US Army Corps of Engineers®
Portland District

SEDIMENT QUALITY REPORT

LOWER GRANITE LAKE
COLUMBIA RIVER BASIN
SNAKE RIVER, WASHINGTON

Lower Granite Lake

Sediment Quality Report
August 2020

EXECUTIVE SUMMARY

The Lower Granite Dam is located at River Mile (RM) 107.5 on the Lower Snake River, downstream of the confluence of the Clearwater River and the Snake River (Figure 1-1 and Figure 1-2). Lower Granite Dam is operated by the U.S. Army Corps of Engineers (Corps). Upstream on the Clearwater River is the Dworshak Dam, which is also operated by the Corps. Several non-Federal dams are located upstream on the Snake River: the Hells Canyon Dam, the Oxbow Dam, and the Brownlee Dam were constructed and are operated by the Idaho Power Company. The Lower Granite Dam was constructed between 1965 and 1984, with the first power generating units completed in 1975. The hydraulic height is 105 feet, and the dam has a total storage capacity of 483,800 acre-feet. The pool behind the dam is approximately 100 feet deep at the dam site and approximately 16 feet deep at the upper end of the pool. The Lower Granite pool (reservoir) extends 39.3 miles upstream on the Snake River and 4.6 miles on the Clearwater River.

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ACRONYMS

Acronym	Description
µg/kg	Microgram Per Kilogram
CoCs	Contaminants of Concern
Corps	U.S. Army Corps of Engineers
DMMU	Dredged Material Management Unit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
IDEQ	Idaho Department of Environmental Quality
MCY	Million Cubic Yards
mg/kg	Milligrams Per Kilogram
NRCS	National Resources Conservation Service
ng/kg	Nanograms Per Kilogram
PAHs	Polycyclic Aromatic Hydrocarbons
PBDEs	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
RM	River Mile
RSET	Northwest Regional Sediment Evaluation Team
SEF	Sediment Evaluation Framework for The Pacific Northwest
SL1	Screening Level 1
SVOC	Semi-Volatile Organic Compounds
TDG	Total Dissolved Gas
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
USGS	U.S. Geological Survey
VOC	Volatile Organic Compounds
WWTP	Wastewater Treatment Plant

SECTION 1 - INTRODUCTION

1.1 STUDY AREA

The Snake River originates in western Wyoming at Yellowstone National Park and flows approximately 1,609 kilometers (1,000 miles) through the states of Idaho, Washington, and Oregon to its confluence with the Columbia River near Pasco and Burbank, Washington. It is the largest tributary of the Columbia River and drains an area of approximately 282,000 square kilometers (109,000 square miles), including most of Idaho and portions of Oregon, Washington, Wyoming, Nevada, and Utah. The topography within the basin ranges from steep mountainous areas, mainly in the upper headwater areas, to extensive volcanic plateaus and plains that have been deeply incised by the river over geologic time. The total fall of the Snake River from its source near Two Ocean Plateau, Wyoming, to its confluence with the Columbia River is approximately 9,500 feet. Between Lewiston (confluence with the Clearwater River) and Pasco (confluence with the Columbia River), the lower Snake River falls approximately 400 feet vertically in a distance of approximately 140 miles, an average slope of approximately 3 feet per mile.

The lower Snake River includes a 225-kilometer (140-mile) reach extending from the point of confluence with the Columbia River (Pasco, Washington), upstream to the Clearwater River near Lewiston, Idaho. Between 1961 and 1985, the U.S. Army Corps of Engineers (Corps) completed construction and began operating four run-of-river lock and dam projects on this reach of the Snake River. These project uses include navigation, power generation, recreation, irrigation, and fish and wildlife.

The Lower Granite Dam is located at River Mile (RM) 107.5 on the Lower Snake River, downstream of the confluence of the Clearwater River and the Snake River (Figure 1-1 and Figure 1-2). Lower Granite Dam is operated by the U.S. Army Corps of Engineers (Corps). Upstream on the Clearwater River is the Dworshak Dam, which is also operated by the Corps. Several non-Federal dams are located upstream on the Snake River: the Hells Canyon Dam, the Oxbow Dam, and the Brownlee Dam were constructed and are operated by the Idaho Power Company. The Lower Granite Dam was constructed between 1965 and 1984, with the first power generating units completed in 1975. The hydraulic height is 105 feet, and the dam has a total storage capacity of 483,800 acre-feet. The pool behind the dam is approximately 100 feet deep at the dam site and approximately 16 feet deep at the upper end of the pool. The Lower Granite pool (reservoir) extends 39.3 miles upstream on the Snake River and 4.6 miles on the Clearwater River.

