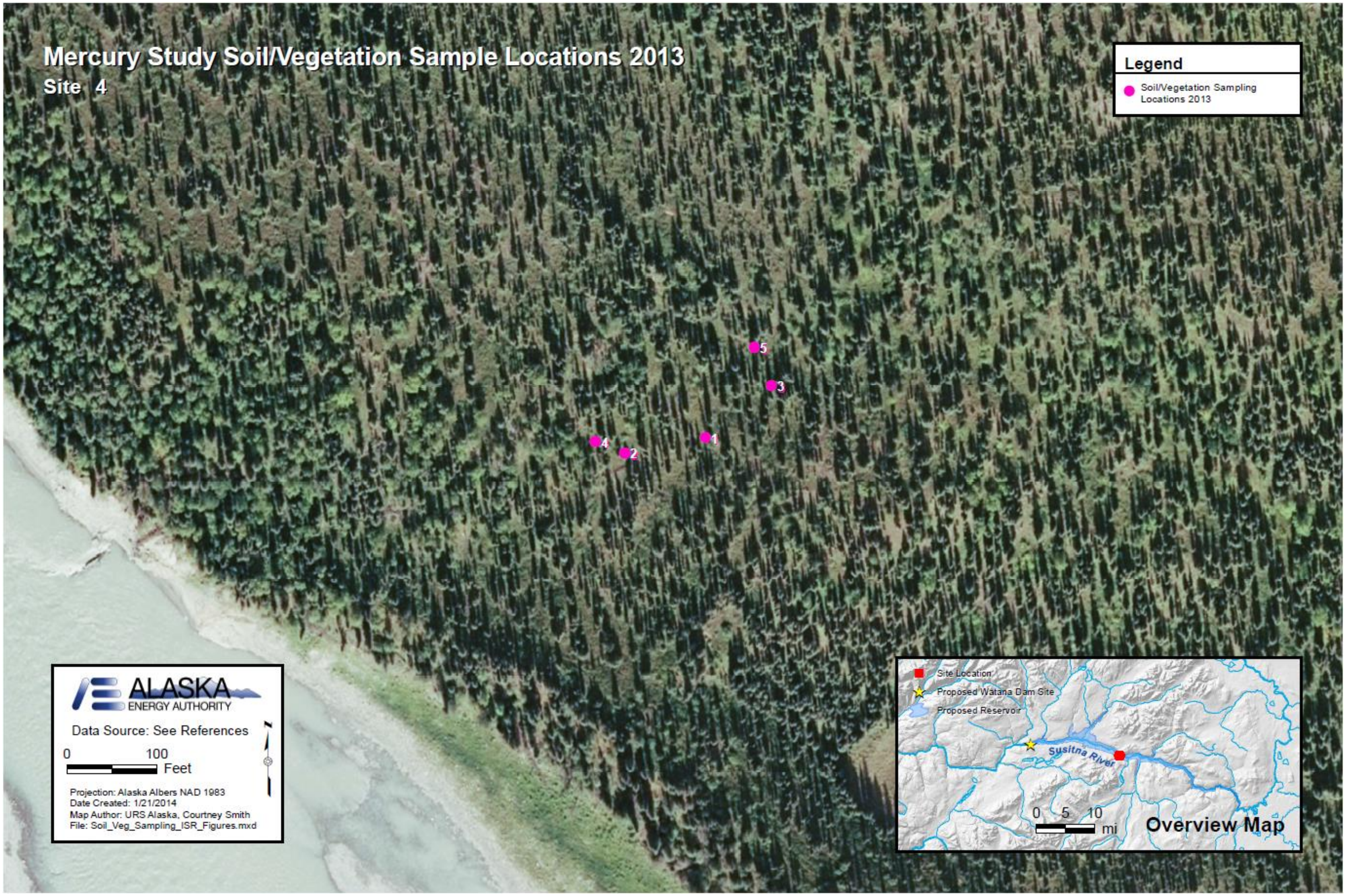


Figure 4.2-5. Vegetation and Soil Sample Location: Site 4

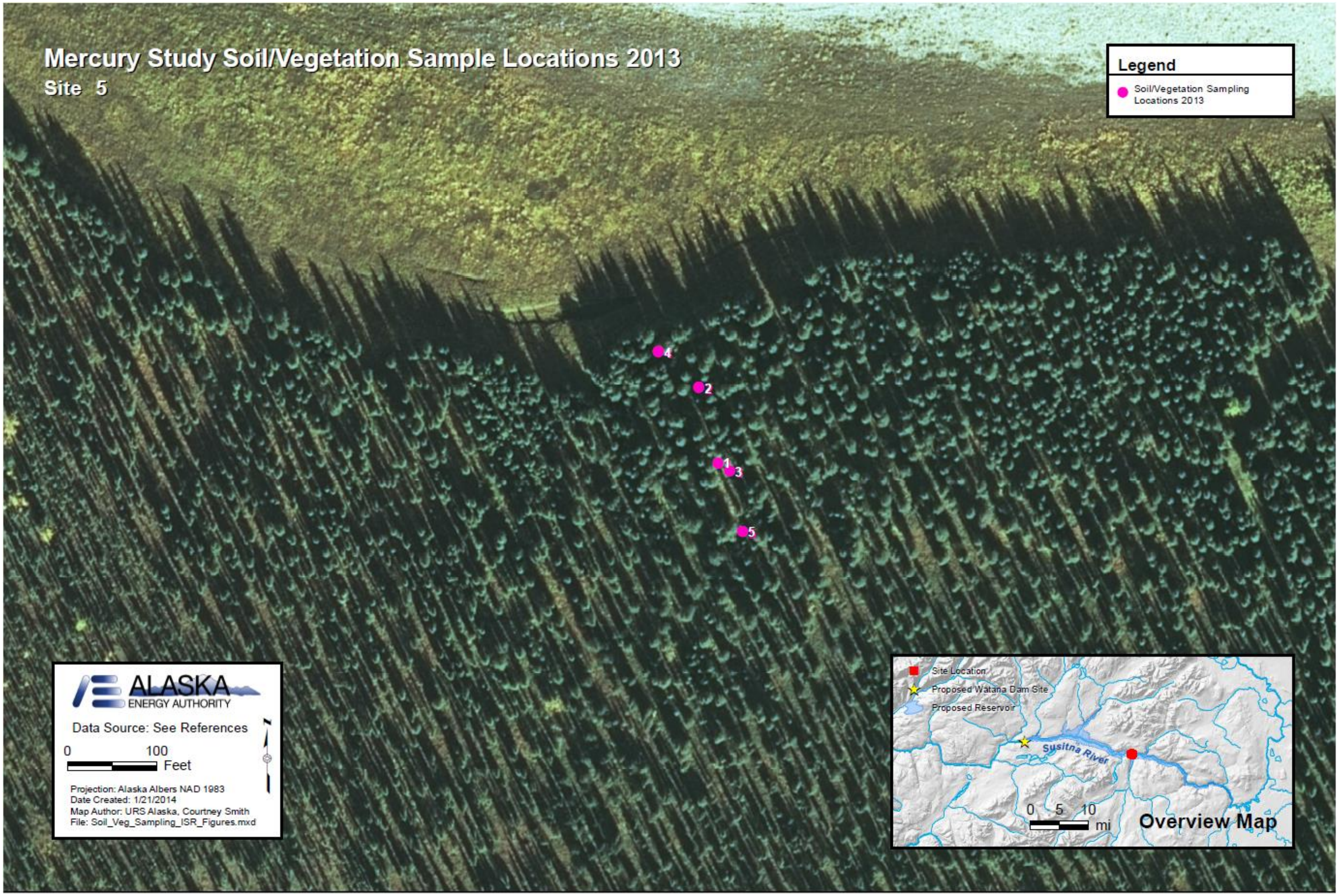


Figure 4.2-6. Vegetation and Soil Sample Location: Site 5

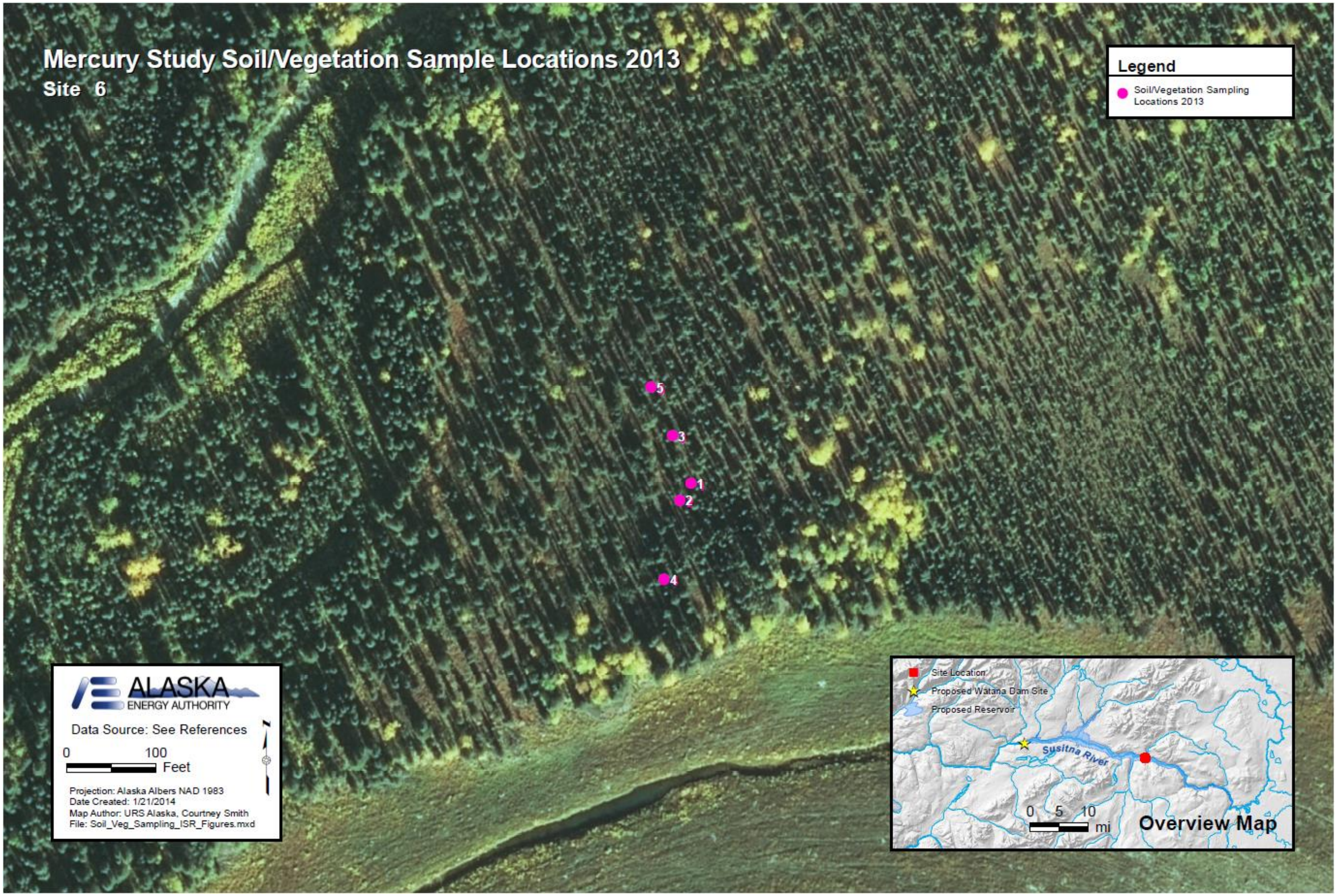


Figure 4.2-7. Vegetation and Soil Sample Location: Site 6

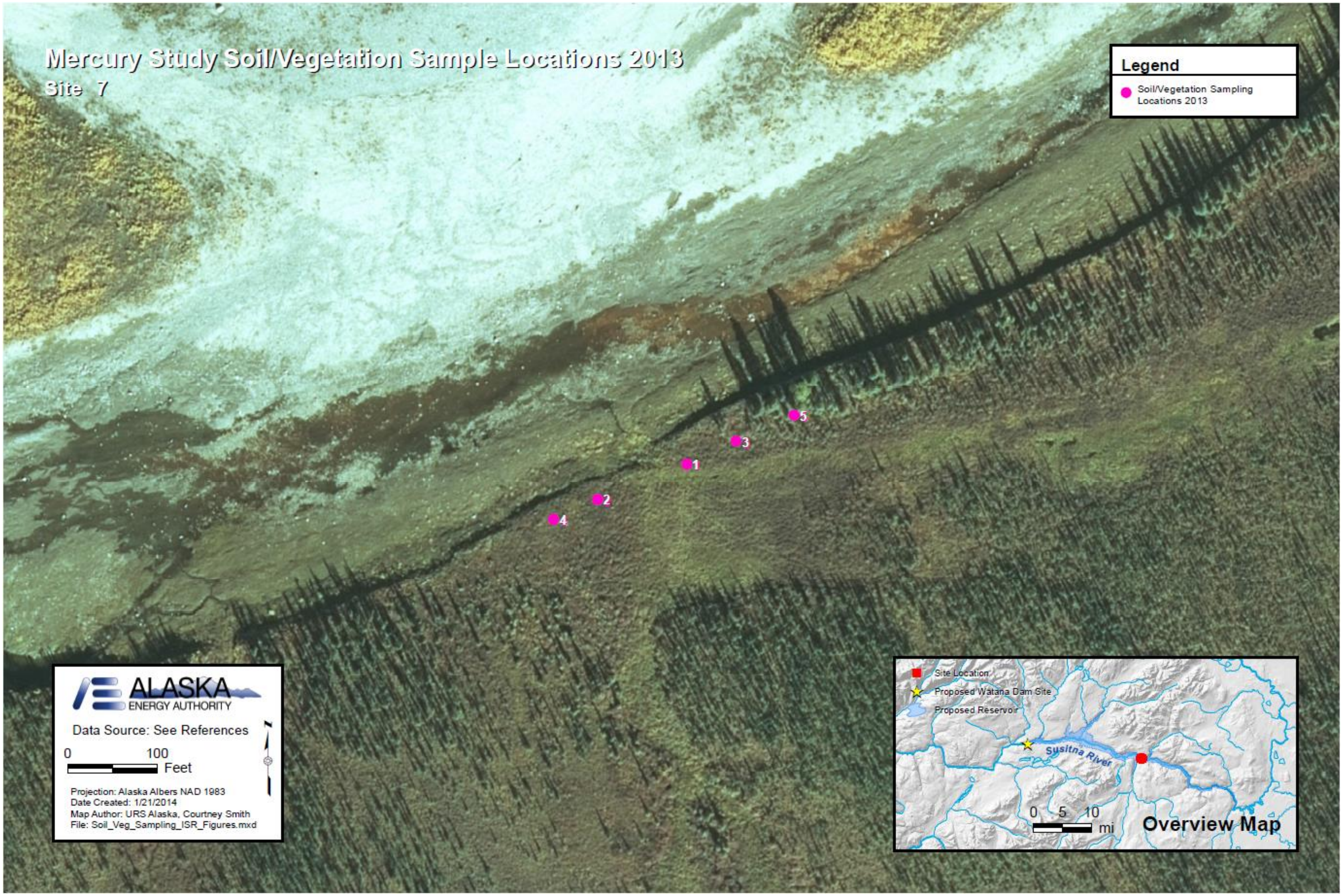


Figure 4.2-8. Vegetation and Soil Sample Location: Site 7

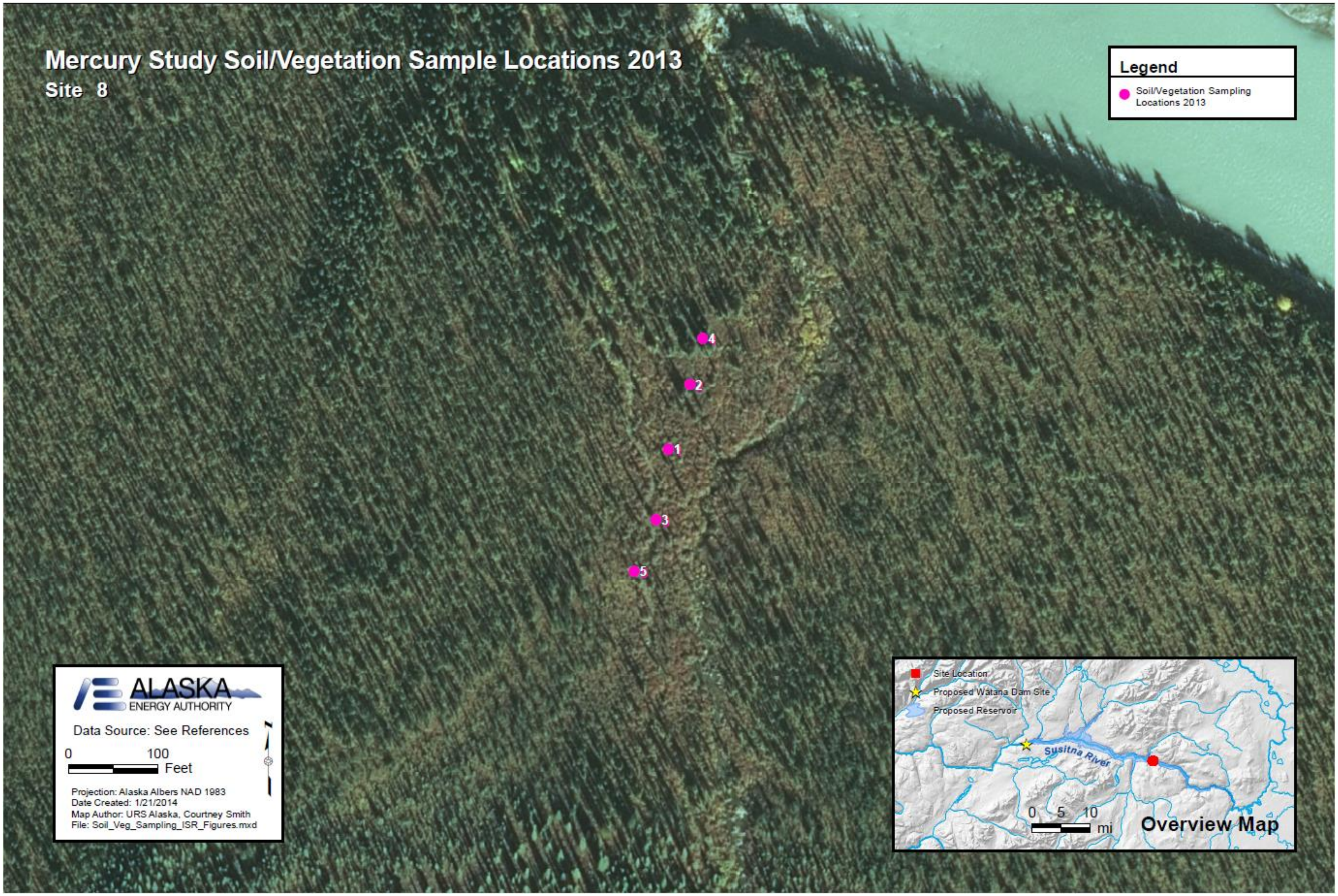


Figure 4.2-9. Vegetation and Soil Sample Location: Site 8

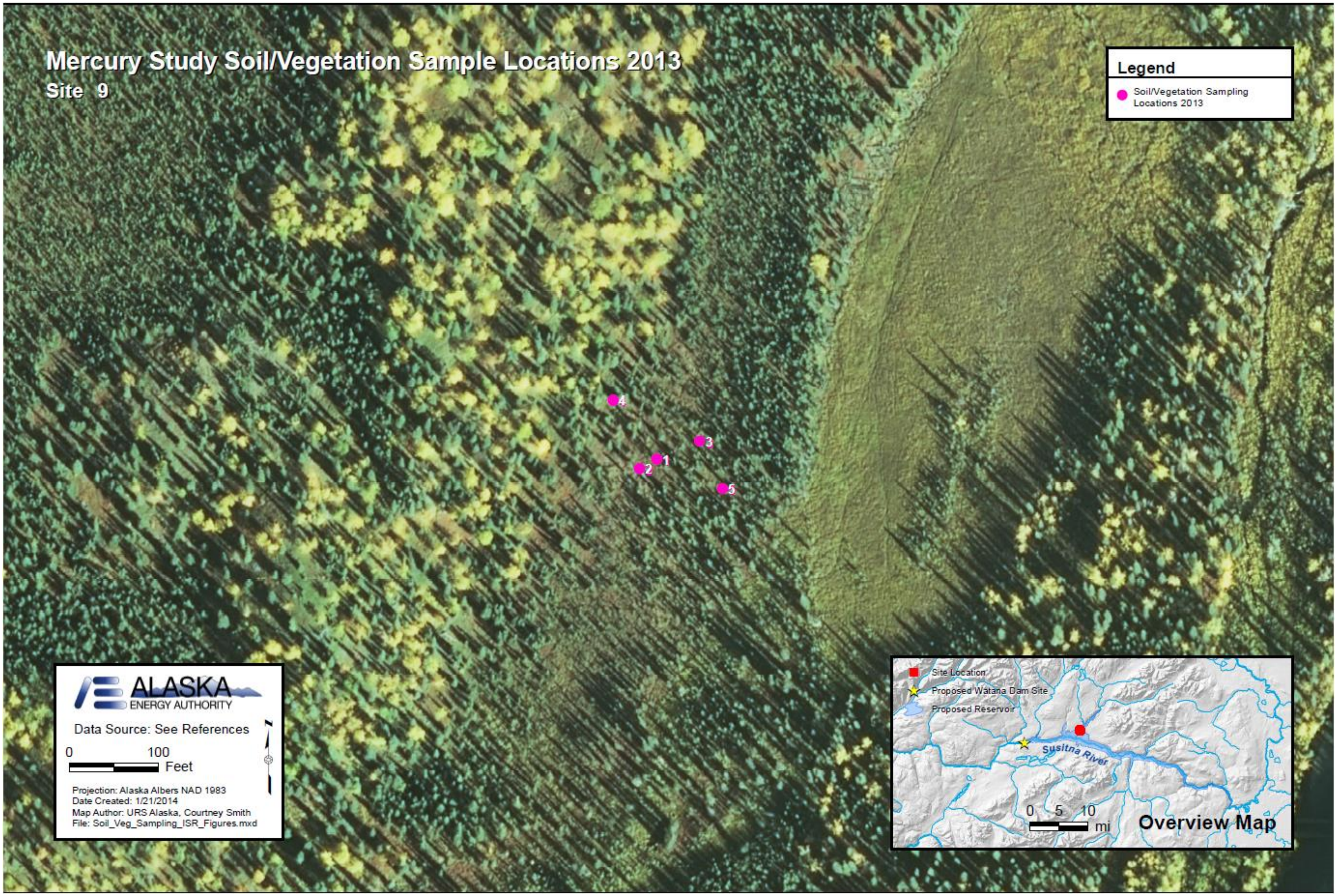


Figure 4.2-10. Vegetation and Soil Sample Location: Site 9

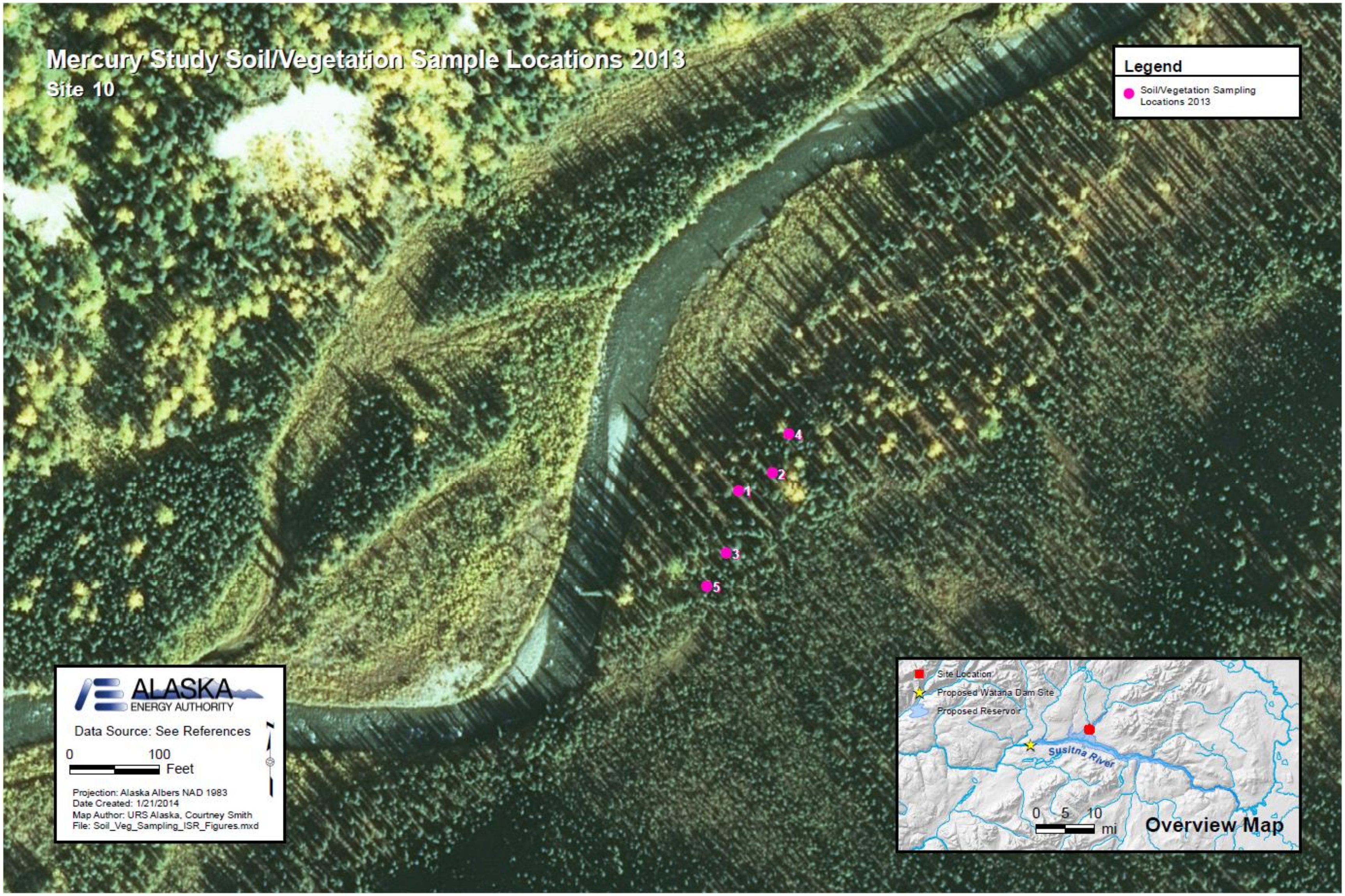


Figure 4.2-11. Vegetation and Soil Sample Location: Site 10

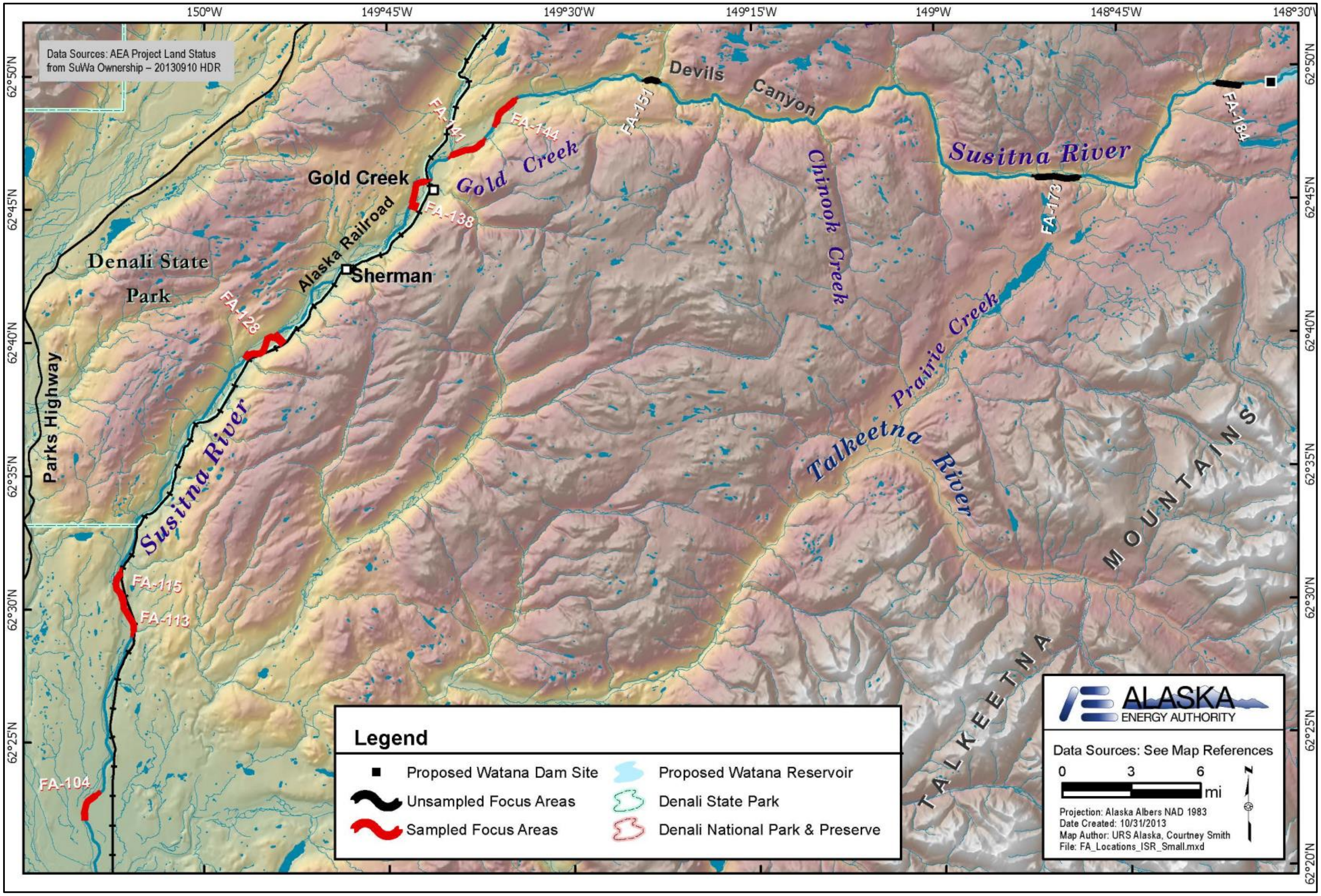


Figure 4.2-12. Focus Area Sampling Location Overview

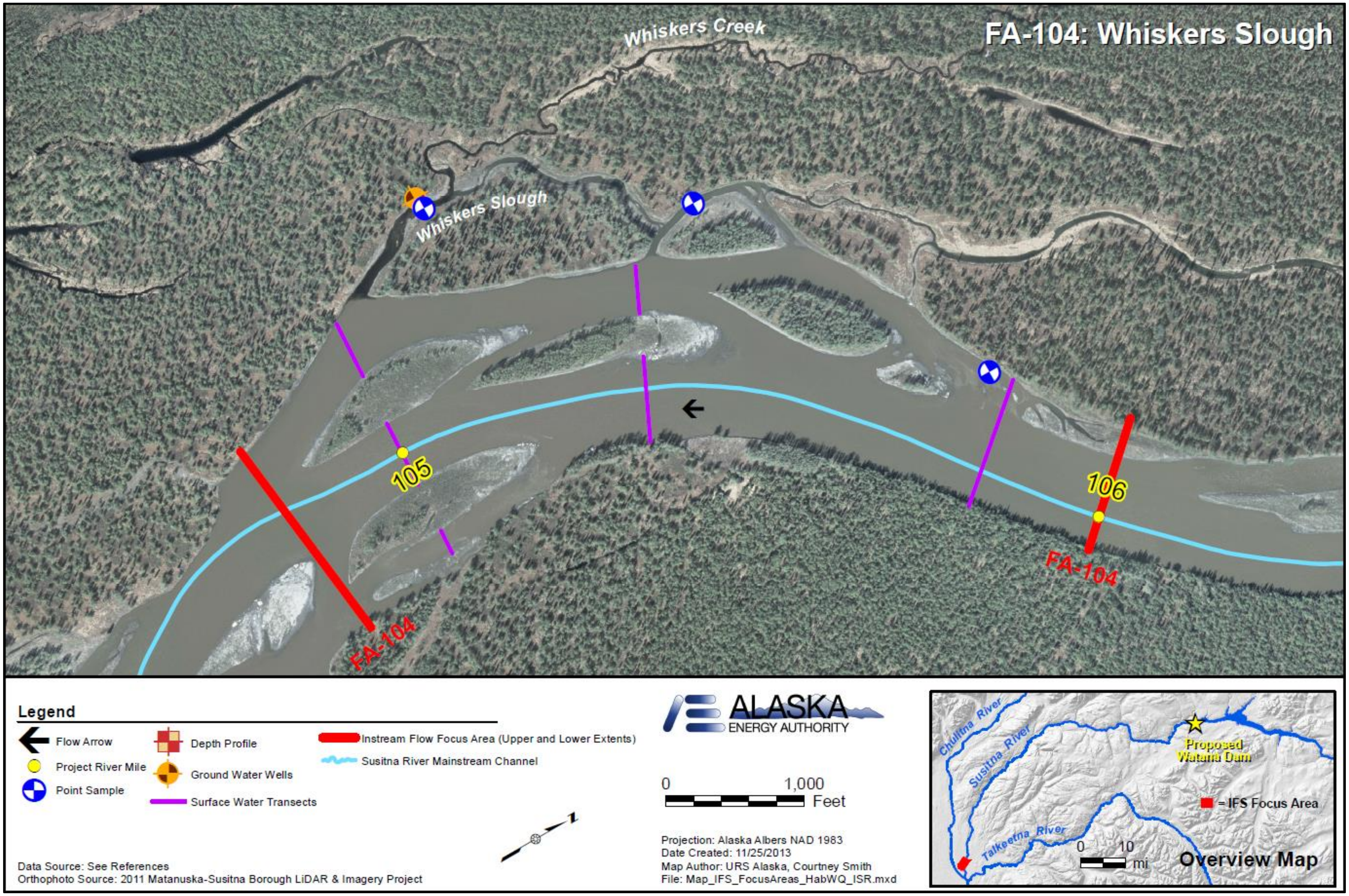


Figure 4.2-13. Example Detail of Focus Area 104: Whiskers Slough

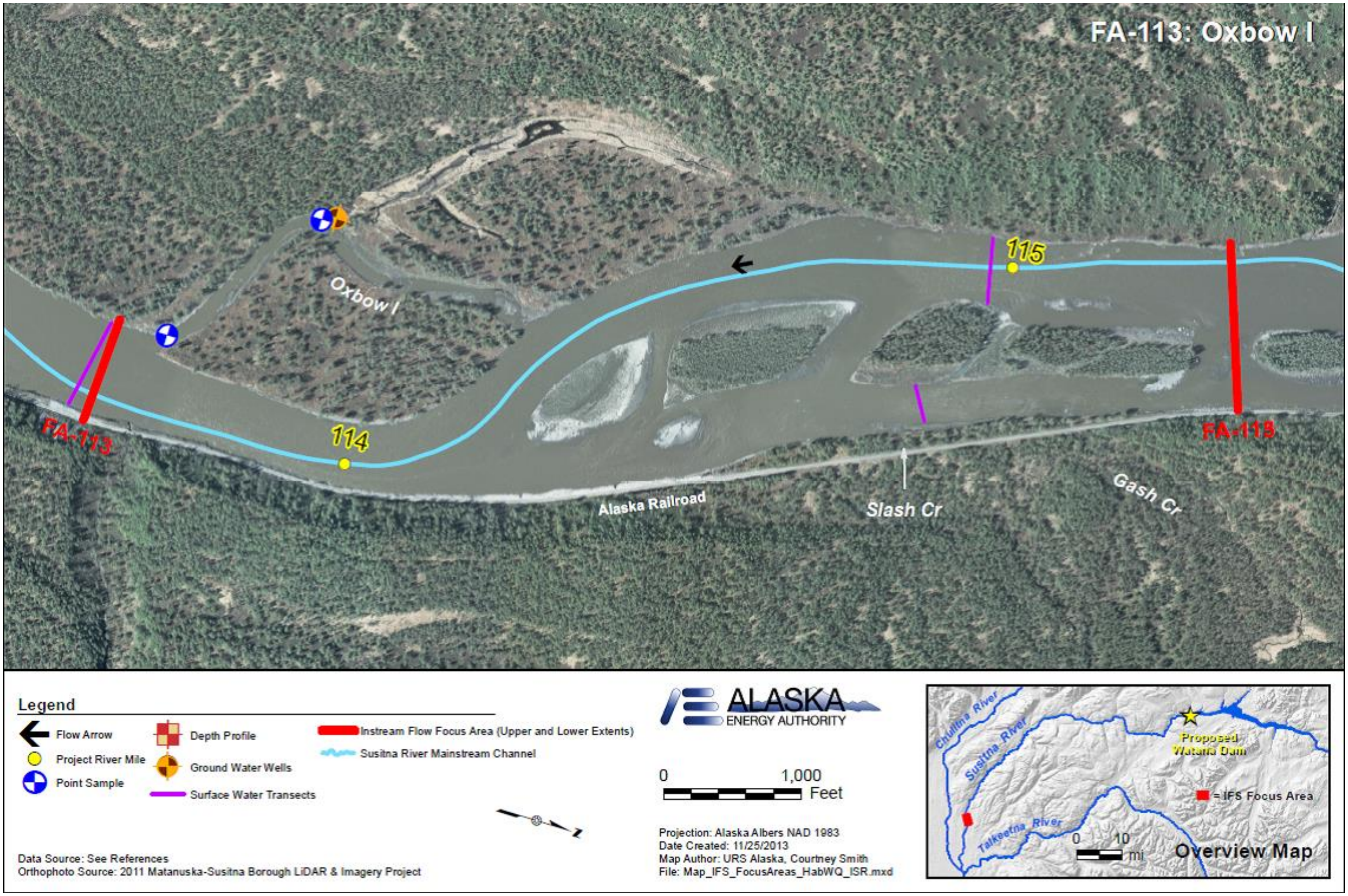


Figure 4.2-14. Detail of Focus Area 113: Oxbow I.

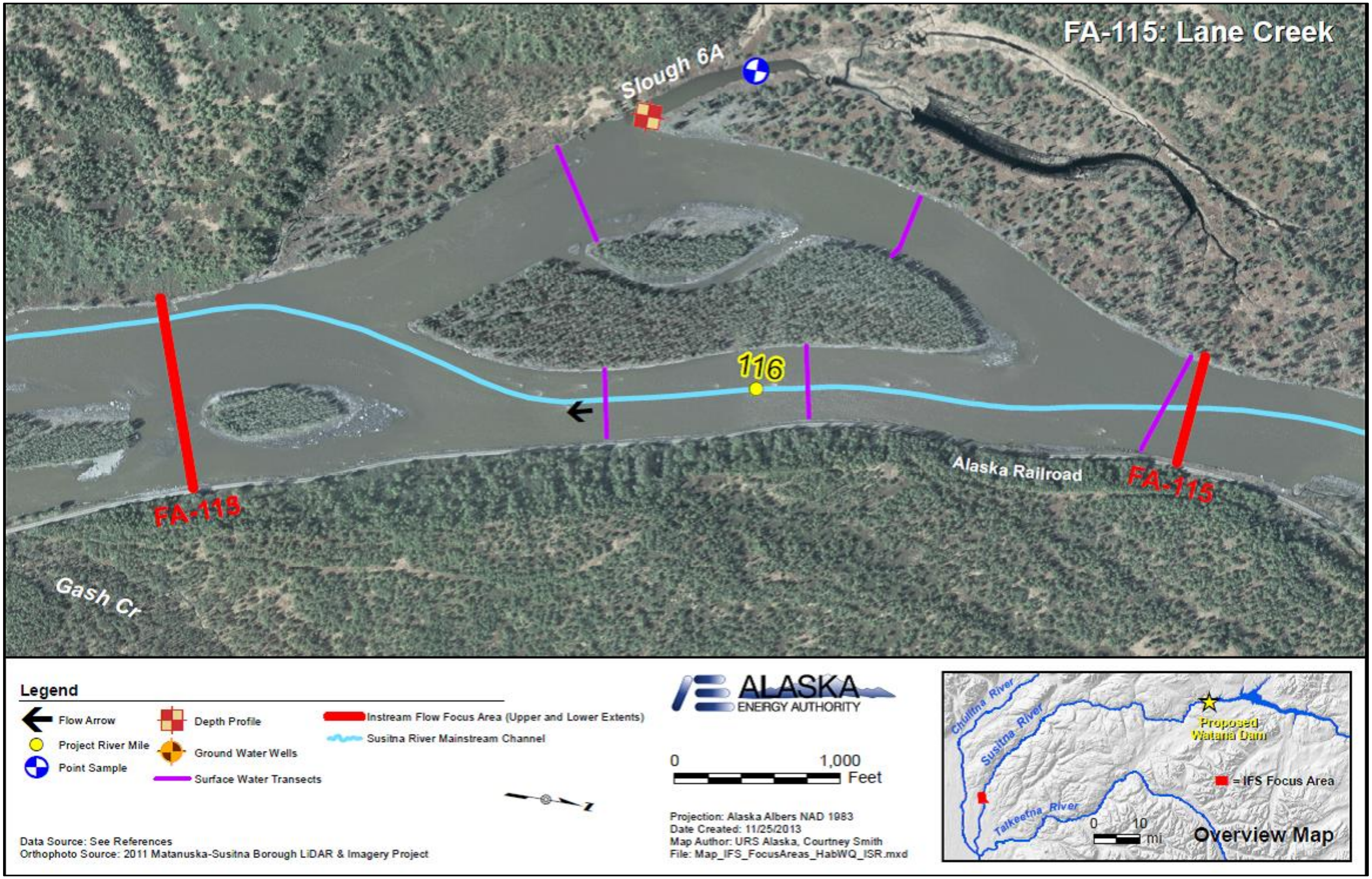


Figure 4.2-15. Detail of Focus Area 115: Slough 6A.