Figure 1-1. Lower Snake River Overview

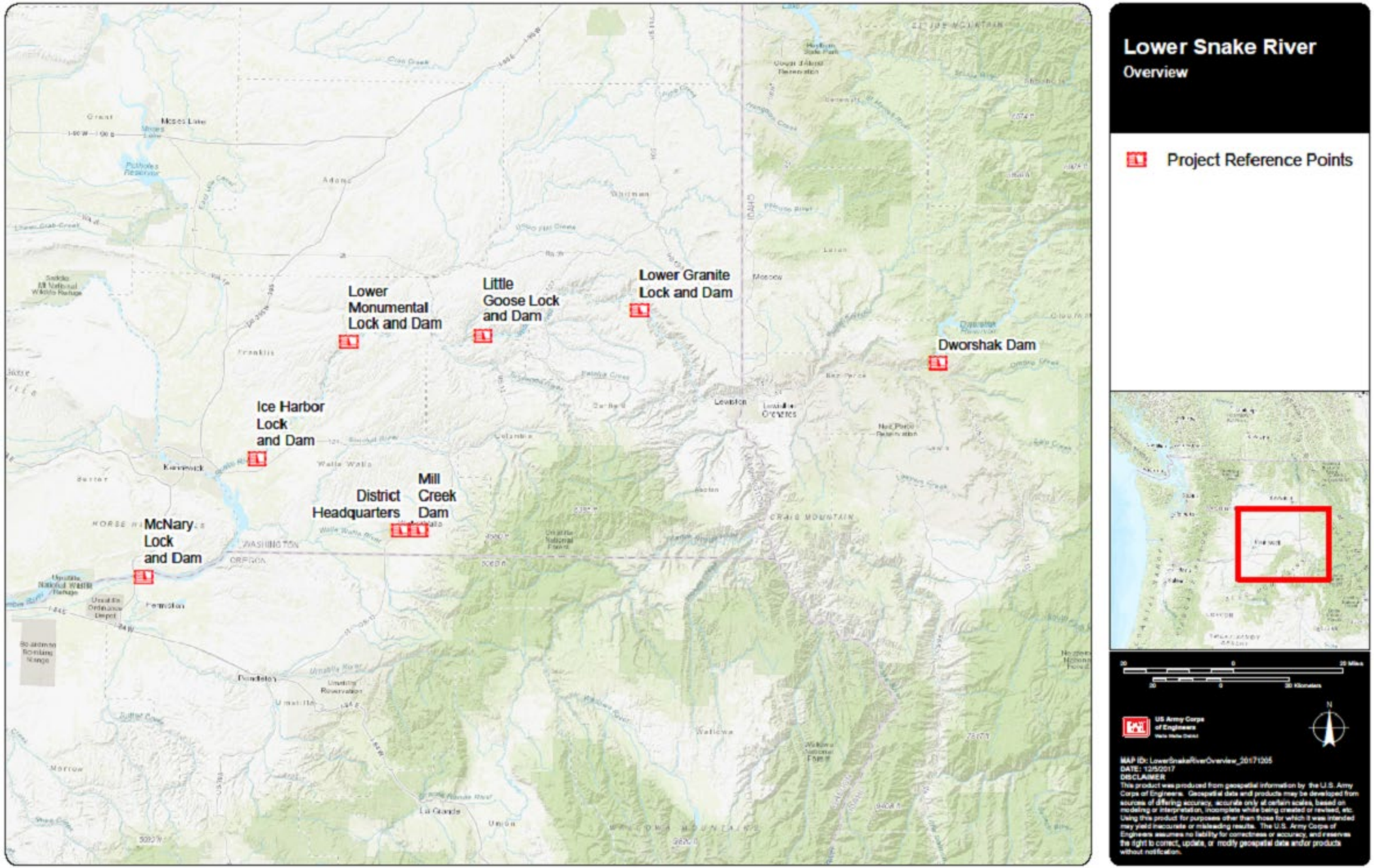
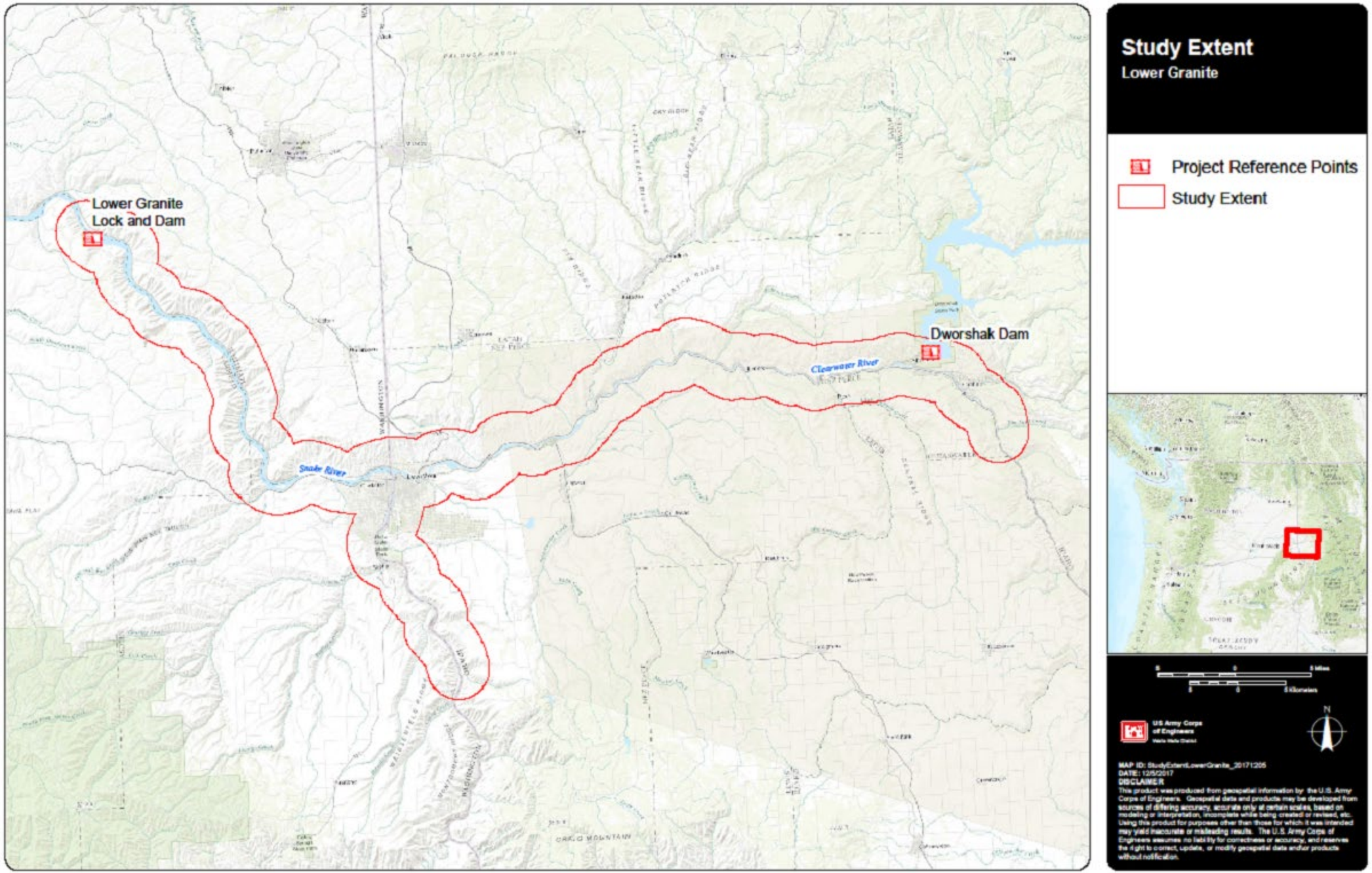


Figure 1-2. Lower Granite Reservoir and Pool



This report includes an evaluation of sediment conditions and quality on the portion of the Clearwater River bounded by the Dworshak Dam upstream, continuing downstream through the confluence with the Snake River, and along the Snake River to the Lower Granite Dam. Figure 1-1 shows the Columbia River Basin. Figure 1-2 shows the portion of the Clearwater and Snake Rivers discussed herein. This evaluation of sediment conditions is not intended to support a specific dredging or other project, but rather to support the analysis of existing and future conditions and aid in the evaluation of alternatives for the Columbia River System Operations Environmental Impact Statement.

1.2 SEDIMENT EVALUATION FRAMEWORK

The Sediment Evaluation Framework (SEF) for the Pacific Northwest (Northwest Regional Sediment Evaluation Team [RSET] Agencies 2016) is a regional guidance manual produced by federal and state agencies. It provides a framework for the consistent characterization and assessment of sediment. Specifically, the framework can be used to determine the suitability of the materials for unconfined aquatic placement and to predict water quality impacts during dredging operations. The framework is intended for use in the states of Washington, Oregon, and Idaho. It serves as an implementation manual for the *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.—Testing Manual* (Inland Testing Manual) (1998) produced by the U.S. Environmental Protection Agency (EPA) and the Corps for satisfying Clean Water Act testing requirements.

Although the SEF was produced specifically for the evaluation of dredged materials for unconfined aquatic placement, the framework is also used for evaluating non-navigational projects and for anti-degradation evaluations. An anti-degradation evaluation is a site-specific determination as to whether a proposed action will impact water quality such that existing water uses cannot be maintained or water quality will not fully meet Clean Water Act requirements. Because the purpose of the Columbia River System Operations Environmental Impact Statement is similar to an anti-degradation evaluation, the SEF provides a suitable approach for this report.

The SEF provides a “tiered” approach to make risk-based sediment assessments. Level 1 includes an evaluation of historically available data and the development of a conceptual site model. Level 2 includes the physical, chemical, and biological evaluation of the sediment and is conducted if the information collected for Level 1 is insufficient to make a risk-based determination. This report focuses on a Level 1 evaluation; no additional sediment data will be collected at this time. This report does discuss data gaps and data needs for potential future project implementation and provides recommendations on future data collection.

SECTION 2 - SEDIMENT QUALITY

2.1 GENERAL DESCRIPTION

2.1.1 Geology and Soils

The Lower Granite drainage area includes both the Clearwater River Subbasin and the Snake River Subbasin (downstream of Hells Canyon Dam). The land surrounding the Clearwater River below Dworshak Dam consists of plateaus and foothills divided by breaklands and the Selway-Bitterroot mountain range (Corps 2014a). The breaklands are sloped between 60 to 80 percent, which contributes to sediment transport. The area is dominated by volcanic rocks such as granite and schist. The schists are highly erodible and are the least stable geologic materials in the basin. Basalts are also present in the eastern portion of the Clearwater River Subbasin. The soils are built on windblown loess, and these fine-grained materials are easily disturbed by erosion. Overall, the predominant soil types are silty loams (National Resources Conservation Service [NRCS] 2017).

Downstream of the Hells Canyon Dam, the Snake River flows through a steep-sided canyon that has basalt and metamorphic rock sides; these materials are largely resistant to erosion but may experience rockfalls and landslides (Corps 2014a). Further downstream, near the Asotin Creek area, the topography becomes less severe. The area includes hills consisting of loess and alluvial deposits, as well as scablands where the surficial soils have been scoured away leaving the underlying basalt exposed. Soils are loams, with areas of sandy and stony loams and areas of silty loams (NRCS 2017). The sandy and cobbled soils reflect the rocky upstream areas of Hells Canyon, as well as the more steeply sloped river channel.