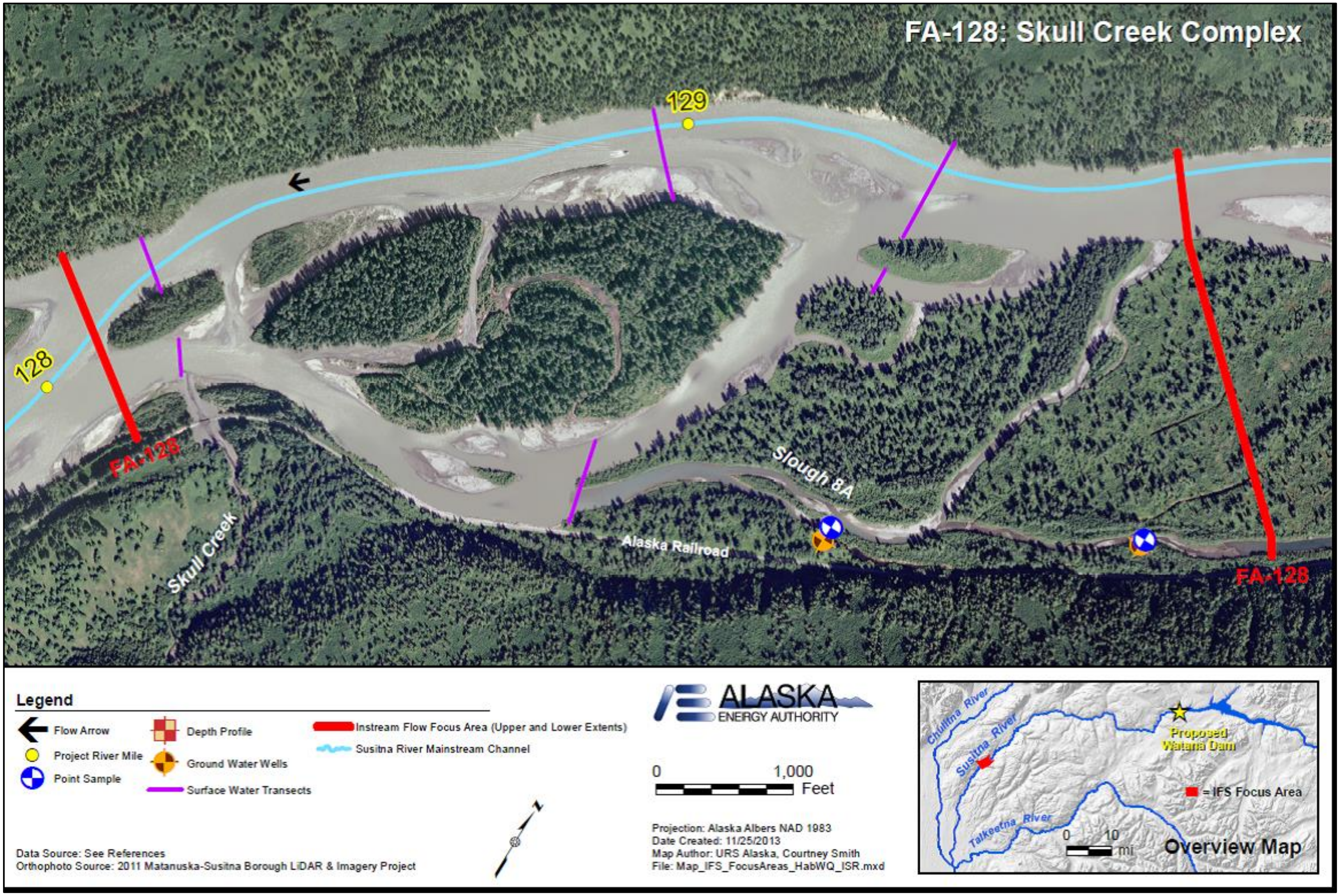


Figure 4.2-16. Detail of Focus Area 128: Slough 8A.

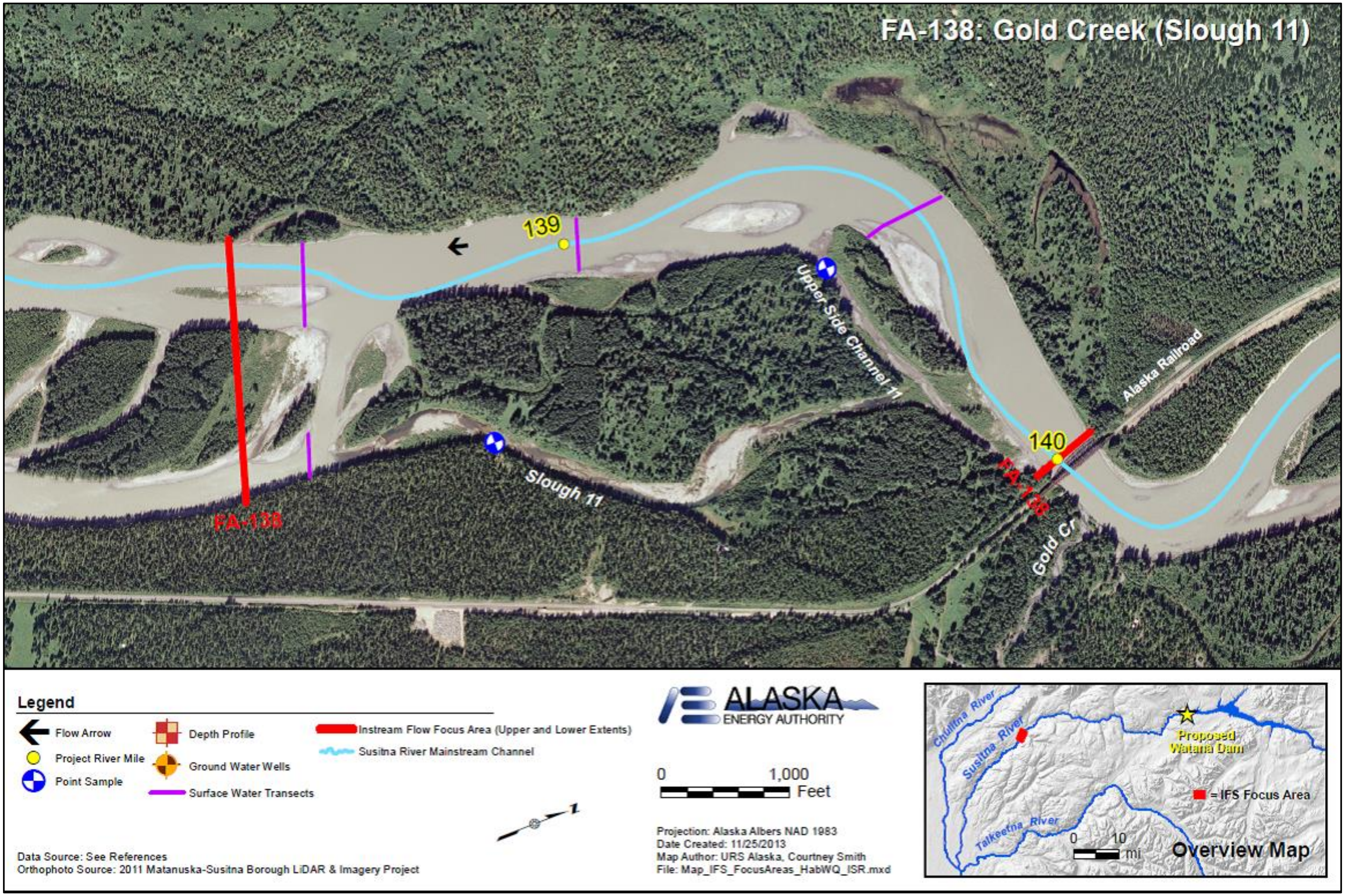


Figure 4.2-17. Detail of Focus Area 138: Gold Creek.

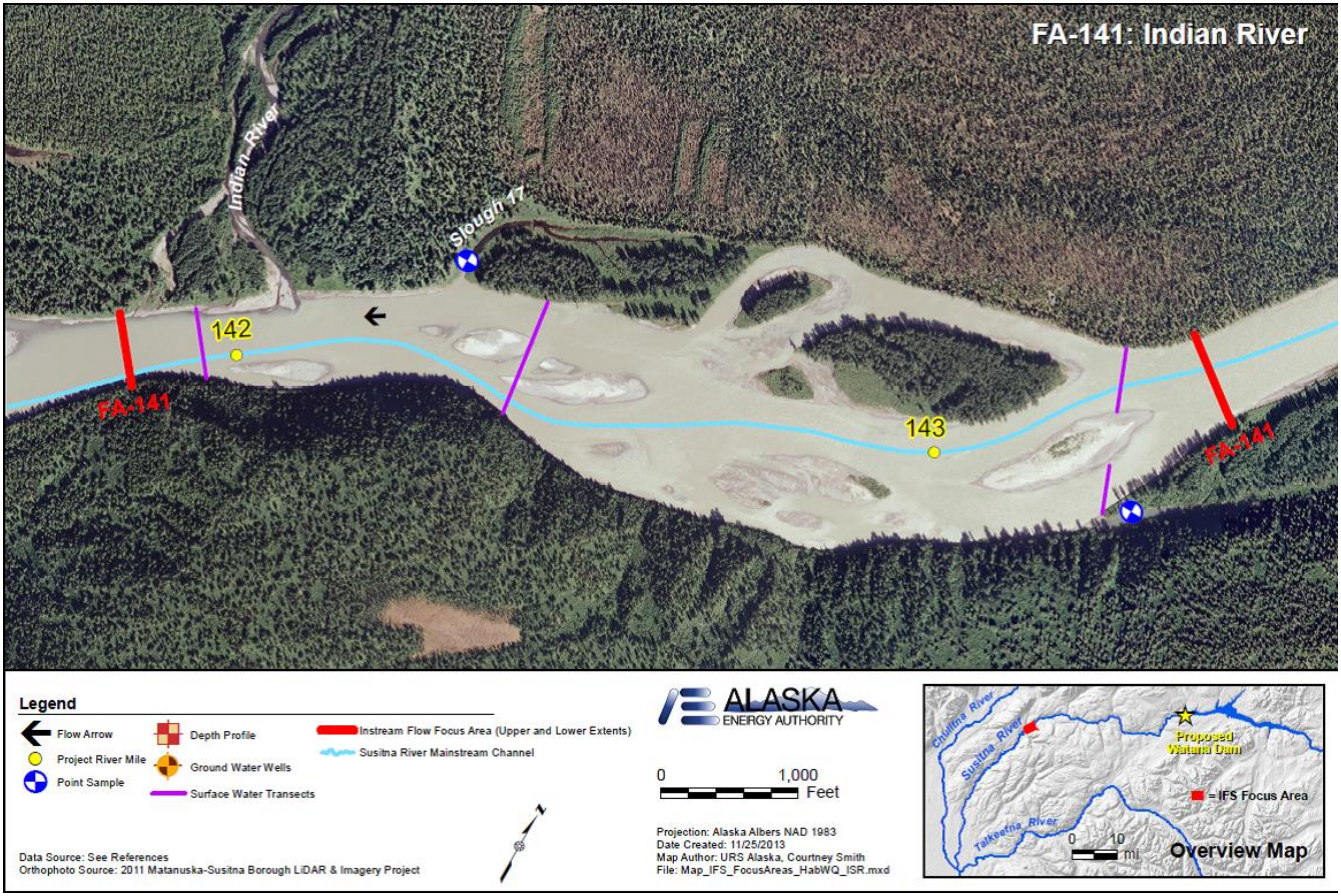


Figure 4.2-18. Detail of Focus Area 141: Indian River.

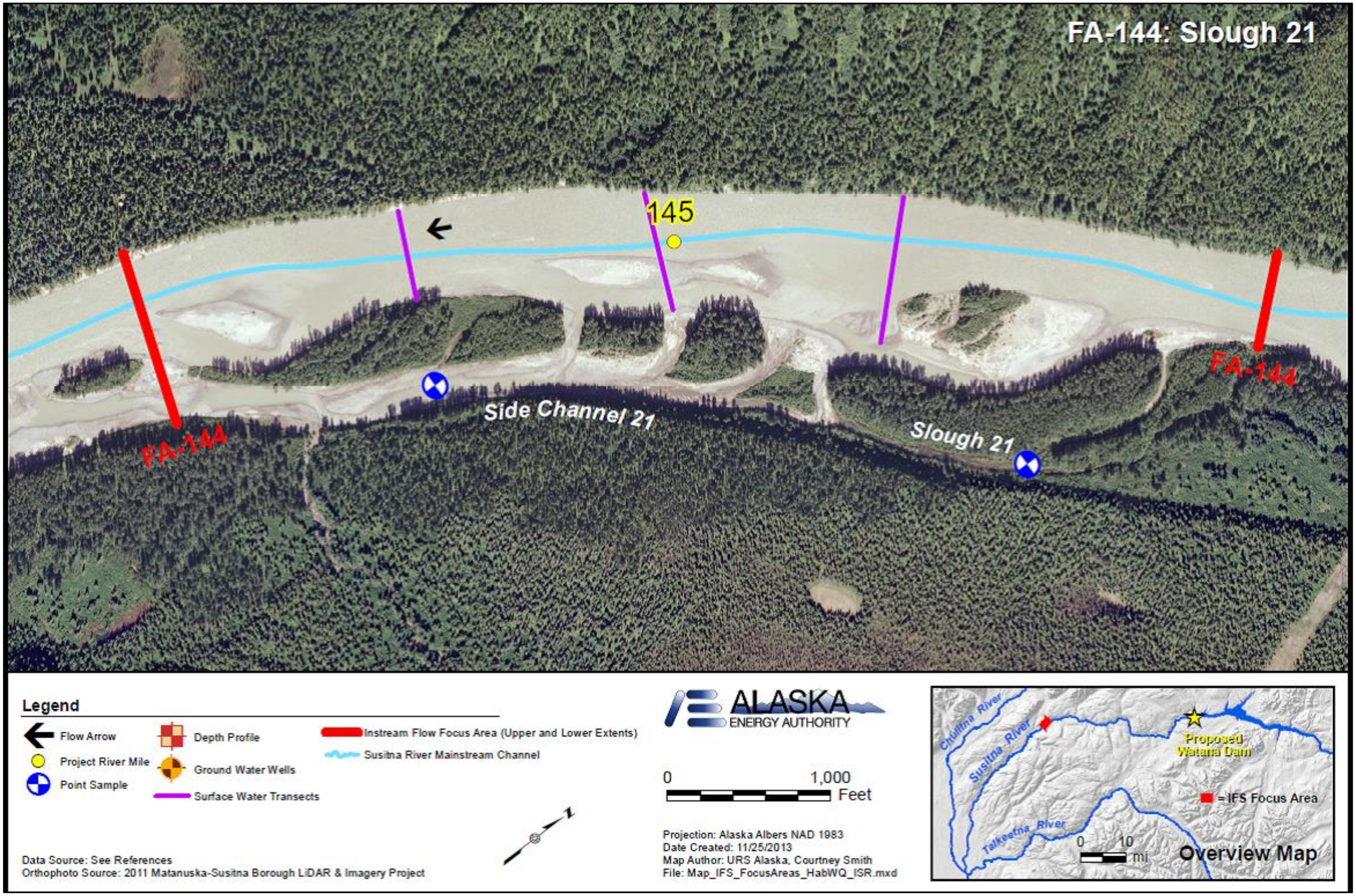


Figure 4.2-19. Detail of Focus Area 144: Side Channel 21.

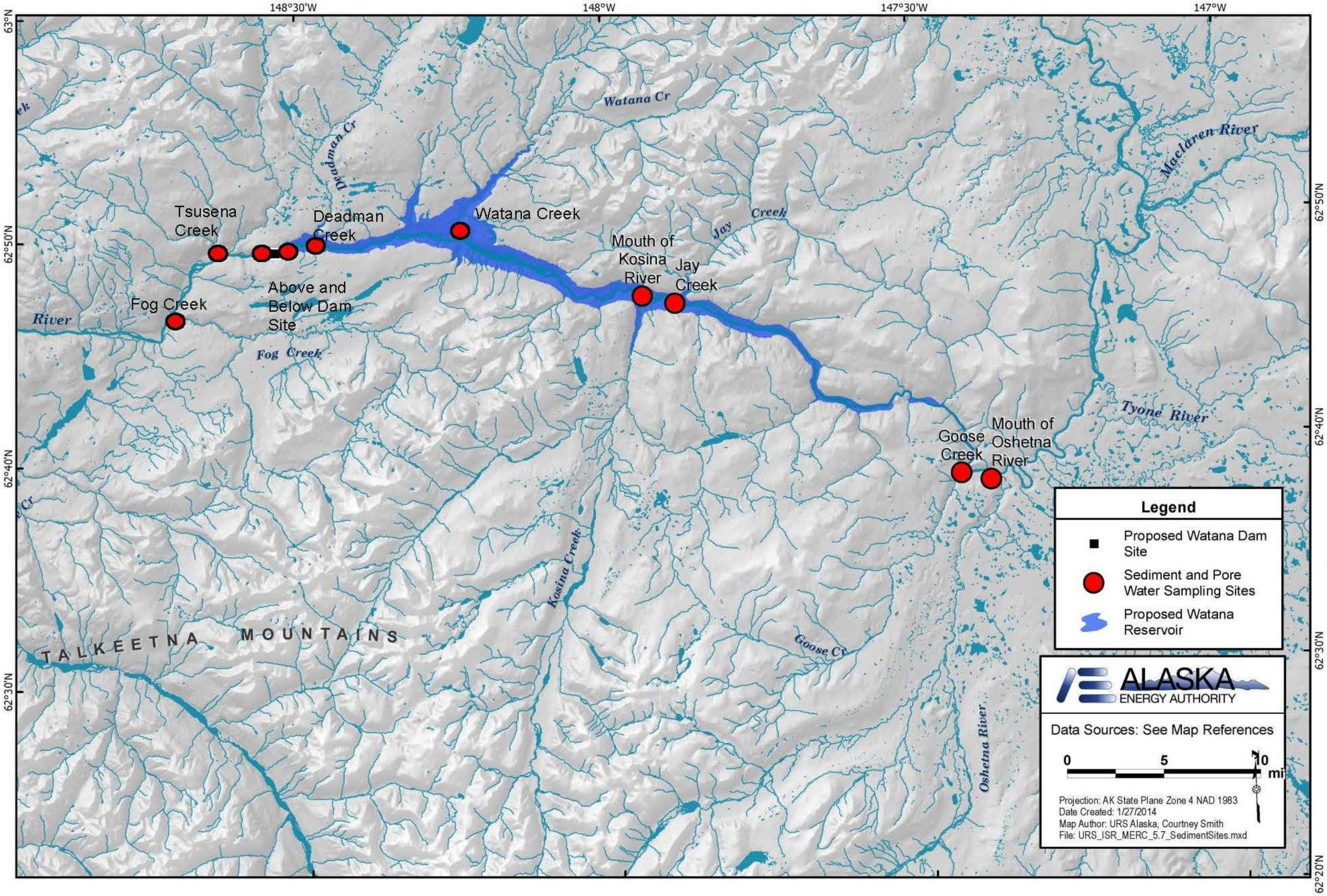
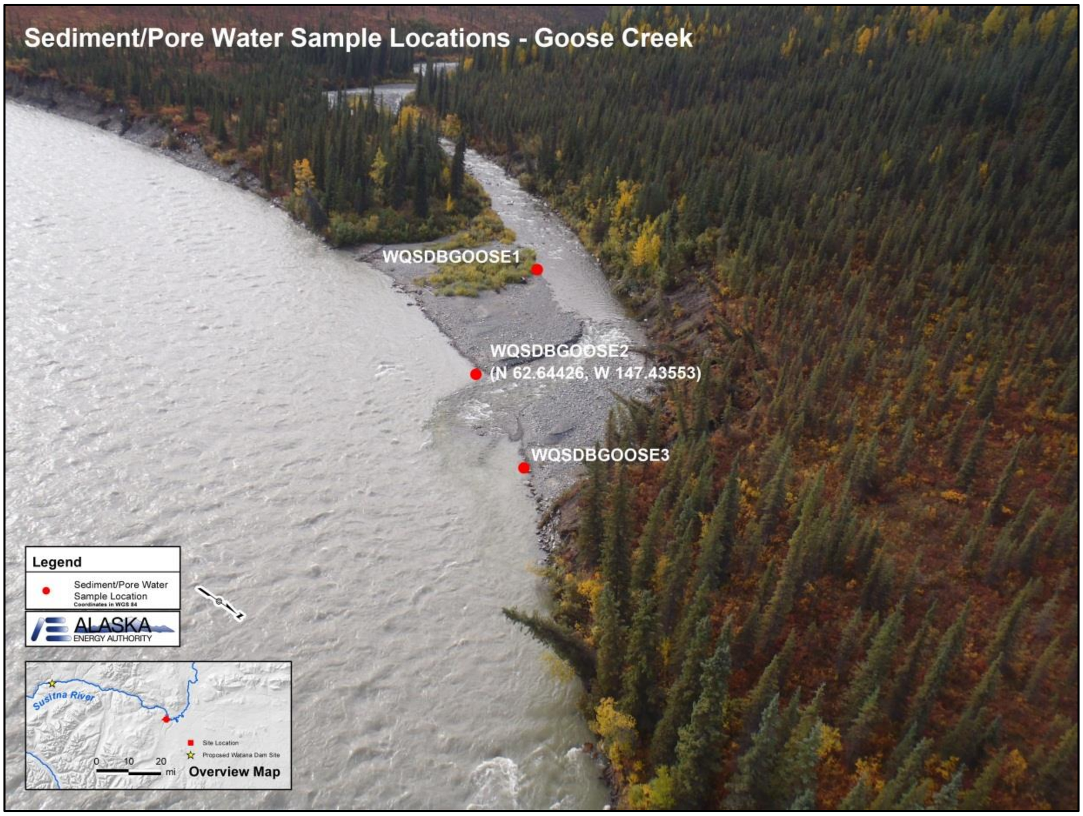