2.1.2 Sediment Loading in the Reservoir

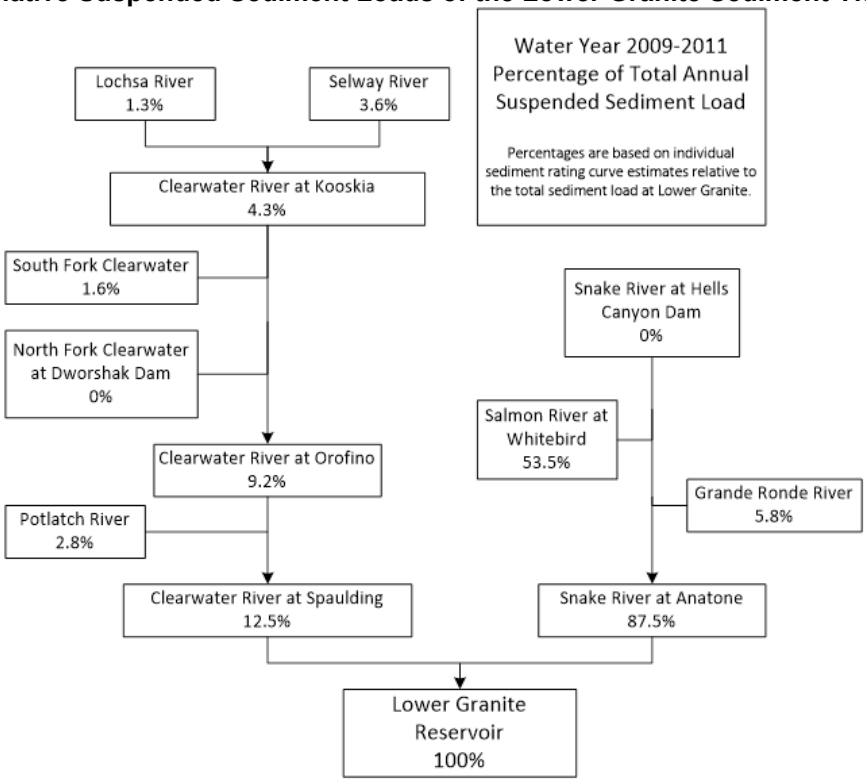
The U.S. Geological Survey (USGS) conducted a study of sediment transport in the lower Snake and Clearwater River Basins in Idaho and Washington from 2008 to 2011 (Clark, Fosness, and Wood 2013). For that study, both traditional suspended sediment and bedload measurements were performed, and acoustic Doppler velocity measurements were used as a surrogate to estimate combined sediment concentrations and transport. Suspended sediment is measured in water samples; suspended sediment is the fraction of solids that are in suspension and move with the flow of the water. Bedload is the most difficult measurement to make and often has the least data available; bedload is the sediment that moves along the bottom of the waterway by sliding, rolling, or bouncing with more movement at greater flows. Both suspended sediment deposition and bedload movement contribute to the accumulation of sediment within the reservoir. The data collected by Clark et al. from 2008 to 2011 were compared to an earlier study in the 1970s. In general, the amount of suspended sand being transported downstream had increased compared to the earlier results; the cause is suspected to be related to the numerous wildfires that occurred in Idaho during the intervening years between the studies. Bedload was highly variable within the study area and was less than suspended solids load. The estimated bedload to the Lower

Granite Reservoir is 64,500 tons of material per year, while the estimated suspended solids contribution to the reservoir is on the order of 10,000,000 tons per year. For both suspended solids and bedload, the majority of the material entering Lower Granite Reservoir is contributed by the Snake River. This study was conducted in support of the Programmatic Sediment Management Plan development, discussed below.

The most recent and comprehensive evaluation of sediment movement in the Clearwater and lower Snake Rivers is the Lower Snake River Programmatic Sediment Management Plan (Corps 2014a). The plan was developed by Corps for the purpose of analyzing sediment sources and movement, and evaluating sediment management strategies for the lower Snake River. This report includes a summary of sediment surveys taken periodically from 1974 (just before the Lower Granite Dam began pooling water) through 2011. Survey data were used to determine the bed changes along the river, to calculate sediment movement and accumulations, and to evaluate future conditions. The following summary is largely drawn from that report.

Sediment in the Lower Granite Reservoir originates in the Clearwater River and tributaries and the Snake River and tributaries. Figure 2-1 shows the relative inputs from the various tributaries as percentages of the total loading to the Lower Granite Reservoir. These percentage inputs are based on average annual contributions; several of the tributaries do not have linear inputs, and sediment loading is more episodic and related to discharge. These numbers should be taken as relative contributions, but not specific loading rates for a specific time.

Figure 2-1. Relative Suspended Sediment Loads of the Lower Granite Sediment Yield Watershed



Source: Corps (2014a)

The vast majority of the sediment originates in the Snake River and its tributaries. The average annual inflow of sediment in Lower Granite Reservoir is estimated to be 3 million cubic yards (MCY) per year (Corps 2002), with approximately 2.2 MCY of that deposited (Corps 2014a). From 1974 to 2010, the total gross sediment volume accumulated in Lower Granite Reservoir (below the confluence) is estimated to be 74.7 MCY (Corps 2014a). Sediment movement is not constant or linear, however, and tends to vary over time in response to weather, watershed conditions, and reservoir operation.

Sediment deposition is highly variable. Little sediment settles above the confluence between the Snake and Clearwater Rivers. At the confluence, including the Port of Lewiston immediately above the confluence, sediment accumulation is a problem within the navigation channel; this area is dredged with some regularity. The confluence notwithstanding, the majority of the sediment entering the Lower Granite Reservoir accumulates farther downstream, below Silcott Island. Only 16 percent of the accumulation is between the confluence and Silcott Island; this area is mainly sandy material. Deposits downstream of approximately RM 130 are mainly silt. Above the confluence the river beds in both the Clearwater and Snake Rivers are fine sands. Figure 2-2 shows typical shoaling areas near the confluence (Corps 2014a).

Figure 2-2. Shoaling Near the Confluence of the Snake and Clearwater Rivers

Source: Corps (2014a)

Periodic dredging, mainly at the confluence, has been performed to maintain the navigation channel. Table 2-1 below shows a summary of the dredging events. Overall, the volume of sediment moved during dredging is small compared to the total loading of the reservoir, less than 6 percent (Corps 2014a).

Bathymetry and bed plots suggest that the upper reach of Lower Granite Reservoir, between the confluence and Silcott Island, is tending toward equilibrium under the current discharge and sediment input regimes. There is no evidence that the annual sediment loading to Lower Granite Reservoir is decreasing over time, and in fact, a comparison of past and present measured conditions indicate an increasing trend in suspended sand load. Although additional data would be needed to confirm this trend, for now it is assumed that sediment inflow to Lower Granite Reservoir is increasing over time. The modeled sediment accumulation in Lower Granite reservoir over the next 50 years is estimated to be 69 MCY, with about 16 MCY of that accumulating between the confluence and Silcott Island.

2.1.3 Past Dredging

The Lower Granite Reservoir (particularly the Clearwater River/Snake River confluence) is a well-identified deposition zone, and for this reason, periodic dredging events have occurred since the Lower Granite Dam pool was raised in 1975. Table 2-1 lists past dredging events in this segment of river.

The number of dredging events and the large volumes of material removed are indicative of the large volumes of sediment that move down the lower Snake River and accumulate in Lower Granite pool. The majority of deposition occurs downstream of the confluence of the Snake and Clearwater Rivers. The depth of sediment accumulated behind the dam has not been explicitly estimated, although the total gross accumulation within the reservoir is estimated to be on the order of 80 MCY. Although sediment accumulates in many locations along this river reach, only the navigation channel is maintained by dredging. Sediment from the recent dredging events was placed in open water within the Snake River to create shallow riverine habitat.

Table 2-1. Past Dredging in Lower Granite Pool

Year	Location	Volume (cubic yards)	Sediment Sampling[1/]
1982	Port of Lewiston—Lower Granite Reservoir	256,200	NA
1982	Port of Clarkson—Lower Granite Reservoir	5,000	NA
1985	Confluence of Clearwater and Snake Rivers	771,000	NA
1986	Port of Lewiston—Lower Granite Reservoir	378,000	NA
1988	Confluence of Clearwater and Snake Rivers	916,000	NA
1989	Confluence of Clearwater and Snake Rivers	993,500	NA
1992	Confluence of Clearwater and Snake Rivers	520,700	NA
1996–1997	Confluence of Clearwater and Snake Rivers	68,700	NA
1997–1998	Confluence of Clearwater and Snake Rivers	215,200	NA
1997–1998	Port of Lewiston	3,700	NA
1997–1998	Port of Clarkston	12,150	NA
2000	Confluence of Clearwater and Snake Rivers	118,000	1997

Year	Location	Volume (cubic yards)	Sediment Sampling[1/]
2005–2006	Confluence of Clearwater and Snake Rivers, Ports of Lewiston and Clarkston	553,200	2003
2014–2015	Confluence of Clearwater and Snake Rivers, Ports of Lewiston and Clarkston	372,000	2013–2014

Note: 1/ Sediment sampling results before 1997 did follow sediment characterization and analysis guidance similar to that used now (as referenced in the Inland Testing Manual and Sediment Evaluation Framework). These historic results were not evaluated in this study.

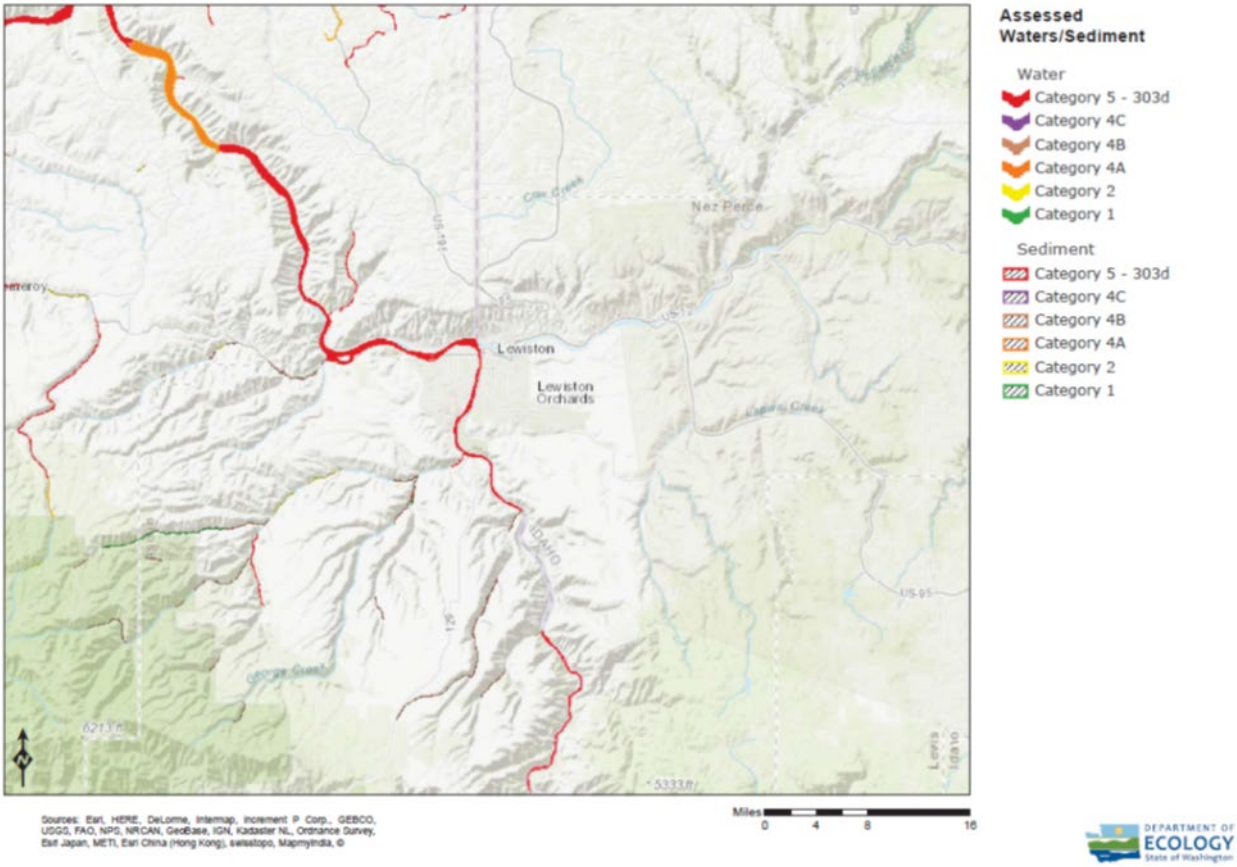
2.1.4 303(d) Status

The Clean Water Act requires that all states restore their surface waters to be “fishable and swimmable.” The assessment required is covered under Section 303(d) of the Clean Water Act. States prepare a “303(d) report” that lists the results of the assessment. The 303(d) assessments for the states of Washington and Idaho were reviewed to determine the condition of the Clearwater River (below Dworshak Dam to the confluence with the Snake River) and the lower Snake River down to Lower Granite Dam. Water quality is categorized by impairment and source for each river segment. Because sediment issues impact water quality and aquatic life, sediment contamination issues are also listed in the 303(d) report.

The most current 303(d) list for the State of Idaho was prepared in 2014 and approved by Corps in 2017 (Idaho Department of Environmental Quality [IDEQ] 2014). The Clearwater River above the confluence with the Snake River is designated as category 2 and can fully support recreation and cold water aquatic life (the uses for which it was assessed). Some tributaries of the Clearwater River are non-supporting uses (Category 4 or 5) due to flow alterations, sedimentation, eutrophication/nutrients, phosphorus, fecal coliform, E. coli, and physical substrate habitat alterations. These issues appear to be tied to land use and runoff, especially agricultural uses. Runoff from agricultural land (nutrients and pesticides associated with the runoff) can impact sediment quality.

The most current 303(d) list for the State of Washington was prepared in 2015 and approved by EPA in July 2016 (Washington State Department of Ecology [Ecology] 2015). Figure 2-3 shows a map of the water quality assessment results for the Snake River above the Lower Granite Dam and within the State of Washington. A large portion of the river is rated “Category 5” in the assessment, with the pool above the dam listed as “Category 4A.” Waters with a Category 5 rating are considered “impaired” and require a total maximum daily load (TMDL) study or other water quality improvement project. The TMDL study is used to identify sources and the relative magnitude of sources so that improvement to the watershed can be targeted. Category 4 covers waters that do not require a TMDL; Category 4A is for waters that already have an approved TMDL in place that is being implemented.

Figure 2-3. 303d List Status for Snake River in Washington



Source: Ecology. 2019

The impairments for the Snake River are varied but include both water and (fish) tissue impacts. The water quality impairments of total dissolved gases, dissolved oxygen, and pH are related to the presence and operation of the hydroelectric dams (the Lower Granite Dam as well as dams upstream). Dioxin is also listed as an impairment. In response to the water quality impairments identified in the Lower Granite Reservoir, water quality improvement plans have been developed. Specifically for the Columbia River, including the Snake River tributary, plans for temperature and total dissolved gas (TDG) have been developed. A TMDL study was conducted to allocate pollutant loads among dischargers and to set a limit for the total loading for the waterway. The TMDL for TDG was developed in 2003 (Ecology 2003). The plan includes load allocations for each dam, as measured at a specific distance below the spillway. The TDG, dissolved oxygen and pH water quality impairments are not of concern for the sediment quality.

A TMDL for 2,3,7,8-TCDD (dioxin) has been issued by EPA for the Columbia River Basin (EPA 1991). This was a federally established TMDL due to the interstate nature of the watershed. The dioxin TMDL dates to 1991, but it has been re-issued by Ecology. “Dioxin” is the name given to a family of large, chlorinated, hydrophobic compounds. The most toxic of these is 2,3,7,8-tetrachlorodibenzo-p-dioxin. The toxicity of other large and hydrophobic compounds which behave in a similar manner (such as polychlorinated biphenyls (PCBs) is sometimes expressed in terms of TCDD. The

presence of these compounds in water may also indicate accumulation in the sediment because these compounds are sparingly soluble. As part of the TMDL study, waste load allocations were set for the various pulp and paper mills throughout the Columbia River Basin. Dioxin discharges were decreased but not eliminated through changes in industrial practices. For the Snake River Subbasin, the dioxin loading capacity is 1.18 milligrams per day. Other compounds that have been measured in the river at concentrations above the water quality standard but are not considered water quality impairments include PCBs, toxaphene, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), heptachlor, heptachlor epoxide, endrin and dieldrin. These compounds are clearly related to human activities, and these anthropogenic compounds are known to accumulate in sediment.