Figure 4.2-20. Map of Sediment/Porewater Sampling Locations



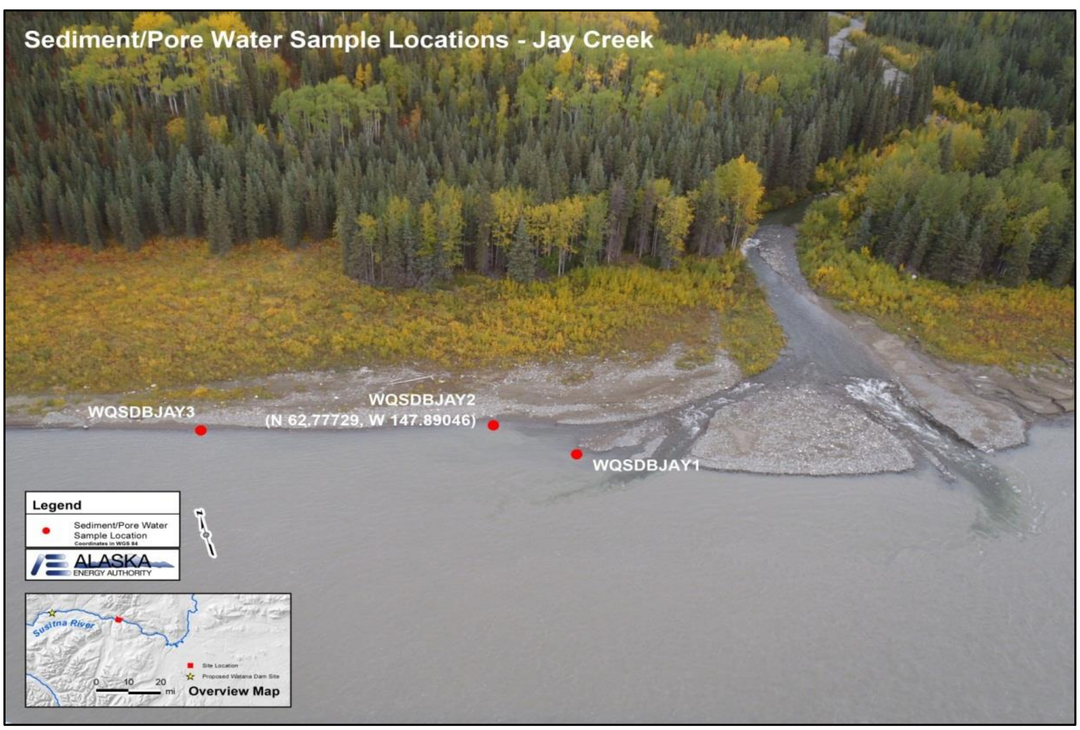
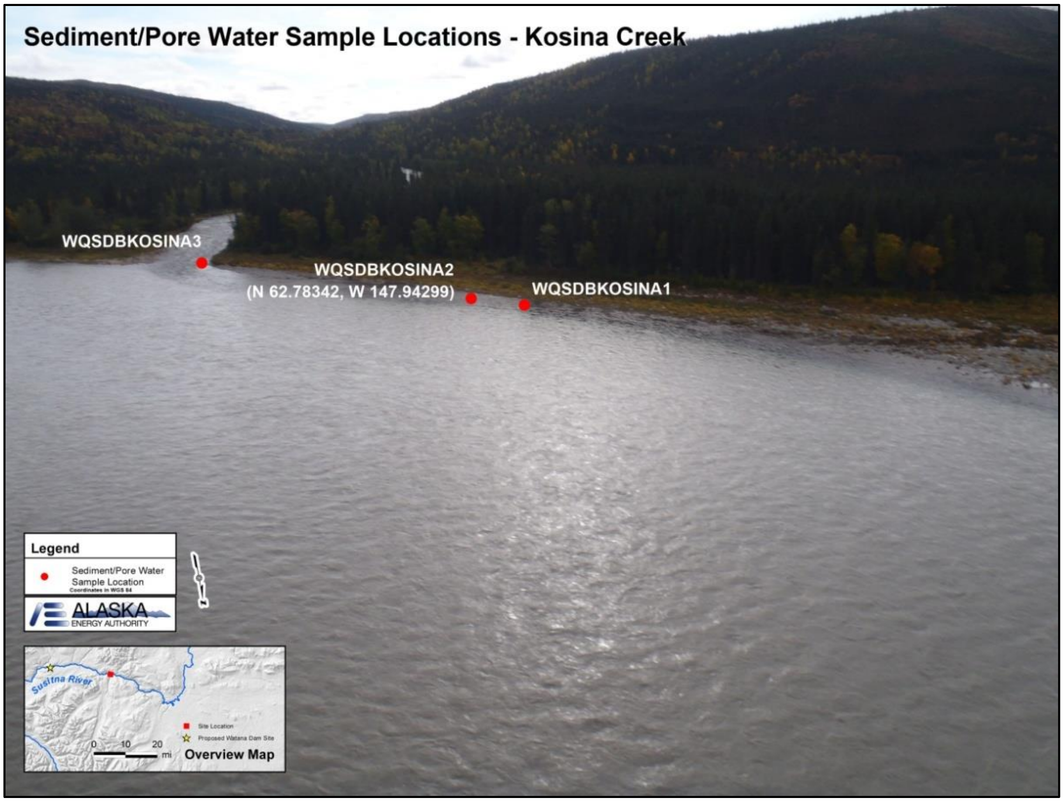


Figure 4.2-21. Sediment and Porewater Sample Locations for Goose and Jay Creeks



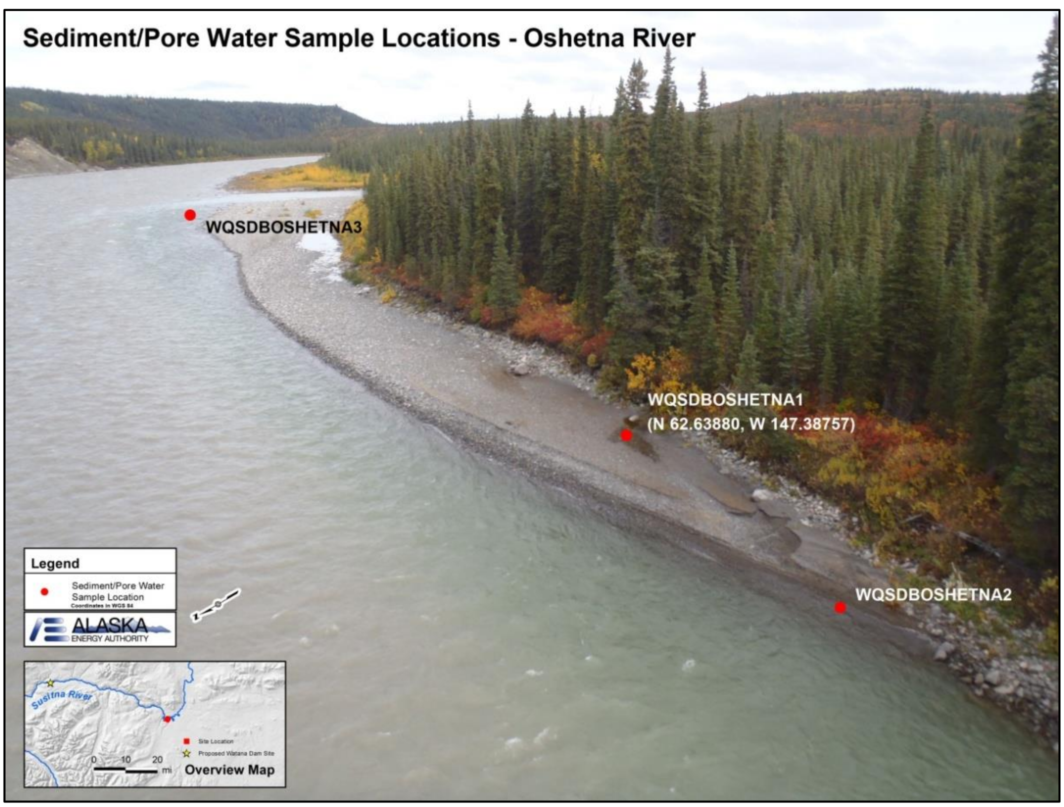


Figure 4.2-22. Sediment and Porewater Sample Locations for Kosina Creek and Oshetna River

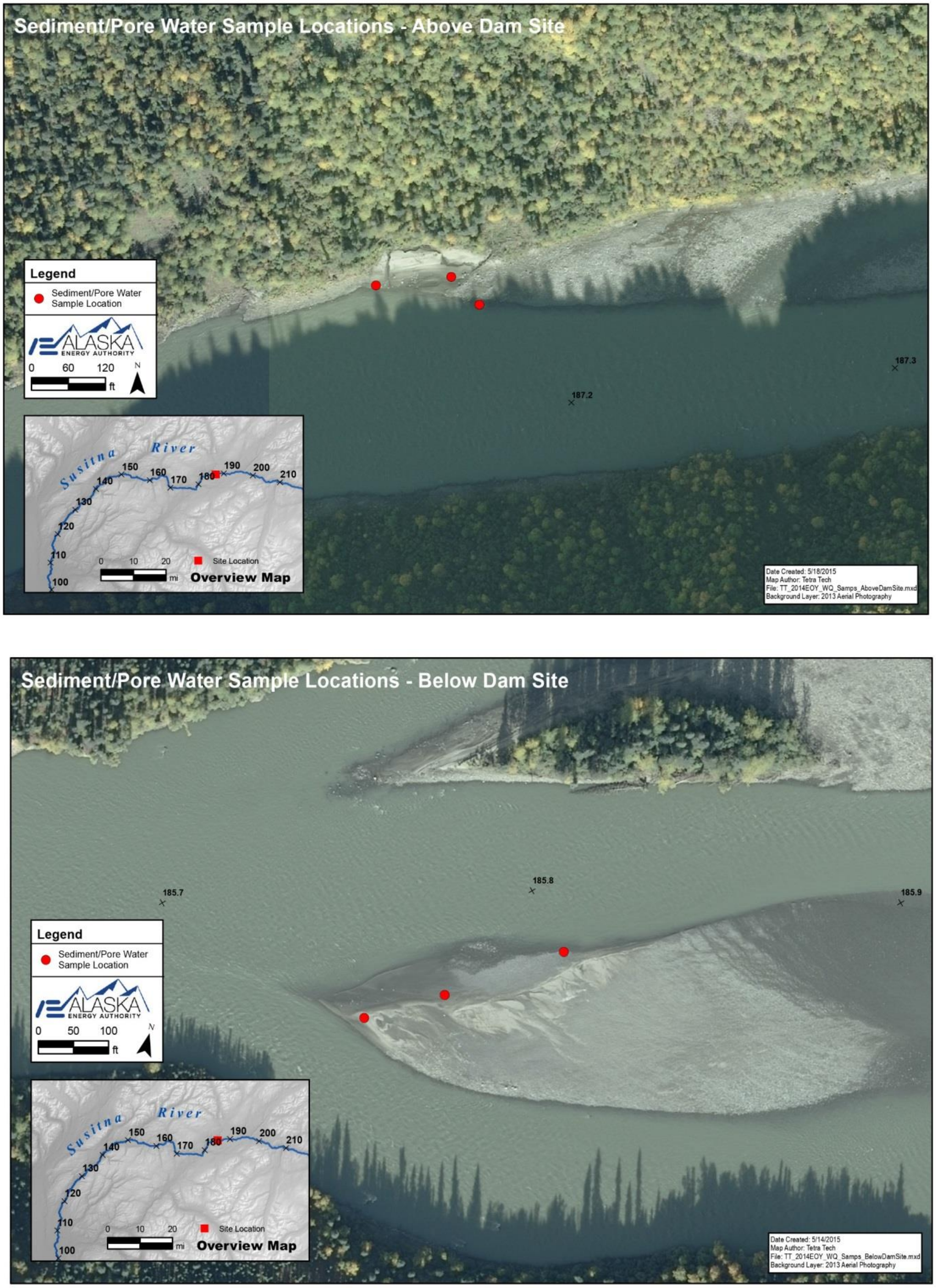


Figure 4.2-23. Sediment and Porewater Sample Locations for Above and Below Dam Site

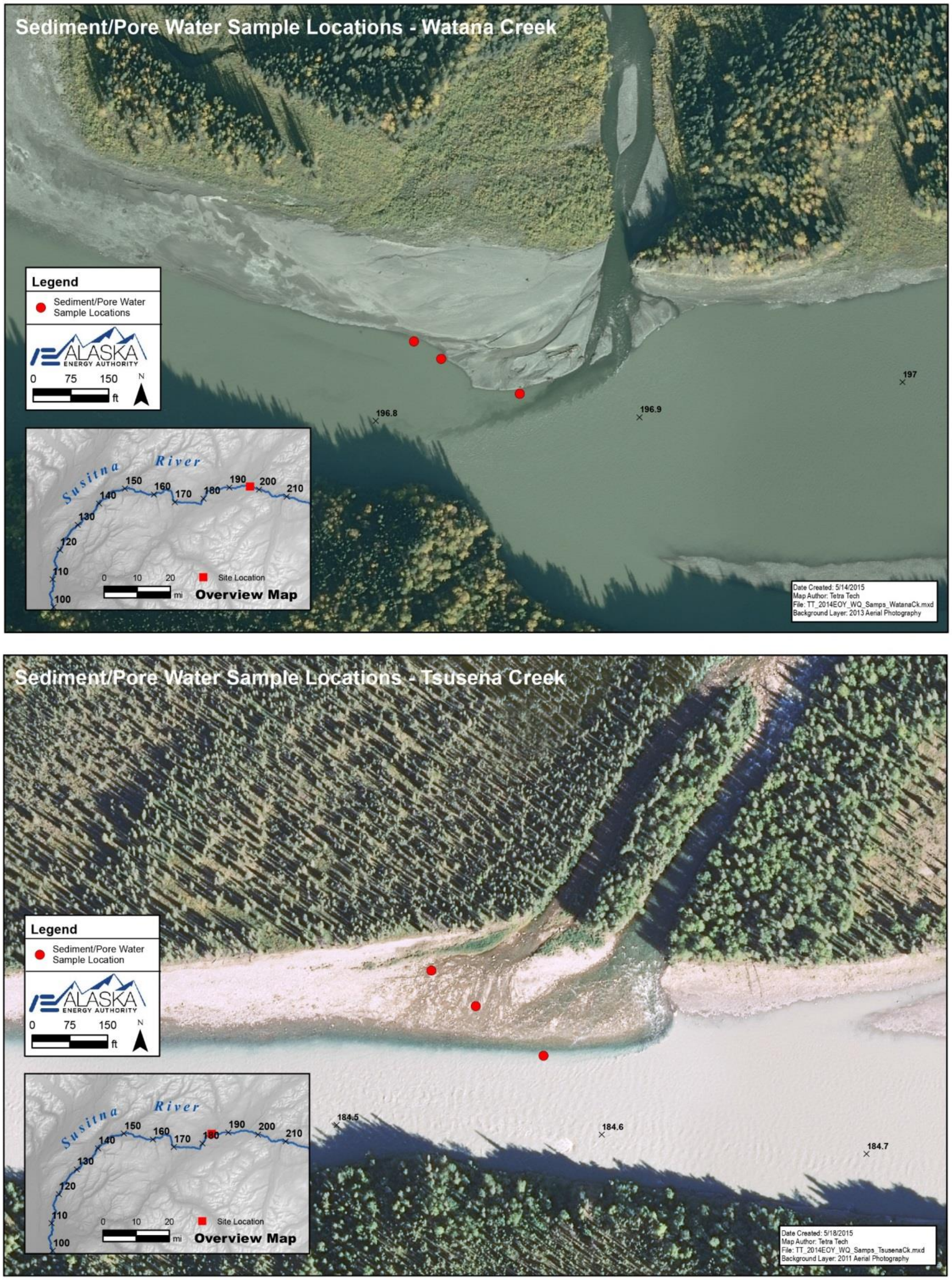
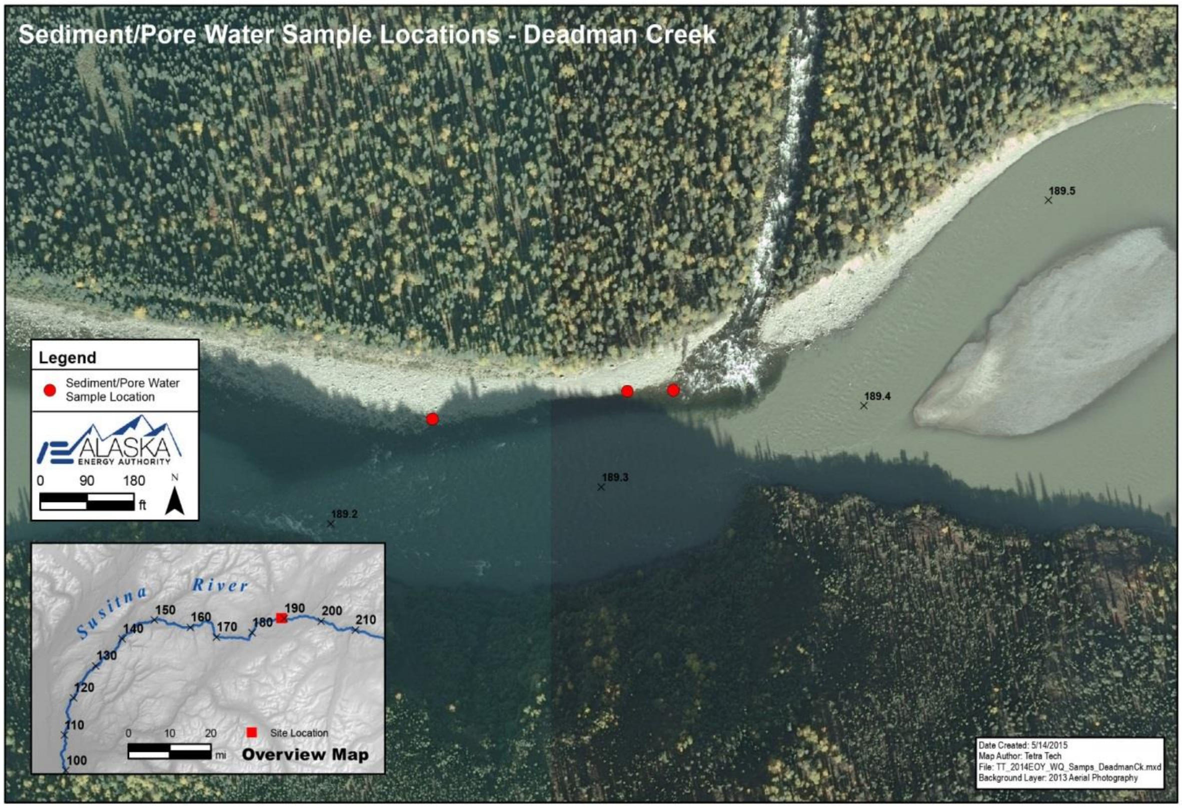


Figure 4.2-24. Sediment and Porewater Sample Locations for Watana and Tsusena Creeks



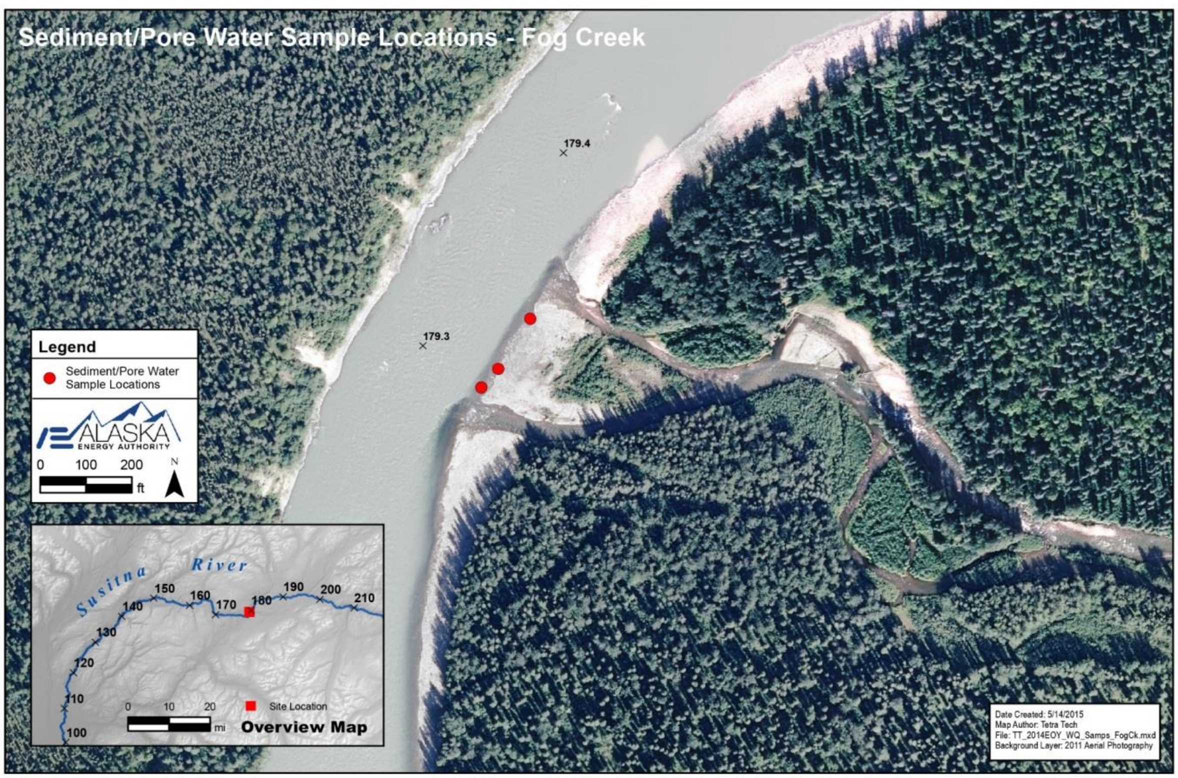


Figure 4.2-25. Sediment and Porewater Sample Locations for Deadman and Fog Creeks