Table 2-2 lists the fish tissue impairments for Lower Granite pool. Fish tissue impairments are caused by elevated concentrations of contaminants in fish tissue samples, such that the levels exceed human health consumption guidelines according to the National Toxics Rule water quality criterion for the protection of human health (EPA 1992). For Lower Granite pool, the fish tissue impairments are related to the presence of dioxins, PCBs and pesticides; these compounds are also measured in solution as noted above.

Mercury is present in fish tissue in the Lower Granite Reservoir, but it is not considered an impairment because concentrations are lower than health-based standards. Further upstream, in the Hells Canyon Complex, mercury is considered an impairment by the State of Oregon. Due to concerns related to the potential altering of operations at the three dams along the Snake River within the Hells Canyon Complex (upstream of the confluence with the Clearwater River), the USGS is conducting investigations into mercury cycling in this area (Clark et al. 2016). Although mercury is not listed by Washington State as an impairment, the Lower Granite Reservoir shares features with the Hells Canyon Complex dams that may lead toward higher mercury tissue concentrations. This includes the transition from a riverine system to a lacustrine system due to the presence of the dam. The lacustrine system receives high nutrient loading and is seasonally thermally stratified. In the Hells Canyon Dam pool, the cooler deeper waters tend to become anaerobic and provide an environment conducive to microbial transformation of inorganic mercury to methylmercury. When seasonal mixing occurs, the mercury in the water column can be transported downstream (Clark et al. 2016). Methylmercury is much more toxic than inorganic mercury, is readily taken up into the base of the food web, and efficiently biomagnifies to higher trophic levels. Differences in pelagic and benthic pathways are also important factors in methylmercury cycling in this system. The study of mercury distribution and cycling within the Hells Canyon Complex is ongoing, but it currently appears that mercury transport downstream may impact sediment quality in the Lower Granite Reservoir. Chronic low methylmercury concentrations have been shown to cause adverse effects on fish populations (Depew et al. 2012).

Table 2-2. 303(d) List Impairments (Categories 4 and 5) in Washington State

Compound and Listing IDs	Date Measured	Fish Tested for Tissue Impairment; Concentrations Exceeding Threshold Measured	Type of Sample	Fish Tested For Tissue Impairment; Threshold not Exceeded
Dioxin 34942, 34871	2004[1/]	Bass, sucker	unknown	
Dioxin 34942, 34871	1997	White Sturgeon	fillet without skin	
4,4'-DDE 19017, 19018	1998	Largescale sucker composite	fillet with skin	NA
PCBs 19120, 19121	1998	Largescale sucker composite	fillet with skin	NA
2,3,7,8-TCDD toxicity equivalent (TEQ)[2/] 51580	2009	Common carp, mountain whitefish	fillet, skin on	NA
Dieldrin 52064	2009	Common carp	Fillet, skin on	Bluegill, largemouth bass, pumpkinseed, smallmouth bass
Dieldrin 52064	2004	Peamouth	Fillet, skin on	Largemouth bass, mountain whitefish
Toxaphene 52819	2009	Common carp	Fillet, skin on	Bluegill, largemouth bass, pumpkinseed, smallmouth bass
Toxaphene 52819	2004	None	fillet, skin on	Largemouth bass, mountain whitefish, peamouth

Note: 1/ Dioxin impairment based on the EPA National Bioaccumulation Survey at Lewiston, Idaho. TMDL listing dates from 2004; however, date of original TMDL is 1991.
2/ The samples exceeded the "fish tissue equivalent concentration" for the congener 2,3,7,8-TCDD. The fish tissue equivalent concentration is the concentration of a contaminant in fish tissue that equates to the National Toxics Rule water quality criterion for the protection of human health.

2.1.5 Land Use within the Segment

The majority of land immediately adjacent to the portions of the Clearwater and Snake Rivers under consideration here is either natural (wildlife) area or recreational. Pockets of industrial/commercial use are found at Lewiston, ID; Clarkston, WA; Blyton Landing, WA and immediately adjacent to Lower Granite Dam. Large portions of the upstream watershed are Federal property managed by the U.S. Forest Service; however, the portion of the watershed of interest here is mostly privately owned land with 79 percent of the land used for agriculture or urban uses (Corps 2014a). The Nez Perce reservation encompasses the Clearwater River between Dworshak Dam and the confluence with the Snake River. The estimated population within the partial watershed considered here is 75,000 (FreeMapTools 2017).

The Programmatic Sediment Management Plan (Corps 2014a) included an evaluation of sediment sources and yields, and these are related to land use. The Clearwater River Subbasin is more than half (53 percent) forested land, with another large fraction (24 percent) used for agricultural and urban purposes. The surface soil erosion hazard for the Clearwater River Subbasin is high relative to the entire Columbia River watershed; this is a relative rating based on a comparison of factors such as the level of hydrologic and riparian disturbance, soil erosion and soil mass failure, and road erosion (Corps 2014a). The relatively high soil erosion hazard for the Clearwater River Subbasin is related to the agricultural uses of the land (erodible cropland), which has erosion rates up to 10 times greater than the historical (natural) rate. Soil erosion in forested lands also contributes, but is variable; estimates range from 0.02 to 5 milligram per hectare per year, with the variability attributed to infrequent events such as severe storms and forest fires that impact erosion over the long term. Erosion is a topic that Idaho has addressed partly through TMDLs and controls on agricultural practices (IDEQ 2014). Although not discussed in the TMDLs, forest fires in the forested lands can also lead to erosion; this sediment source is not well controlled when it occurs (Corps 2014a)

Similar to the Clearwater River Subbasin, the Snake River Subbasin upstream of the confluence is 47 percent forested and 22 percent agricultural and urban land. The surface soil erosion hazard for the Snake River above the confluence is high relative to the entire Columbia River watershed. Erosion rates are estimated to be on the order of double historic rates except for the agricultural areas, where erosion rates are more on the order of 8 times historical rates. Specific tributaries deliver much of the sediment load, and erosion related to cropland and grazing practices is identified as the main sediment bearing process. TMDLs have been developed for some tributaries, and actions such as buffer strips and no-till practices have been recommended for reducing the sediment loading (Ecology 2015).

Below the confluence with the Clearwater River, the Snake River is surrounded by primarily agricultural and urban lands (79 percent of the sub basin land use), with small amounts of forested land (9 percent) or shrubland (8 percent). The surface soil erosion hazard is high, and erosion is a well-identified problem on tilled croplands. Erosion rates are up to 10 times historical rates; erosion from croplands has been identified as the most serious issue. Alpowa Creek, a tributary of the Lower Granite Reservoir, has been particularly identified as a source of sediment. Various non-point pollution control programs have been implemented by several agencies (Ecology 2015).