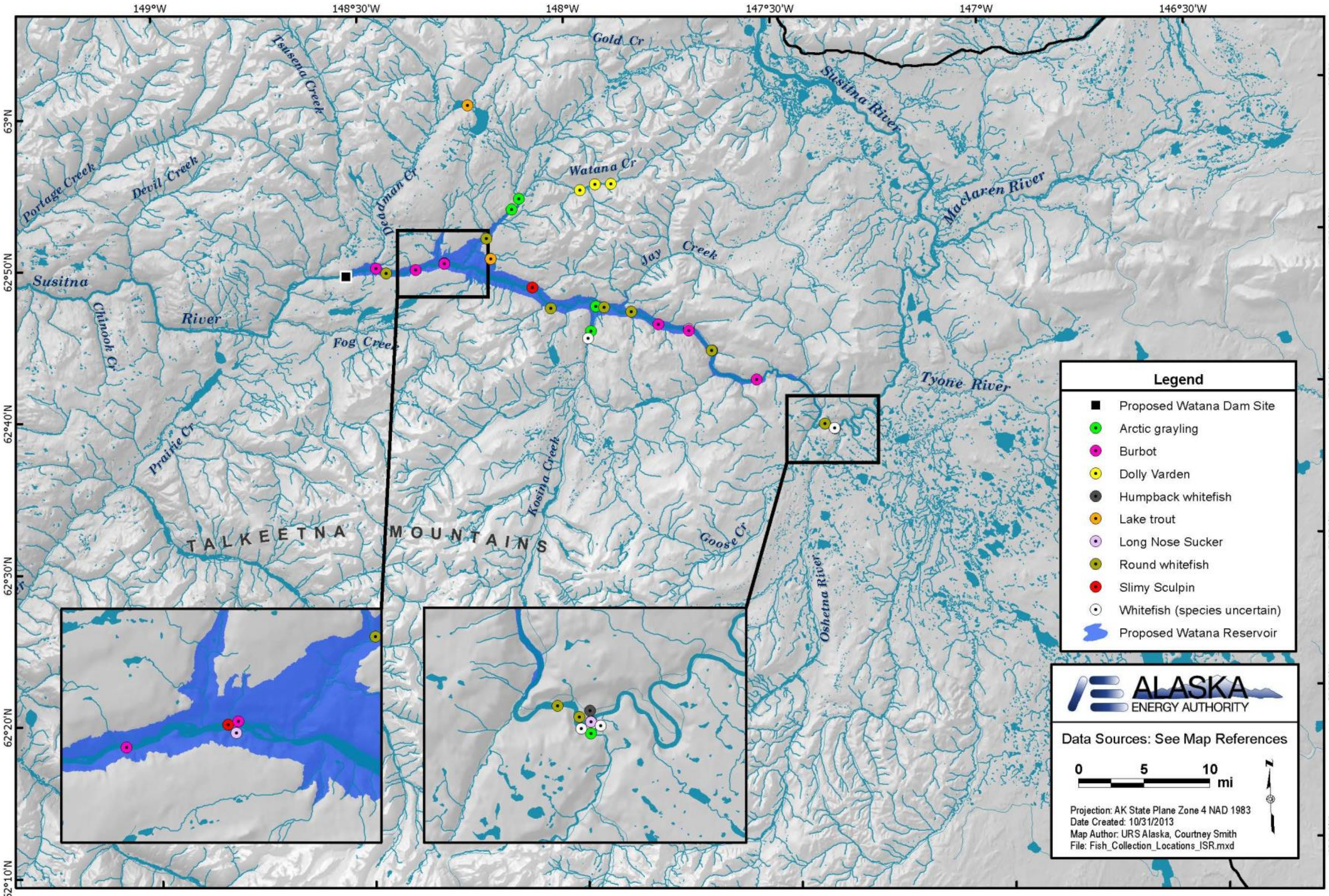


Figure 4.2-26. Fish Tissue Sample Collection Locations

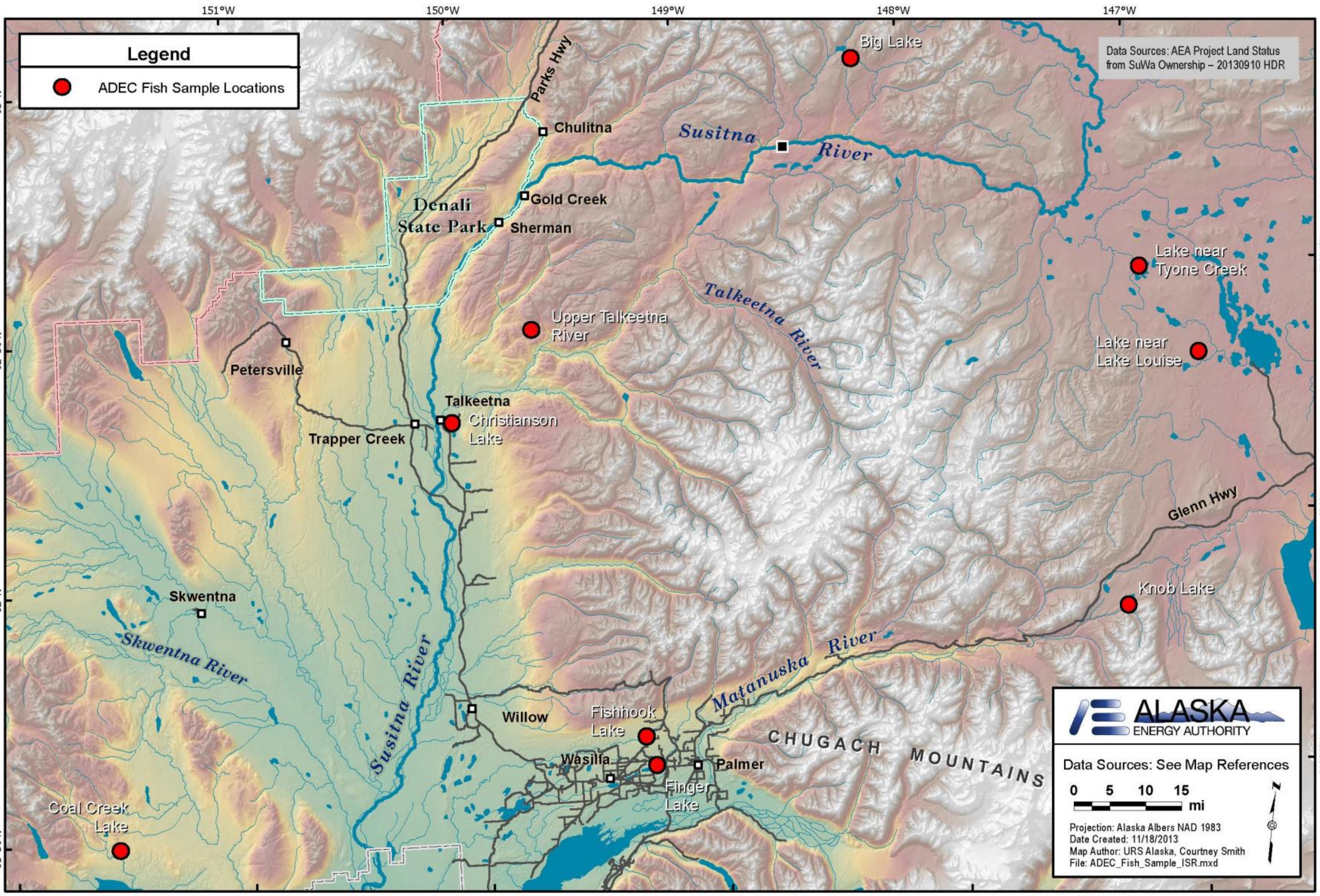


Figure 5.1-1. ADEC Fish Tissue Sample Collection Locations

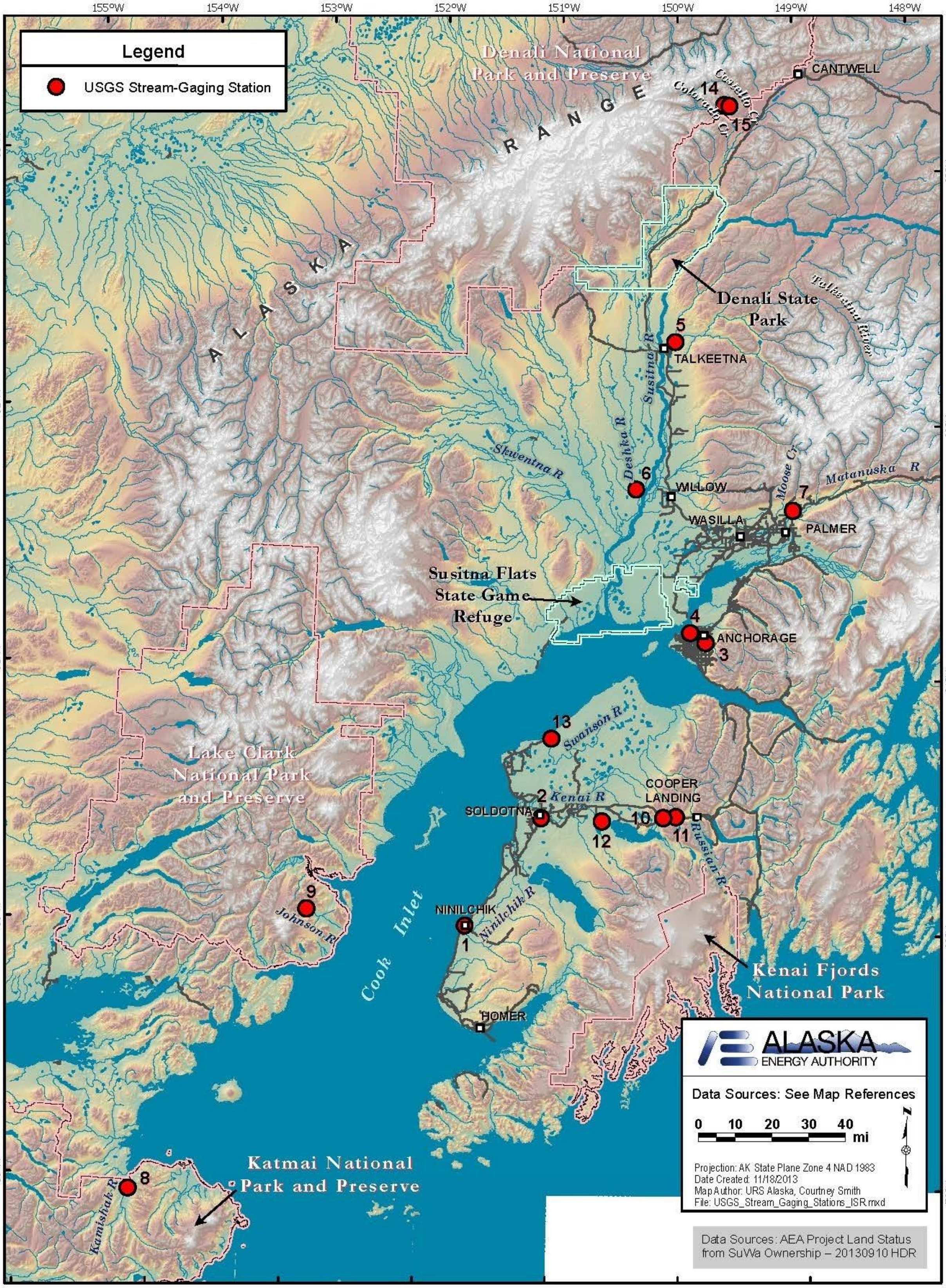


Figure 5.1-2. USGS (Frenzel 2000) Sample Locations

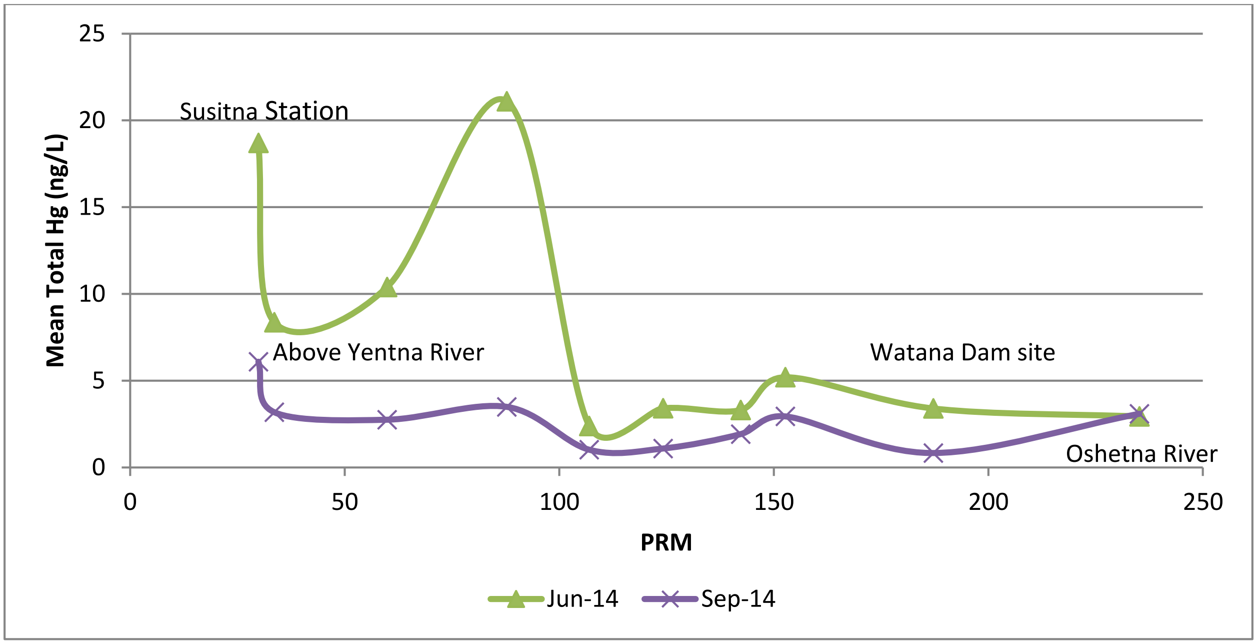


Figure 5.4-1. Total Mercury by Location in Mainstem Susitna River

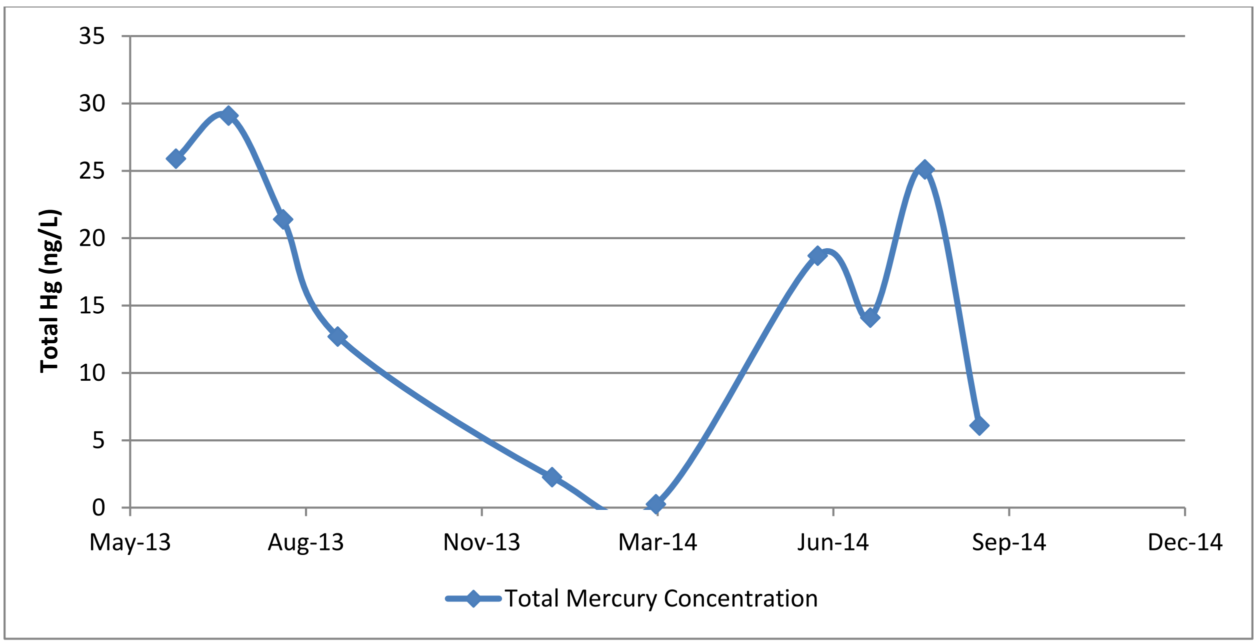
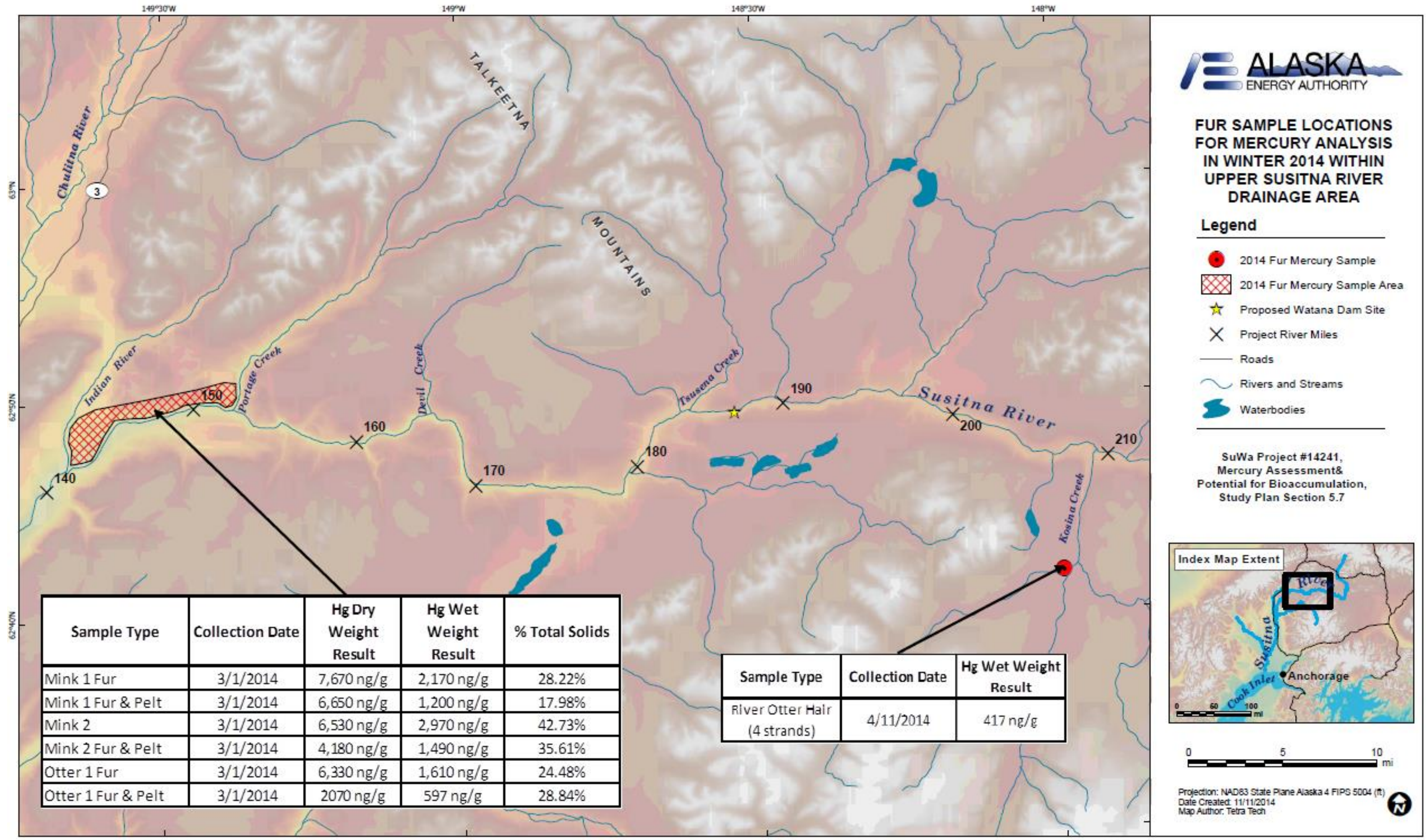


Figure 5.4-2. Total Mercury over Time at Susitna Station (PRM 29.9)



Sample Type	Collection Date	Hg Dry Weight Result	Hg Wet Weight Result	% Total Solids
Mink 1 Fur	3/1/2014	7,670 ng/g	2,170 ng/g	28.22%
Mink 1 Fur & Pelt	3/1/2014	6,650 ng/g	1,200 ng/g	17.98%
Mink 2	3/1/2014	6,530 ng/g	2,970 ng/g	42.73%
Mink 2 Fur & Pelt	3/1/2014	4,180 ng/g	1,490 ng/g	35.61%
Otter 1 Fur	3/1/2014	6,330 ng/g	1,610 ng/g	24.48%
Otter 1 Fur & Pelt	3/1/2014	2070 ng/g	597 ng/g	28.84%

Sample Type	Collection Date	Hg Wet Weight Result
River Otter Hair (4 strands)	4/11/2014	417 ng/g

Figure 5.6-1. Sample Locations for Piscivorous Mammals

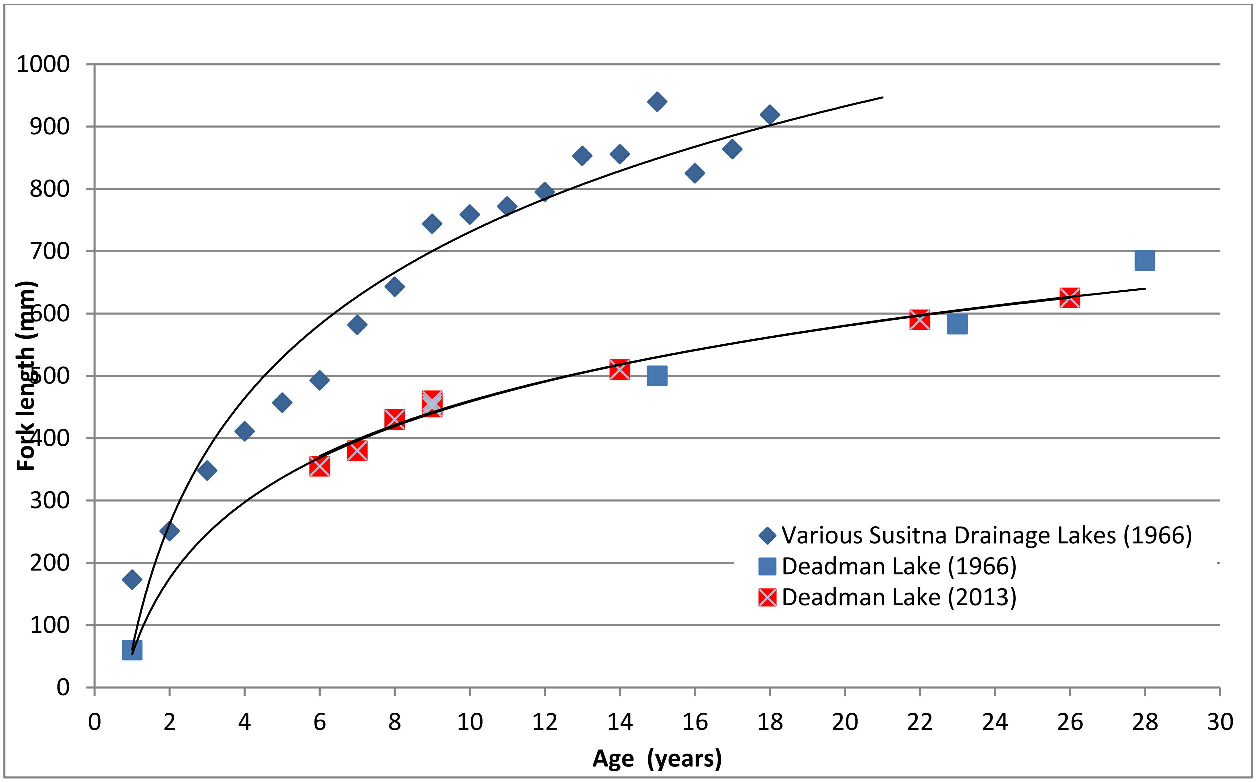


Figure 5.7-1. Lake Trout Fork Length and Age

From Burr (1987) and this study

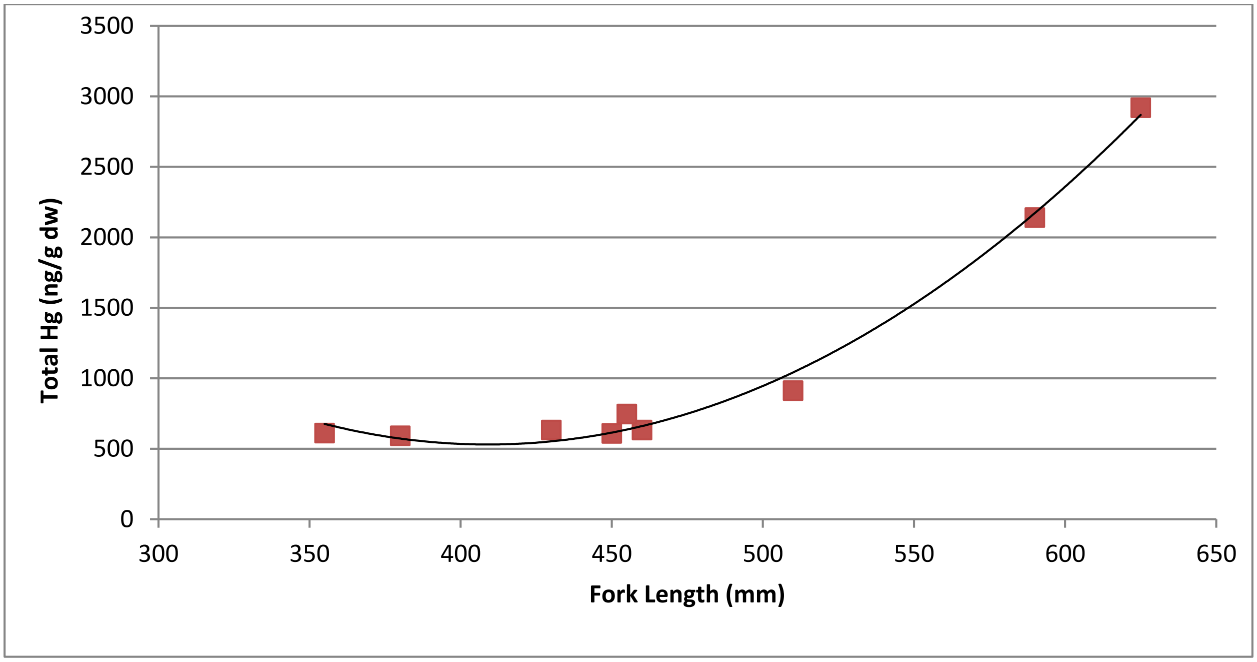


Figure 5.7-2. Lake Trout Fork Length and Total Hg (dw)

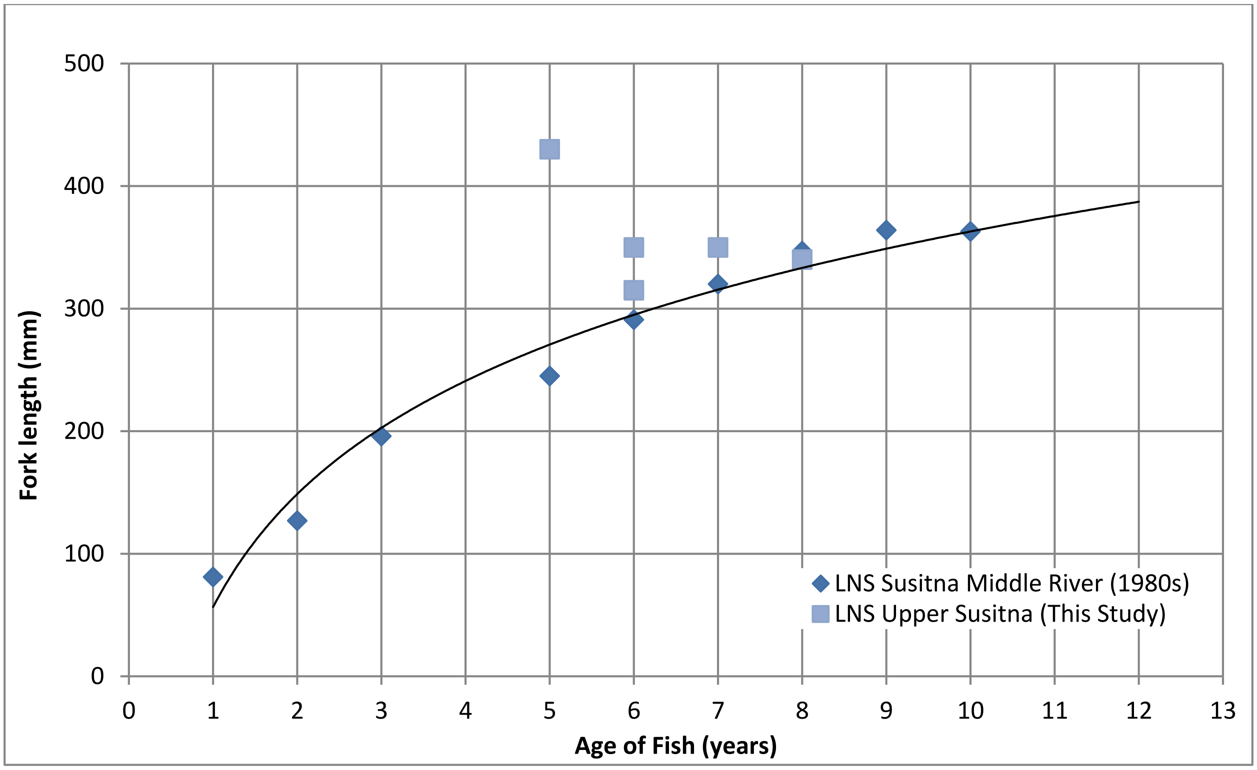


Figure 5.7-3. LNS Fork Length and Age

Susitna Middle River Data from APA (1984b)

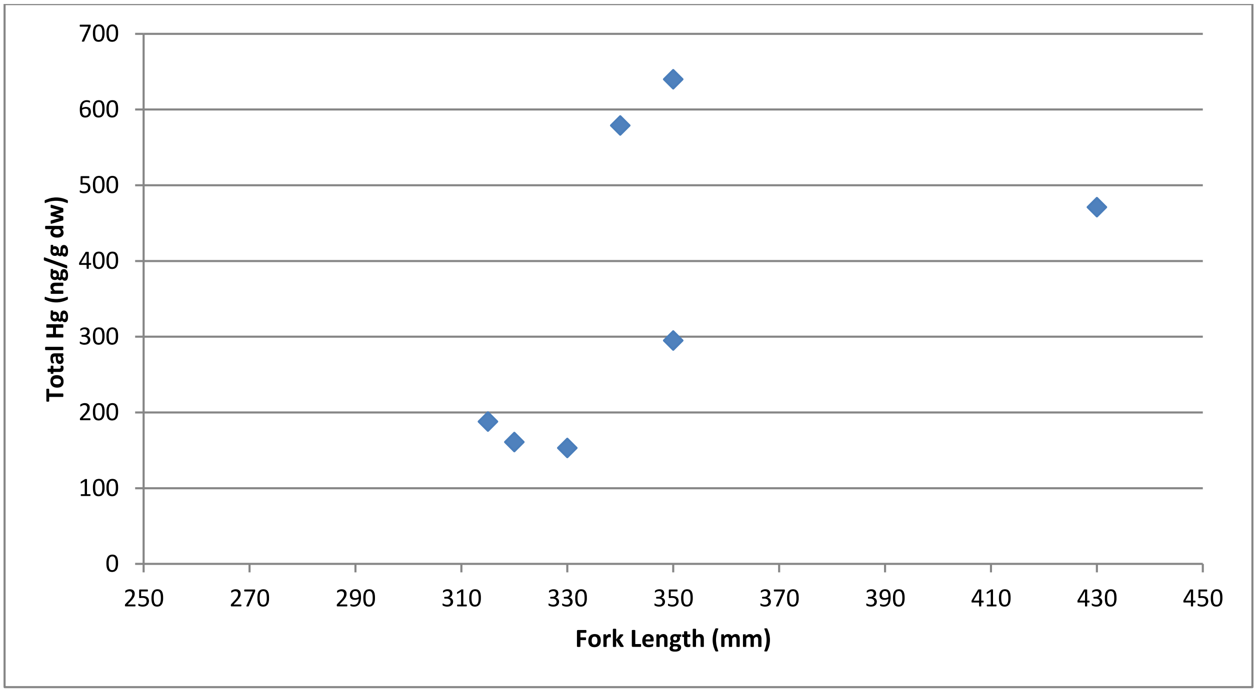


Figure 5.7-4. LNS Fork Length and Total Hg (dw)

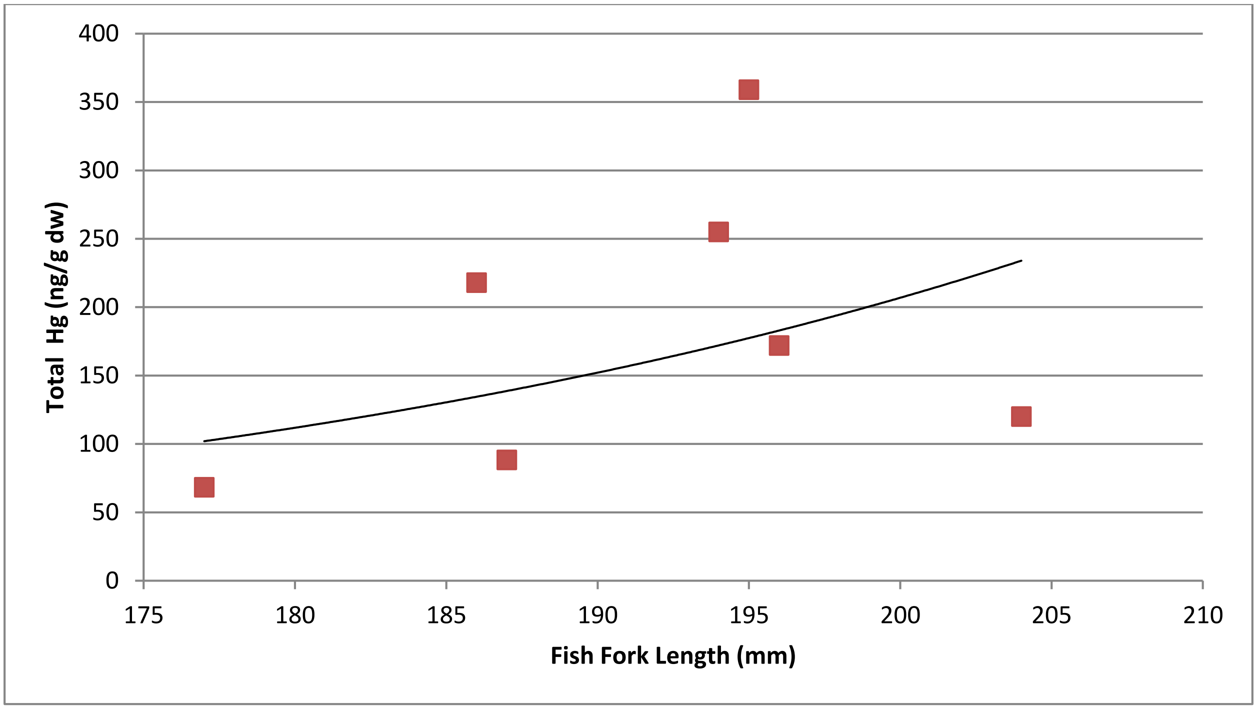


Figure 5.7-5. Dolly Varden Fork Length and Total Hg (dw)

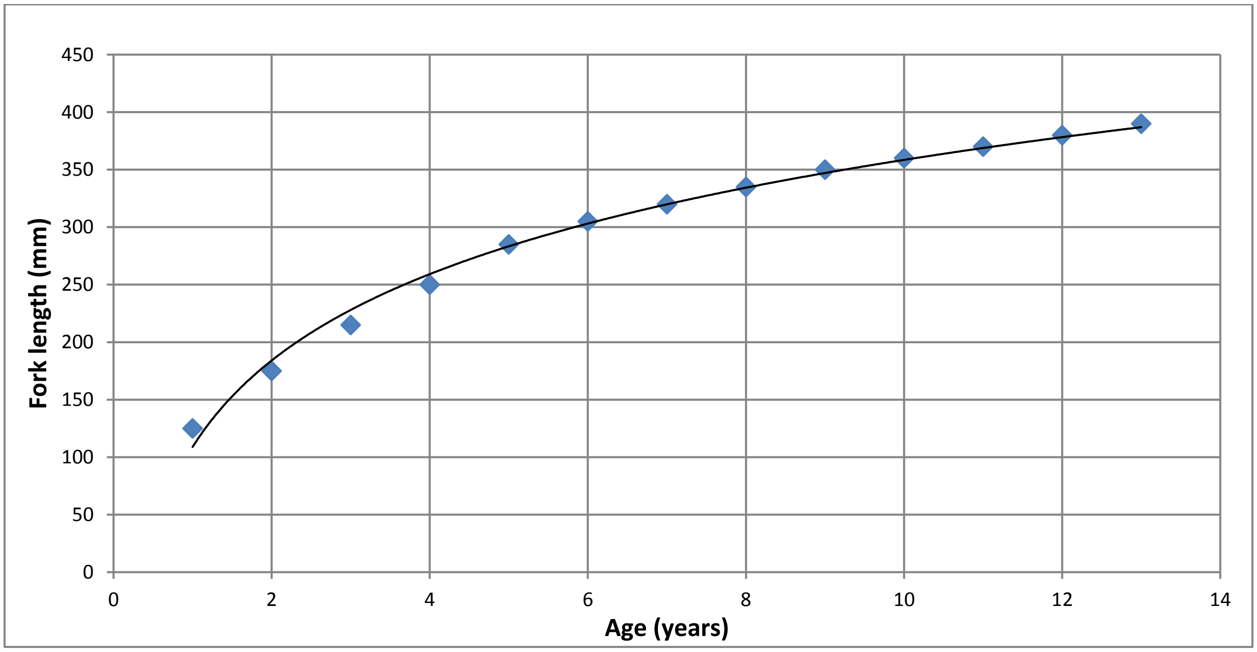


Figure 5.7-6. Arctic Grayling Fork Length and Age in the Upper Susitna

Susitna Middle River Data from APA (1984a)

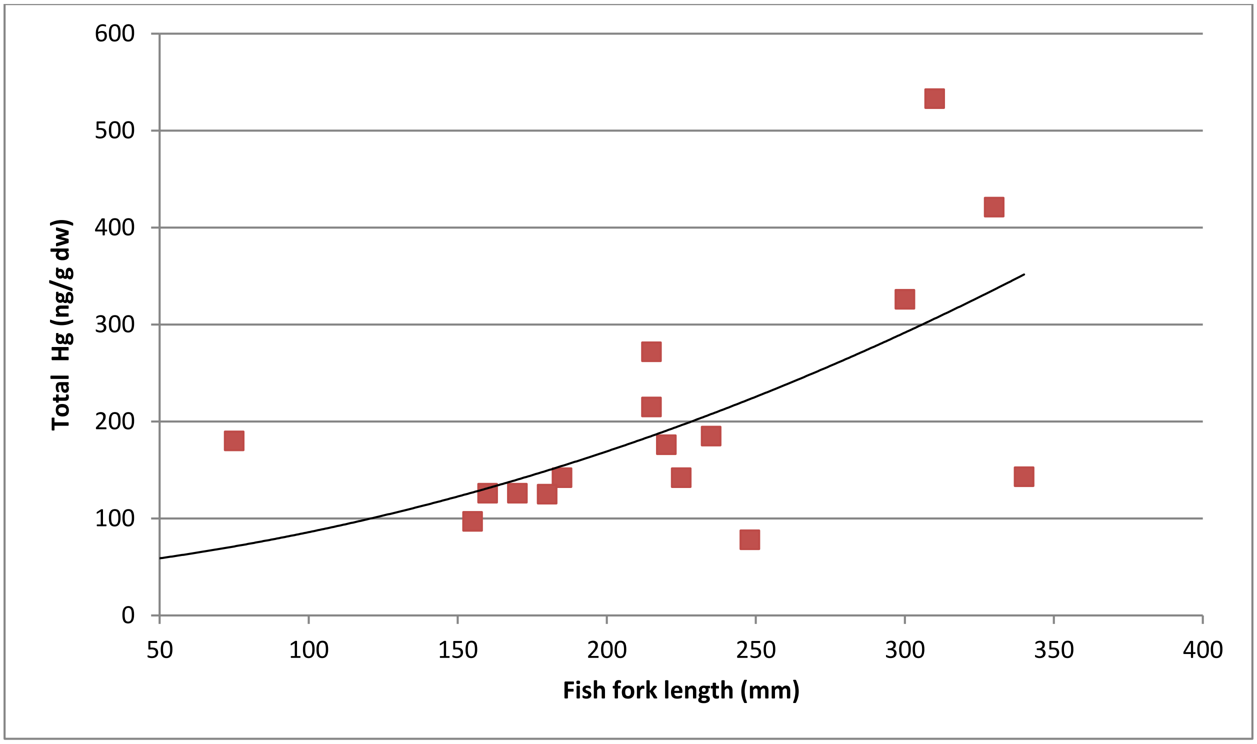


Figure 5.7-7. Arctic Grayling Fork Length and Total Hg (dw)

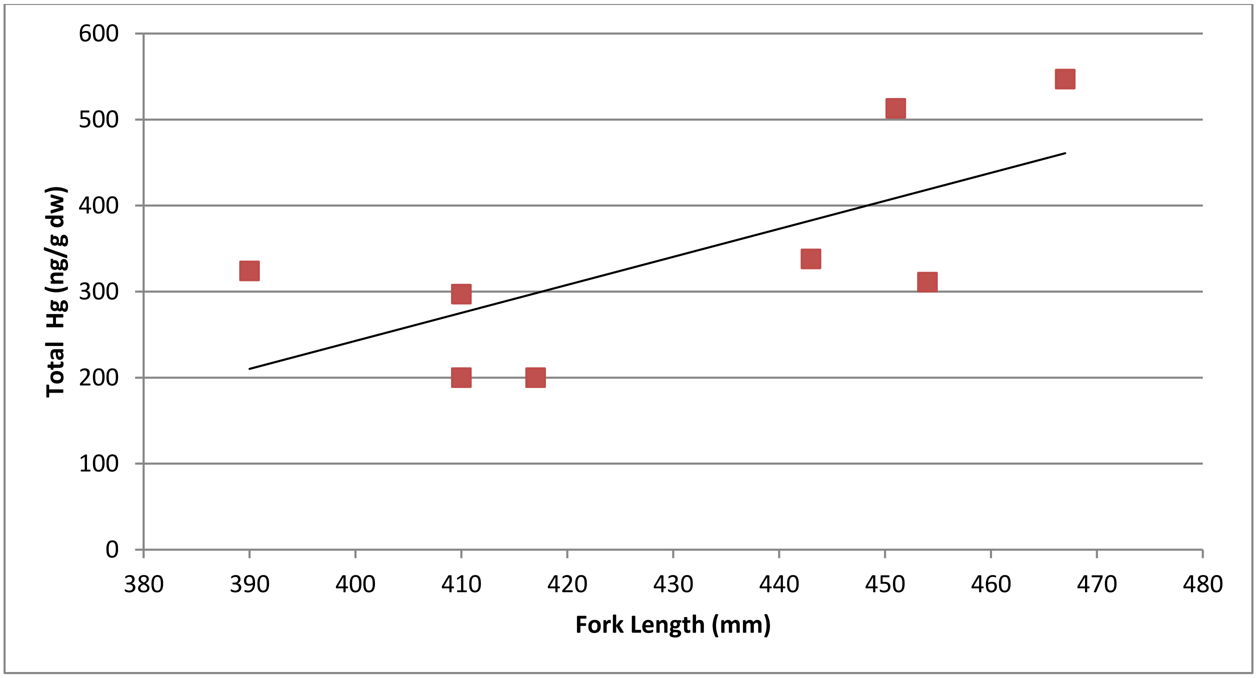


Figure 5.7-8. Burbot Fork Length and Total Hg (dw)