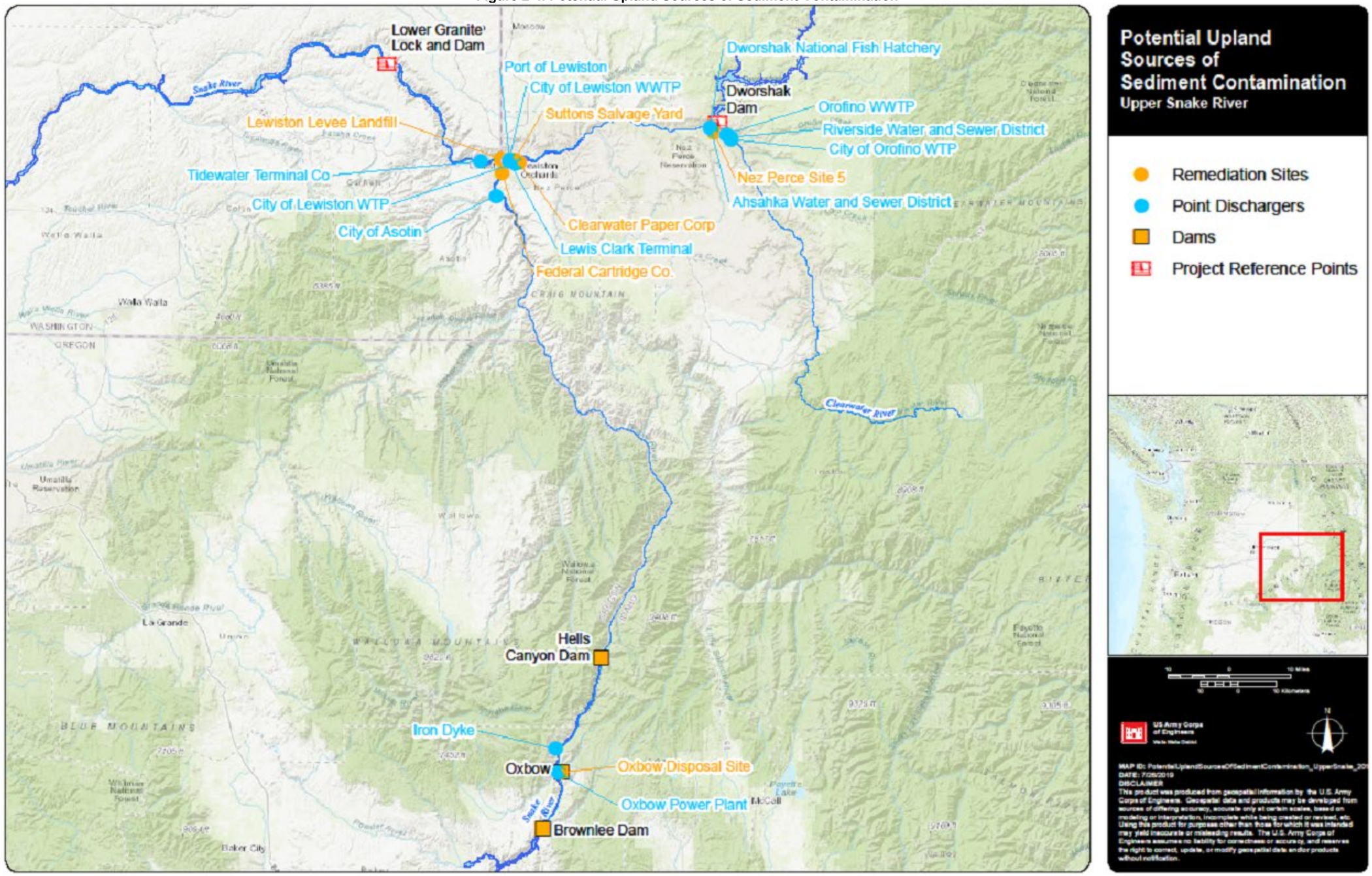
Overall, the large amount of agricultural land contributes to the sediment loading in the Snake River and Lower Granite Reservoir. Future sediment loading should decrease to some extent as soil conservation and water protection (TMDL) actions are implemented. Episodic events (forest fires, floods) are expected to continue to contribute sediment to the system at an unpredictable rate and frequency.

2.1.6 Potential Sources of Sediment Contamination

The Clarkson and Lewiston area at the confluence of the Snake and Clearwater Rivers is a relatively large population center for this region, and because of this, the confluence

area has more potential sources of contamination for the river than the upstream areas. A commercial database search (Sealaska Technical Services [STS]. 2018) was used to identify potential point sources or other areas of contamination along Lower Granite Reservoir and the portions of the Snake and Clearwater Rivers upstream of the confluence. The extent of the search included a half-mile extent either side of the high pool elevation line for the Snake River, from Lower Granite Dam up the Snake River to Brown Lee Dam; and for the Clearwater River from the confluence to Dworshak Dam. A separate 1-mile search radius was used at all dam locations. Figure 2-4 shows a summary of the locations of “significant” sites found. In this study, “significance” is a matter of professional judgment and includes broad categories of sites that might be expected to have an environmental impact on sediment quality (such as National Pollutant Discharge Elimination System (NPDES) point discharges, Resource Conservation and Recovery Act (RCRA) or Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA, aka Superfund)-listed corrective action sites, non-compliant facilities regulated under state or Federal laws, landfills including historic landfills, and other large and discrete sites or potential contamination sources). Sites that generally are expected to have little or no impact or only transient impacts were not plotted (including minor spill reports, clandestine drug labs, schools and day-care facilities, and conditionally exempt small-quantity generators.) The database search results are being used for screening purposes only to identify potential sources or impacts to the Snake River and the chemical parameters associated with these sources that may affect sediment quality. The identification of the potential for sediment contamination from these sources does not imply that these are current sources or that regulatory action is recommended or required. Any specific proposed project would require a site-specific Phase I Environmental Assessment to adequately characterize existing site conditions within the proposed work limits.

Figure 2-4. Potential Upland Sources of Sediment Contamination



2.1.6.1 *Corrective Action Sites*

From the database search, a number of larger remediation sites (including proposed, past, and closed remediation sites) were identified. These sites are listed in Table 2-3. These sites are potentially significant for river and sediment impacts because sites under Superfund or RCRA corrective action often have both soil and groundwater contamination that requires remediation, and that may have the potential to impact adjacent areas. The sites listed in Table 2-3 are discussed further, below.

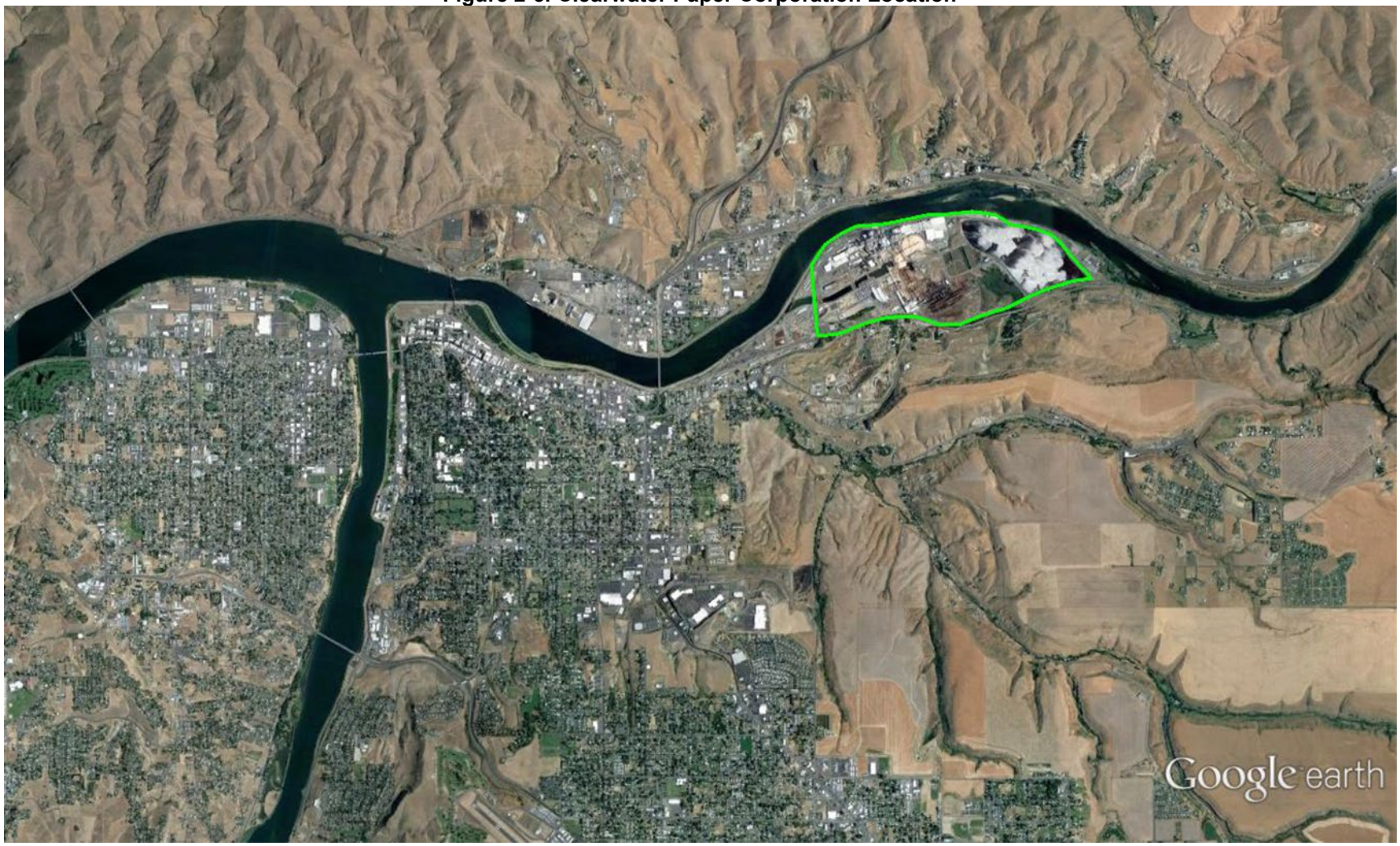
Table 2-3. Superfund and RCRA Corrective Action Sites