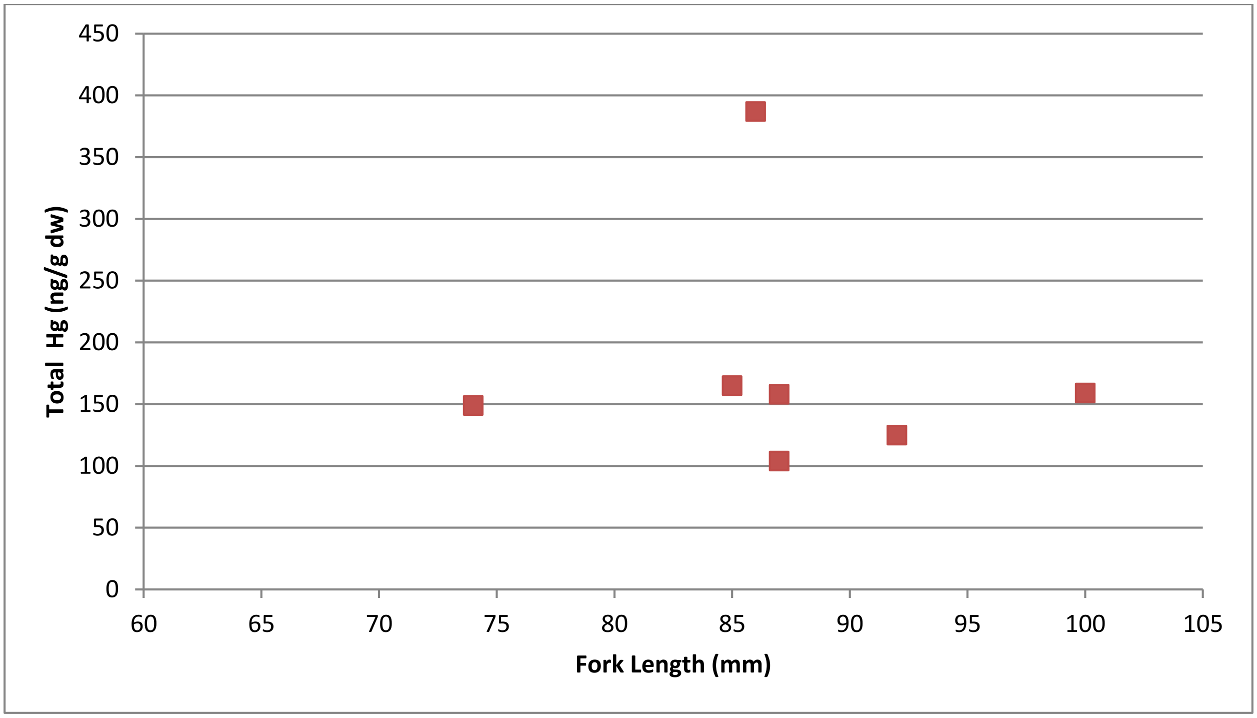


Figure 5.7-9. Slimy Sculpin Fork Length and Total Hg (dw)

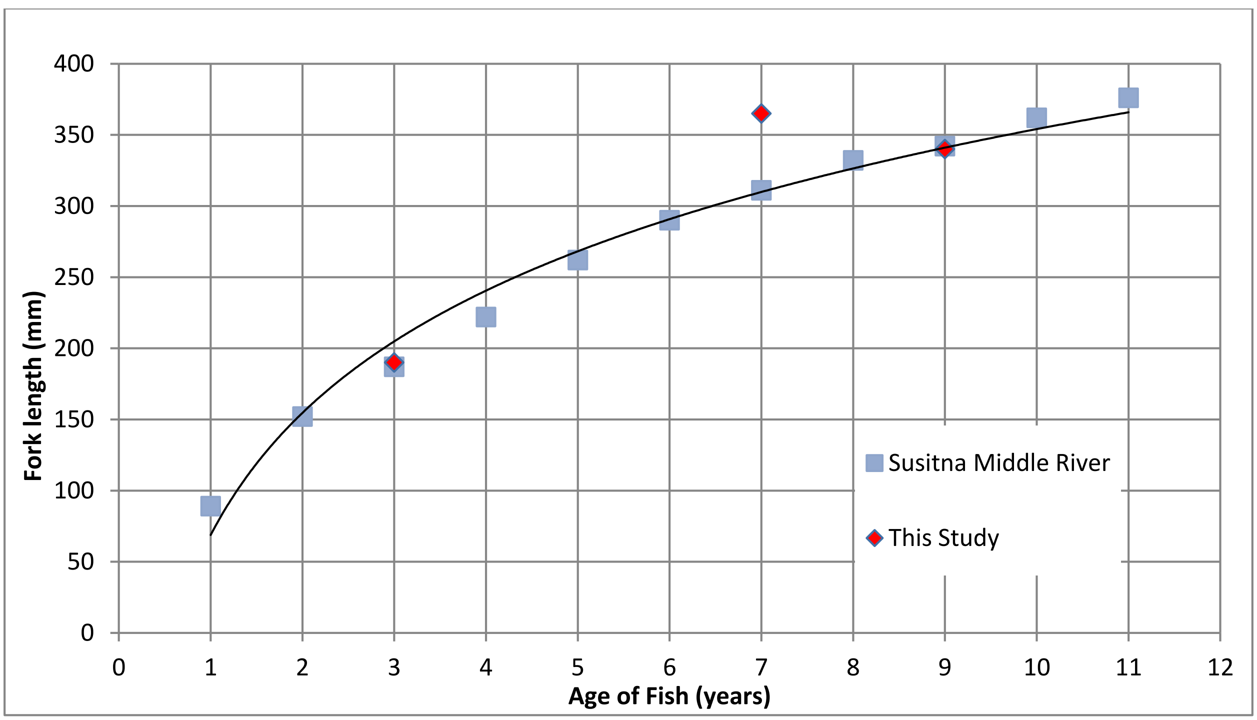


Figure 5.7-10. Round Whitefish Fork Length and Age

Susitna Middle River Data from APA (1984b)

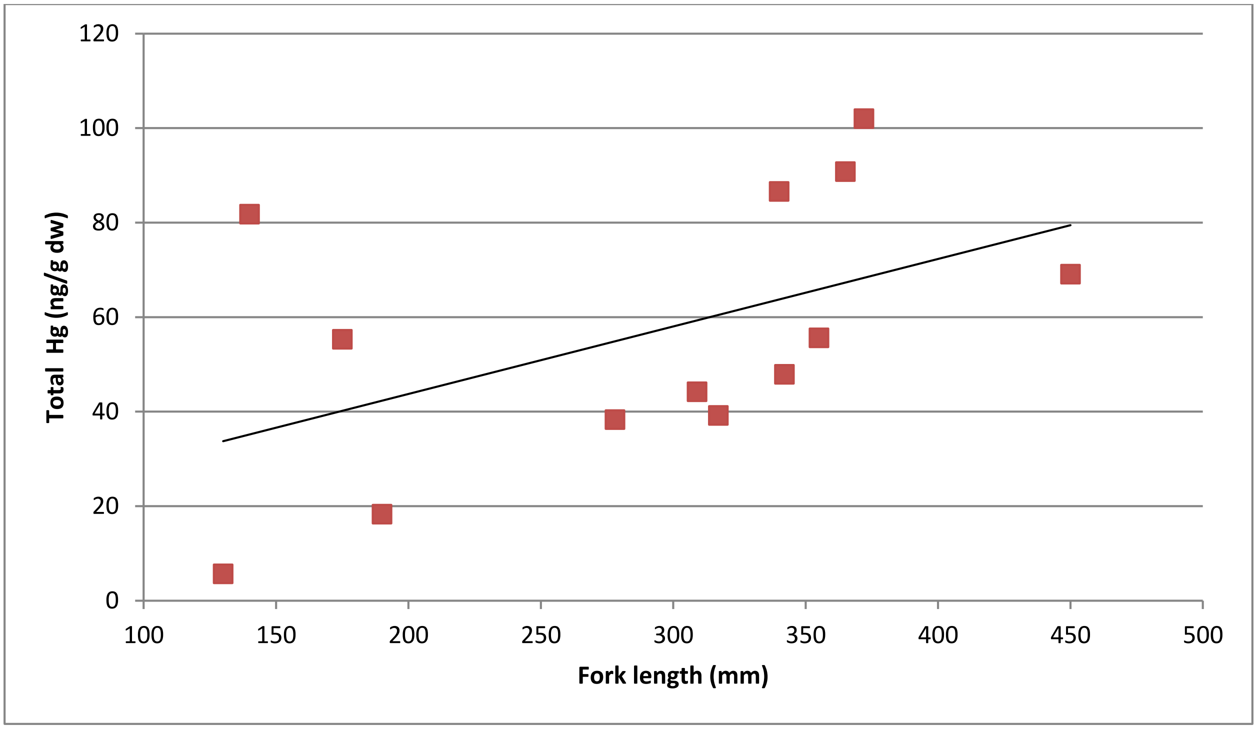


Figure 5.7-11. Round Whitefish Fork Length and Total Hg (dw)

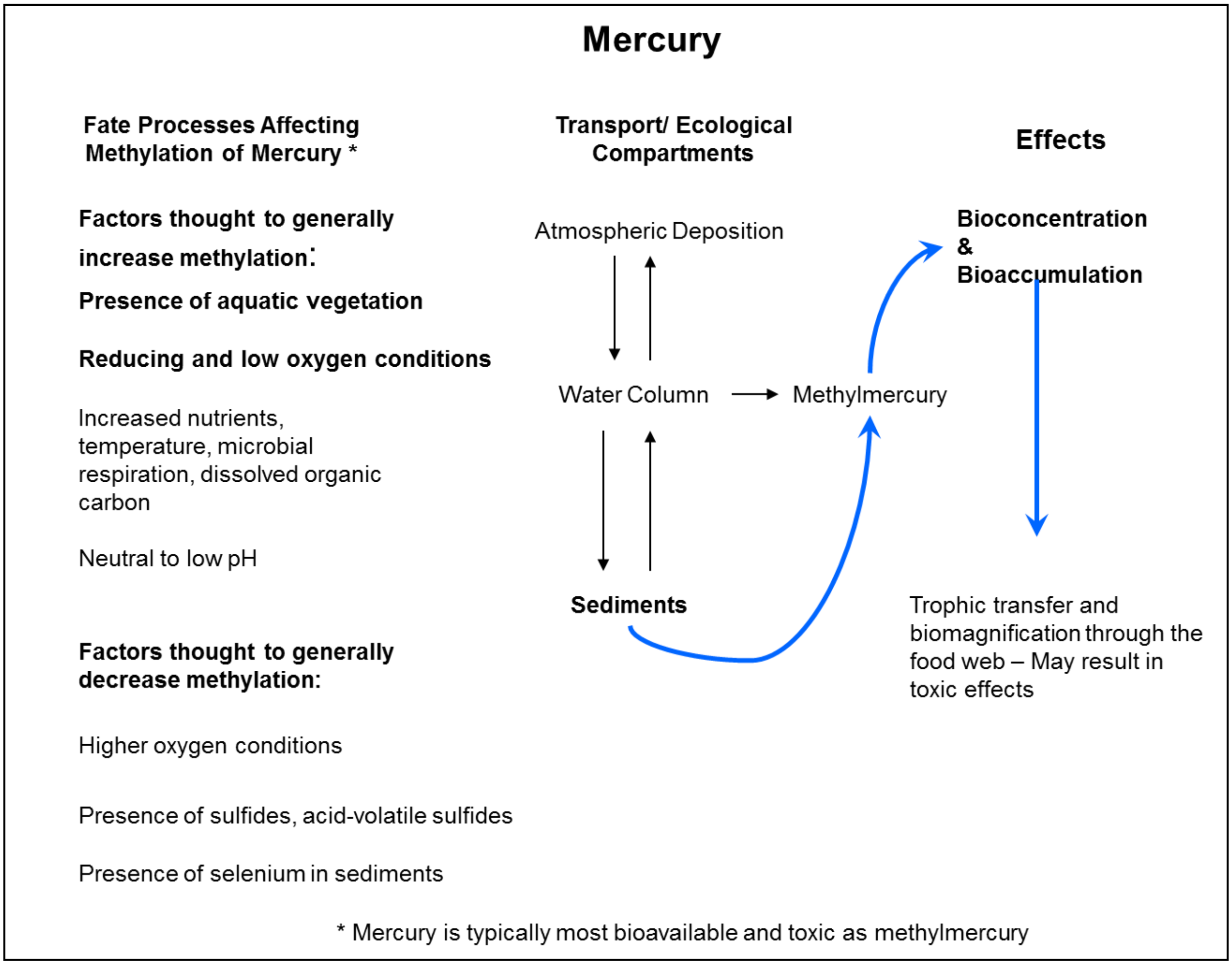


Figure 5.8-1. Factors that Effect Mercury Bioconcentration and Bioaccumulation.

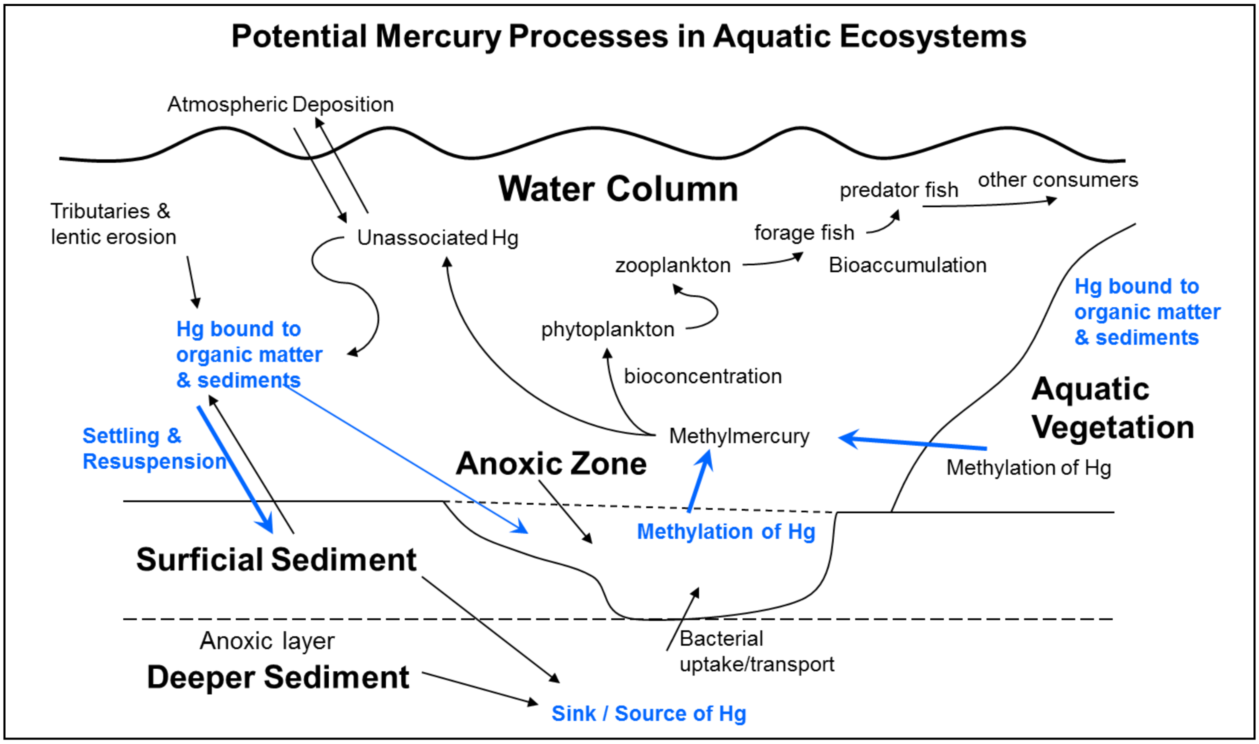


Figure 5.8-2. Potential Mercury Processes Under Existing Conditions.

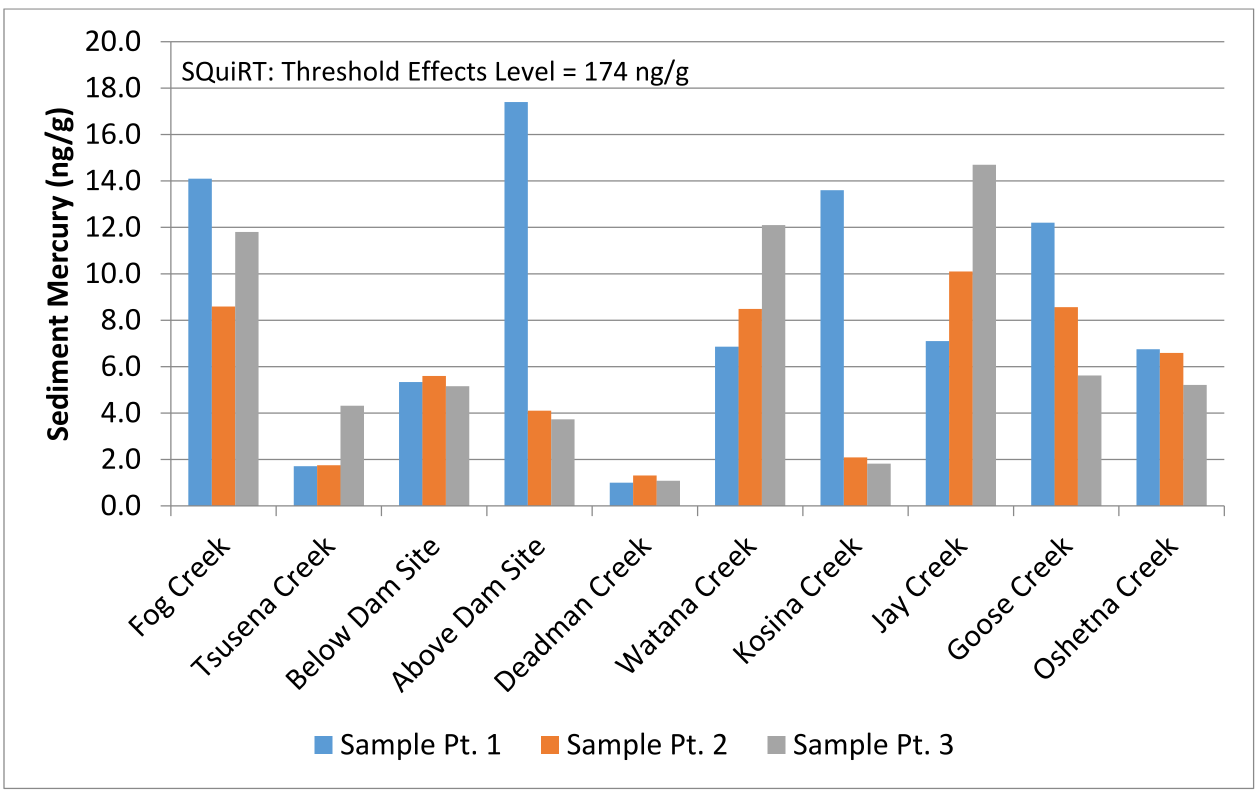


Figure 5.8-3. Sediment Mercury Concentrations Under Existing Conditions

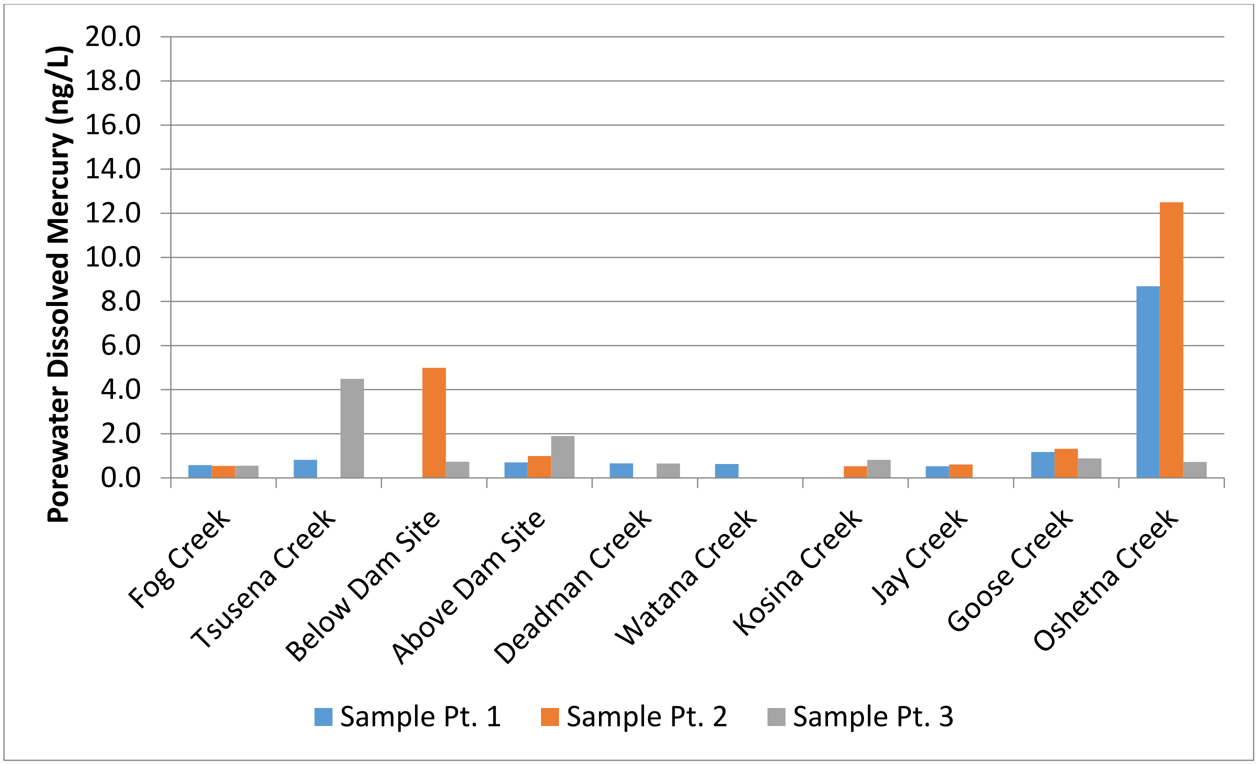


Figure 5.8-4. Porewater Mercury Concentrations Under Existing Conditions.