Site Name	Database	Comments
Clearwater Paper Corporation (Potlatch Corporation) 803 Mill Road, Lewiston, ID	Superfund Enterprise Management System (SEMS)	This site was not placed on the national priority list, but it is listed as a “state-lead” cleanup.
Federal Cartridge Co. (Omark Industries Inc; Blount Inc., CCI Operations, Ammunition Accessories Inc.) 2299 Snake River Ave., Lewiston, ID	SEMS-Archive RCRA Corrective Action Sites (CORRACTS)	This site is archived in the superfund system and is listed as a No Further Remedial Action Planned (NFRAP) site. The site is listed as a RCRA corrective action site with institutional and engineering controls.
Lewiston Levee Landfill 1626 6th Avenue North, Lewiston, ID	SEMS-Archive	This site is archived in the Superfund system, and is listed as a NFRAP site. Corps had some involvement with this property, and documentation on the site conditions exists.
Suttons Salvage Yard 725 29th North, Lewiston, ID	SEMS-Archive	This site is archived in the Superfund system and is listed as a NFRAP site.
Nez Perce Site 5, Nez Perce Reservation, Idaho	Open dump	Site was reported to be an open dump.
Oxbow Disposal Site, Oxbow Hydroelectric Development, Oxbow, OR	Oregon state enforcement site	Site was an open dump with garbage burning.

<u>Clearwater Paper Corporation</u>

The Clearwater Paper Corporation is also listed in records as the Potlatch Corporation and Idaho Forest Group. The facility is located on the south shore of the Clearwater River, approximately 2.5 miles above the confluence with the Snake River, in Lewiston, Idaho. The facility is an active pulp and paper operation that includes industrial stormwater and industrial effluent discharges, air emissions, a bleaching operation that uses chlorine products, on-site incineration, underground storage tanks, an on-site landfill, and above-ground bulk storage of materials. Figure 2-5 shows the location of the facility.

Figure 2-5. Clearwater Paper Corporation Location



The Clearwater Paper Corporation is listed as a RCRA small-quantity generator. Materials handled at the site are reported to include used oil, ignitable waste, corrosive waste, reactive waste, cadmium, chromium, lead, mercury, selenium, silver, benzene, carbon tetrachloride, chloroform, 1,2-dichlroethane, 1,1-dichloroethylene, methylethylketone, tetrachloroethylene, trichlorethylene, various non-halogenated solvents, acetone, analine, chloroform, cyclohexane, ethyl acetate, hydrogen fluoride, methyl alcohol, naphthalene, 1,3-benzenediol, toluene, xylene, tetrahydrofuran, arsenic, calcium oxide, carbonic acid calcium salt, turpentine, chlorine dioxide, terpene hydrocarbons, and barium. The facility was previously listed as a RCRA large-quantity generator (prior to 2000) and has apparently reduced its waste stream and/or changed operations to limit the waste production as it is currently listed as a small-quantity generator. The facility has had a number of violations related to waste handling over the years including for container management, record keeping, pre-transport generation requirements, general generator issues, treatment standards, and used oil handling issues. In 1999, the facility was reported as a “significant non-complier” indicating that there were multiple non-compliance issues at the operation. Several underground storage tanks (USTs) were removed from the site in 1993, and it is unclear how many USTs are currently in operation on site.

The facility has reported numerous releases to air, as well as water and soil. The releases included multiple sources and occurred over a number of years; some of these incidents were “major” and at least one resulted in worker injury. The compounds reported as released include cresol (mixed isomers), acrolein, methylmercaptan, chlorine, chlorine dioxide, boiler ash (high pH waste), low (< 2) pH wastewater, formaldehyde, sulfuric acid, black liquor, unbleached pulp, ethylene dibromide, benzene, ammonia gas, ammonia, green liquor, sodium hydroxide, acetaldehyde, catechol, phenol, polycyclic aromatic hydrocarbons (PAHs) (unspecified chemicals), lead compounds, dioxin and dioxin-like compounds, zinc compounds, methanol, nitrate compounds, barium compounds, hydrochloric acid, manganese compounds, sodium nitrite, methanol, hydrogen sulfide, carbon tetrachloride, and mixed pulp mill effluent. The report of spills includes localized incidents, air releases, and releases within the facility, including to other areas of operation. Not all of the spills would have had the potential to impact the Clearwater River; however, the reported spills are an indication that the sediment may have been impacted in the area near the facility over multiple years of operation.

The facility is listed as having a state-lead cleanup; however, state employees did not know of a specific remediation project that would have occurred on the site (Anderson 2018). Discovery is documented on the EPA SEMS website as having occurred in 1981 with cleanup actions listed as being completed in 2001. The site was not placed on the National Priority List. No further Superfund documentation was available from the EPA website.

IDEQ personnel did confirm that there was an investigation of the ash ponds on site in 2000 and 2001 (Anderson 2018). It was found that the pond ash did include elevated levels of some furans, metals, and PAHs that were above regulatory thresholds for disposal. A more extensive investigation in 2001 looked at concentrations of

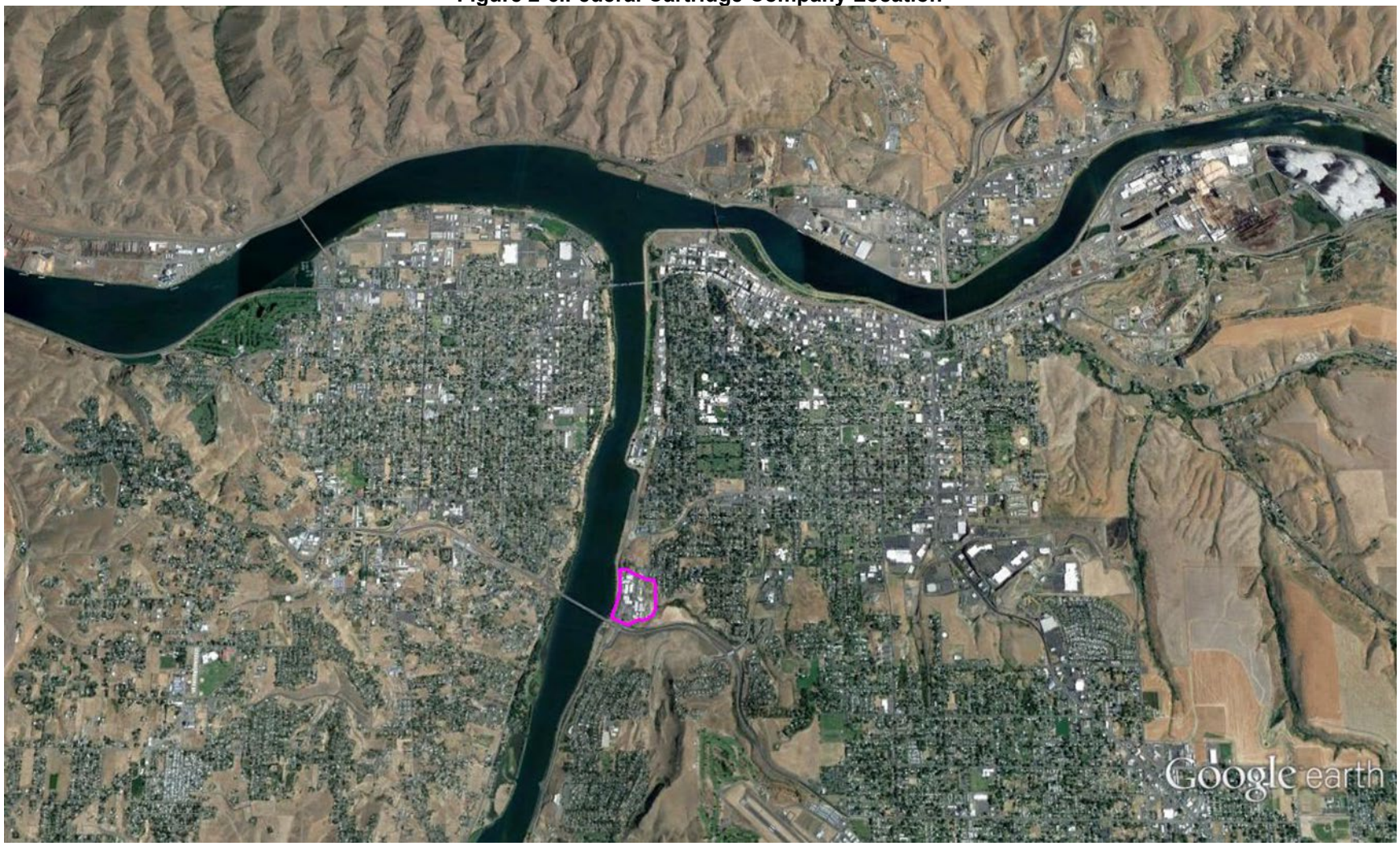
constituents in soil and shallow groundwater around the ponds, and investigated the potential risk related to direct human exposure to the ash (CH2M Hill 2002). Chemicals of concern for the soil and groundwater included metals, semi-volatile organic compounds (SVOCs)/PAHs, volatile organic compounds (VOCs), dioxins, and furans. A total of 65 compounds were detected in the soil. Arsenic was found at concentrations above preliminary remediation goals but within the range of naturally occurring background concentrations for the area. None of the chemicals of concern in the soil was at concentrations exceeding the regulatory target risk levels for worker exposure. With one exception, concentrations in the groundwater did not exceed the maximum contaminant level for drinking water. Based on these findings, it was proposed to close the ponds in place. Current aerial images of the property show the pond areas filled and vegetated.