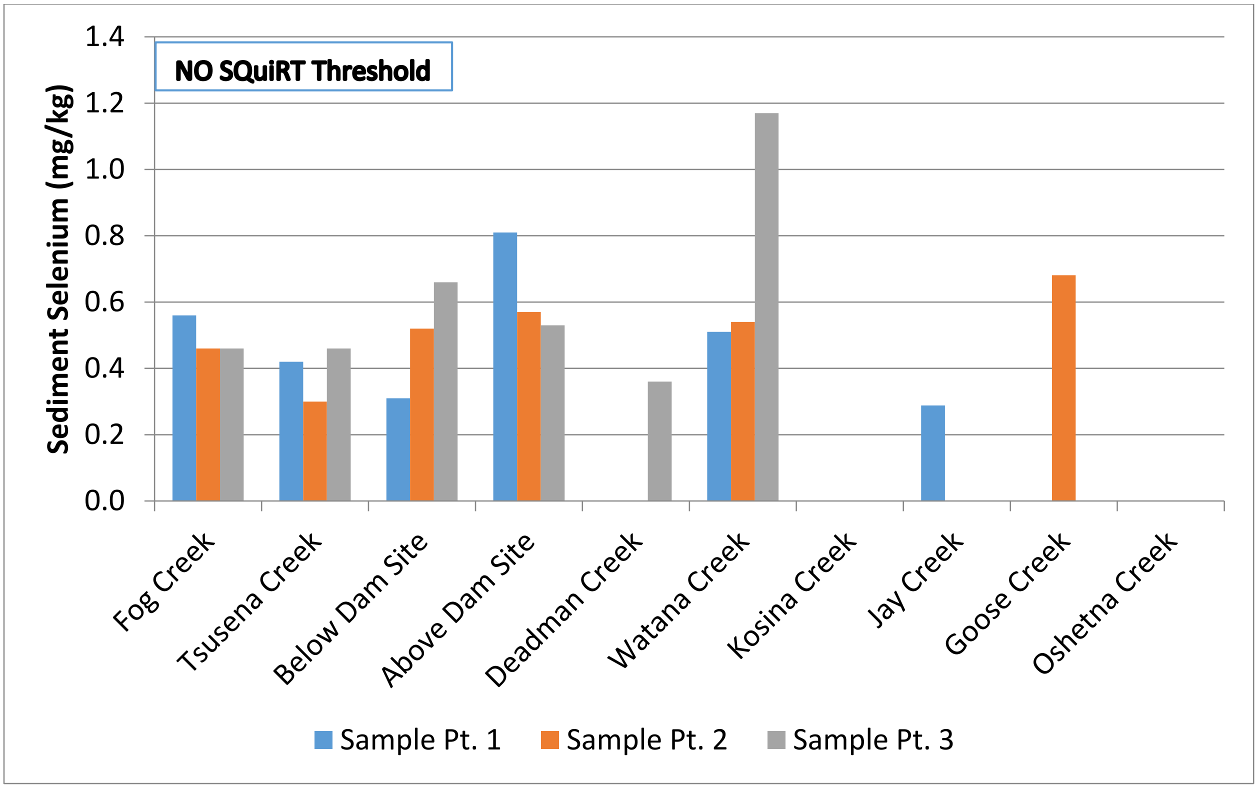


Figure 5.8-5. Sediment Selenium Concentrations Under Existing Conditions.

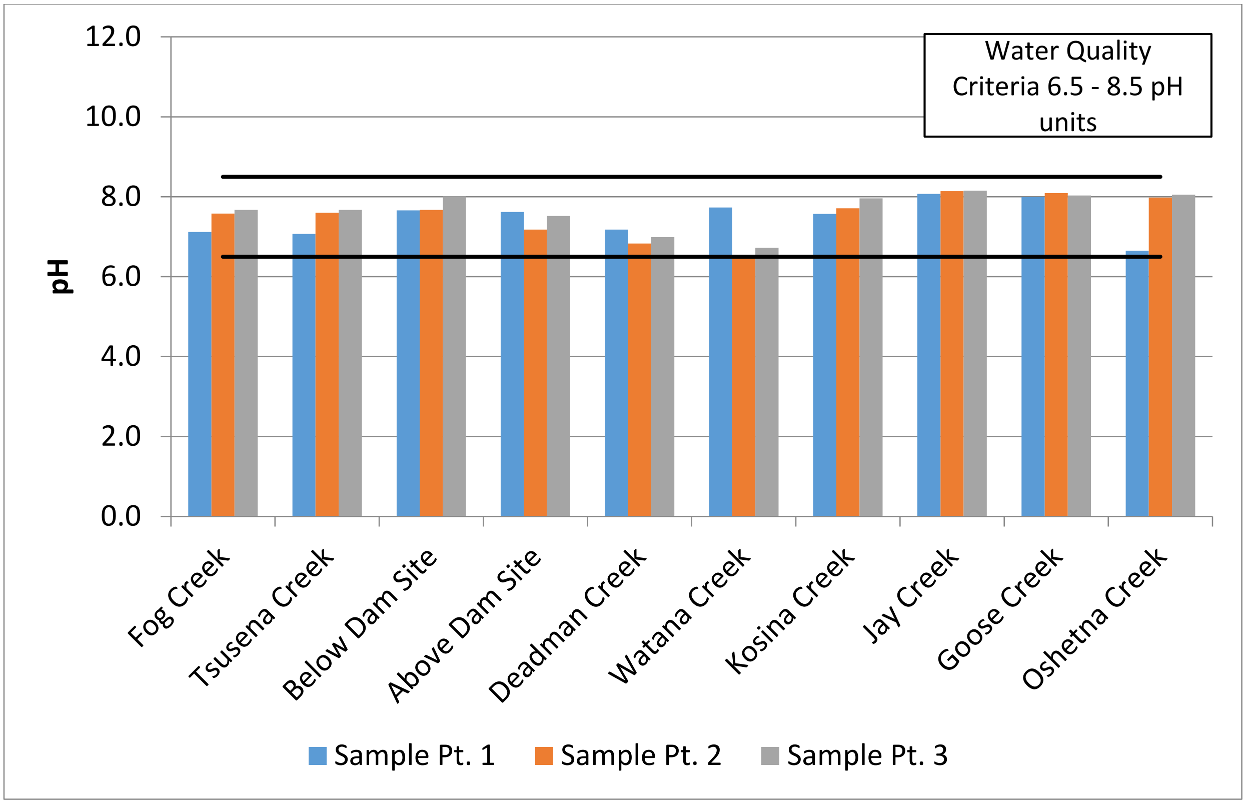


Figure 5.8-6. Surface Water pH Conditions at Sediment Interface Under Existing Conditions.

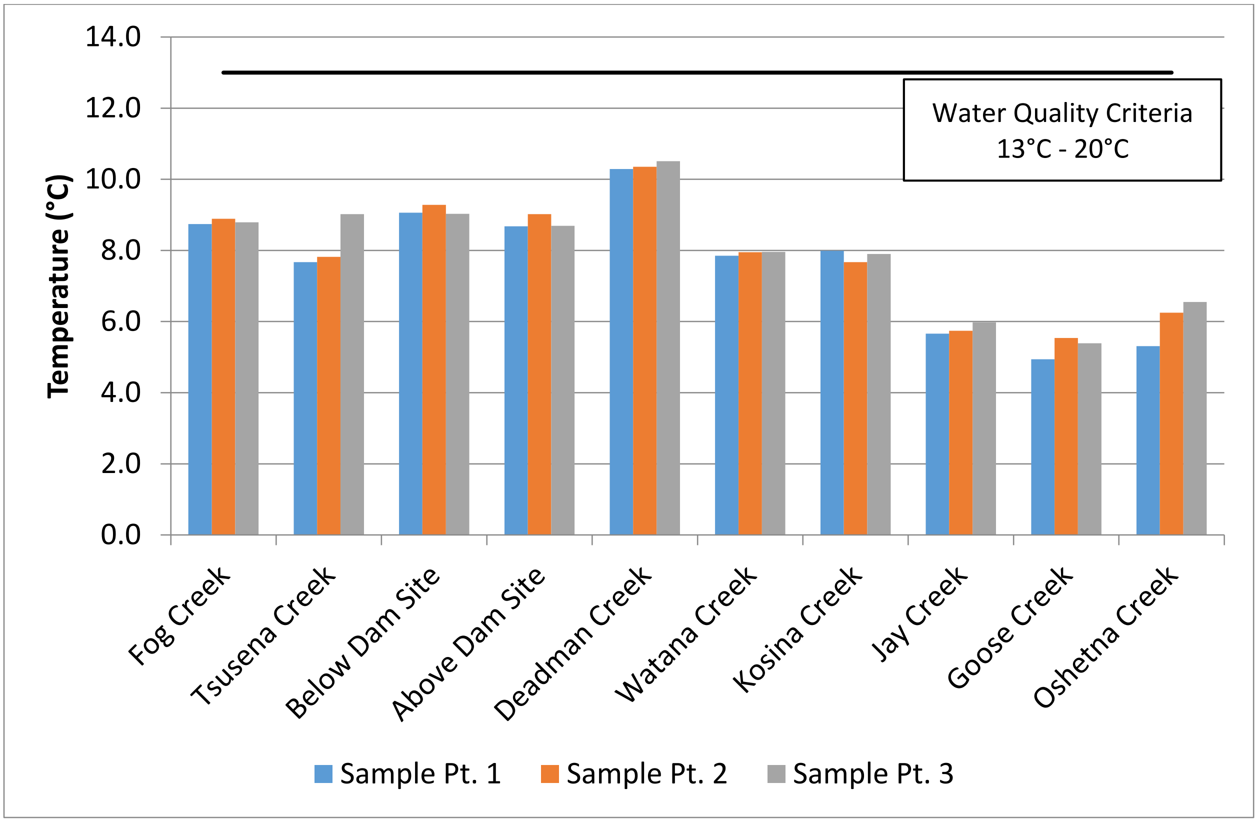


Figure 5.8-7. Surface Water Temperature Conditions at Sediment Interface Under Existing Conditions.

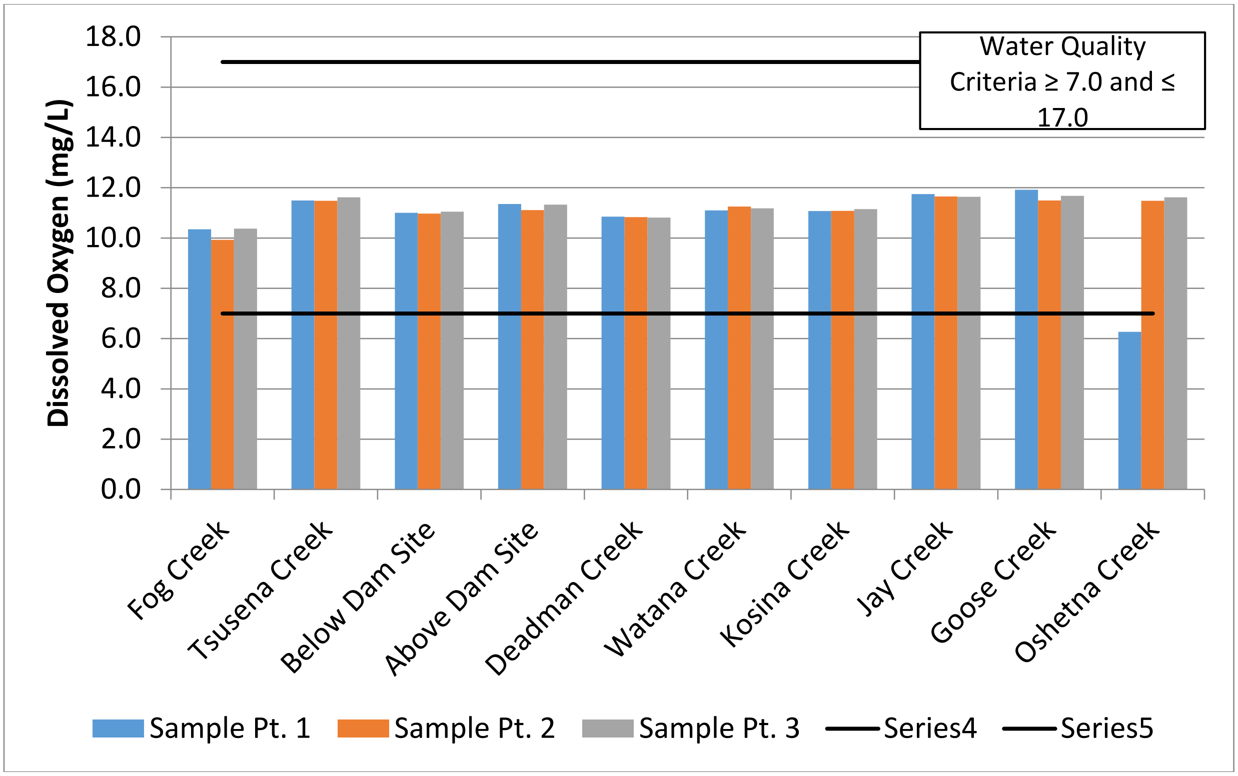


Figure 5.8-8. Surface Water Dissolved Oxygen Concentrations at Sediment Interface Under Existing Conditions.

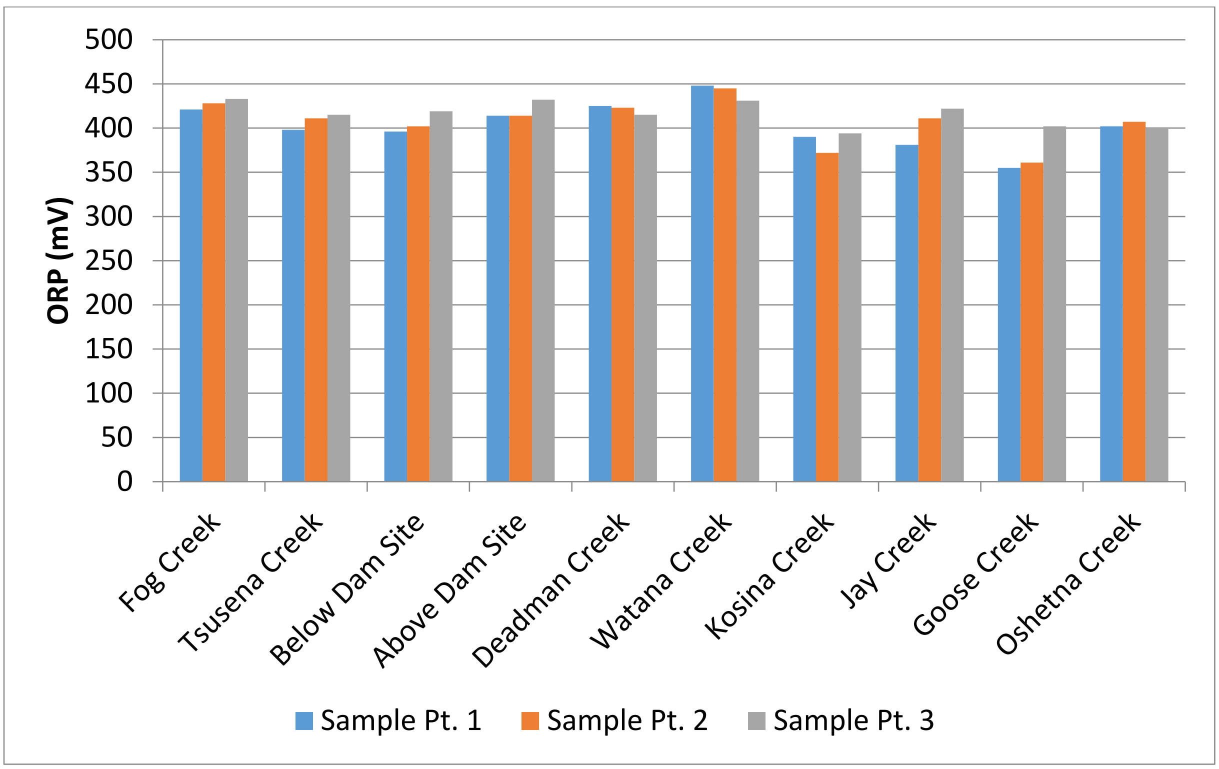


Figure 5.8-9. Surface Water Reduction/Oxidation Potential at the Sediment Interface Under Existing Conditions.

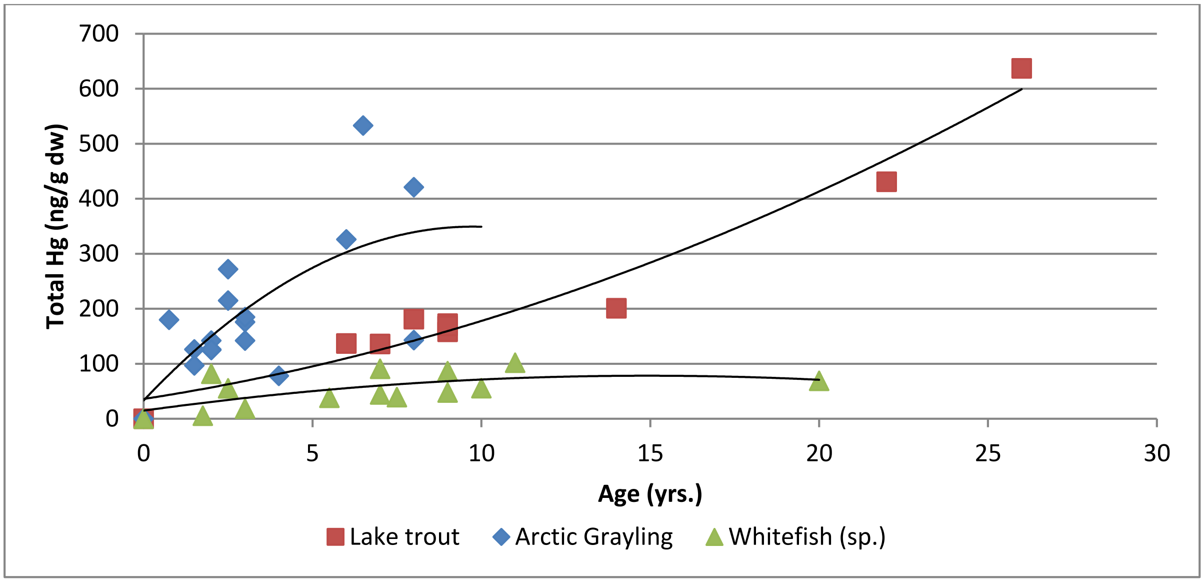


Figure 6.7-1. Comparison Between Fish Age and Mercury Concentrations.

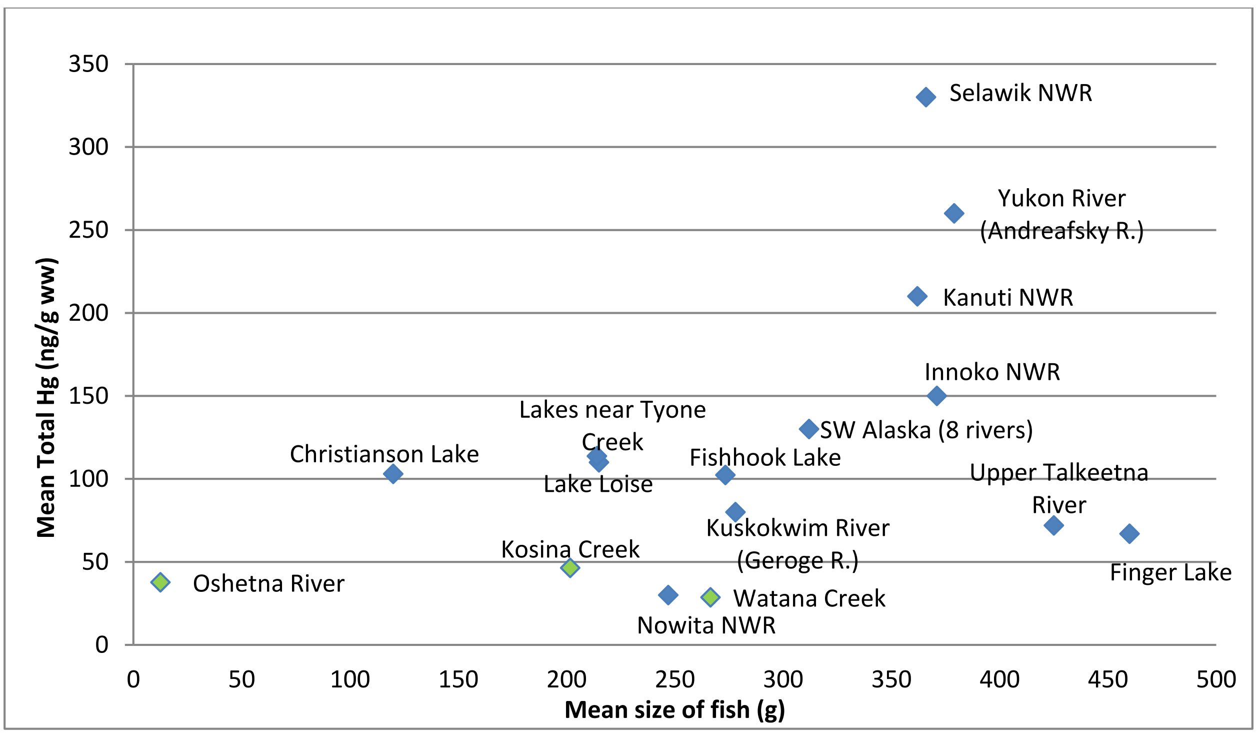


Figure 6.7-2. Arctic Grayling Mean Size and Total Hg Comparison.

Data from this study (green markers), as well as ADEC (2012); Jewett et al (2003); Gray et al (1996); Mueller and Matz (2002); Mueller et al. (1993); and Snyder-Conn et al. (1993)r