Potential contaminants of concern (CoCs) associated with this property include any of the compounds potentially used or produced (products or wastes) at the site. In particular, metals, solvents (SVOCs/PAHs and VOCs), dioxins and furans, ammonia, nitrite/nitrate, and sulfite/sulfate could be associated with discharges or releases from the site. These CoCs should be considered for any sediment sampling in the area. It should be stressed that the identification of CoCs does not imply that the facility has had any releases or is the source of sediment contamination.

Federal Cartridge Company

Federal Cartridge Company (also listed as Omark Industries Inc., Blount Inc., and ATK Ammunition) is located along the Snake River, north of the confluence, in Lewiston, Idaho (Figure 2-6). The company manufactures munitions and small arms, as well as other electroplated metal products. The facility uses a long list of metal and organic compounds as part of the operation. The facility is a RCRA large-quantity generator. Waste materials handled on site are reported to include ignitable waste, corrosive waste, reactive waste, arsenic, barium, chromium, lead, mercury, benzene, methylethylketone, tetrachloroethylene, trichlorethylene, various non-halogenated solvents, sludge from electroplating operations, spent cyanide plating bath solutions, and wastewater treatment sludges from the manufacturing of lead-based compounds. The facility currently has no RCRA violations. The site is also a minor air emitter; the facility appears to be in compliance with Clean Air Act requirements.

Figure 2-6.Federal Cartridge Company Location



Federal Cartridge Company is listed on the Toxic Release Inventory as having discharges to the Snake River. Compounds listed as having been released include antimony and antimony compounds, barium compounds, copper compounds, cyanide compounds, lead compounds, nickel compounds, and nitrate compounds. Although the company discharges to the Snake River under an NPDES permit, the facility is listed as being in compliance.

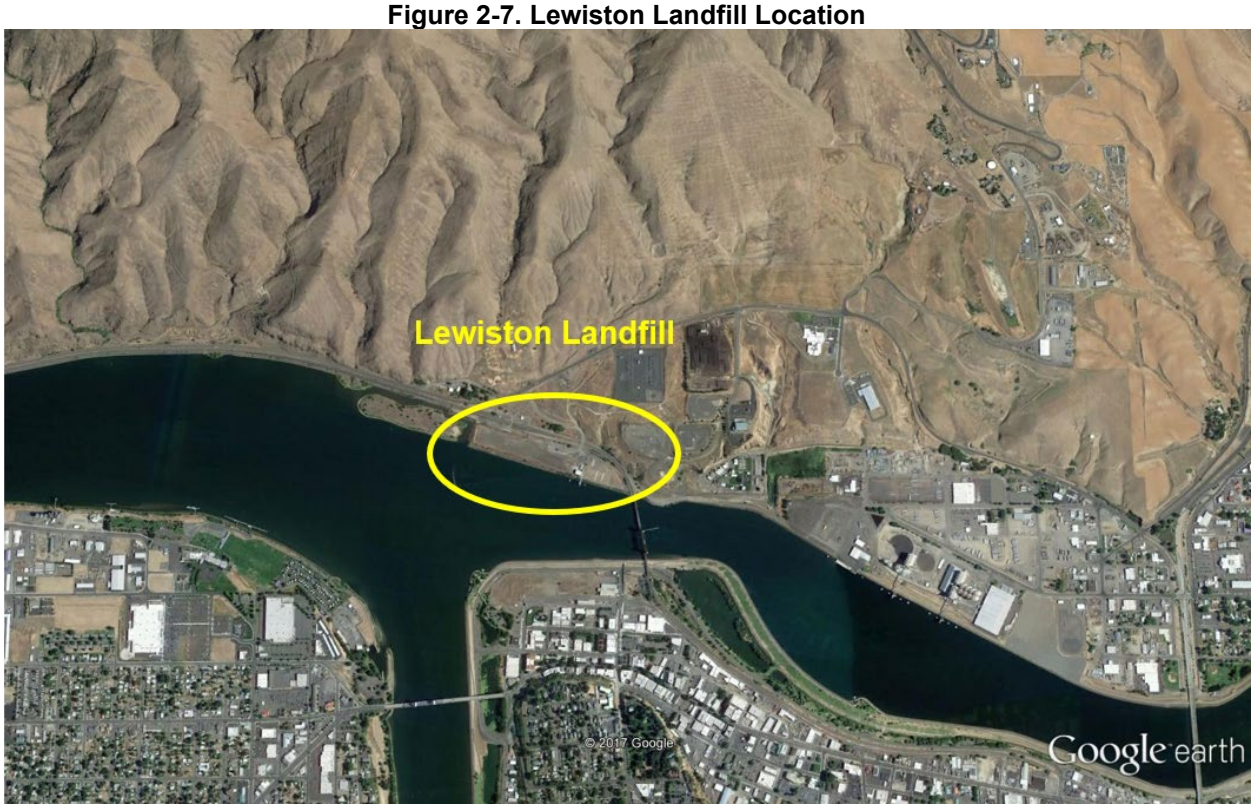
Corrective action investigations at the site began in 1994, and consent orders were entered into in 1994 and 1996, with corrective action completed in 1998. On-site solid and hazardous wastes were remediated to industrial cleanup standards, and monitored natural attenuation is being used to address the groundwater. Land-use restrictions for the property include non-residential use of the site only. Groundwater monitoring occurs on the site and includes water level and chemical analysis for VOCs. A series of 21 wells are used at various screened depths (more than one shallow aquifer is being monitored). The groundwater flow direction depends partly on the pool elevation in Lower Granite Reeservoir; when the pool is high, groundwater in the shallowest aquifer flows from the Snake River, as well as from upland toward the center of the site. When the water level in the river is lower, the shallow aquifer groundwater flow direction is generally toward the river. The second (deeper) water bearing unit generally flows away from the Snake River. Total VOC concentrations are below 10 micrograms per liter (parts per billion) in both water levels. The main constituents monitored include TCE, PCE, and DCE (tri-, tetra- and di-chloroethylene, respectively). In general, VOC concentrations at the wells are decreasing over time.

Potential contaminants of concern (CoCs) associated with this property include any of the compounds potentially used or produced (products or wastes) at the site. In particular, metals and solvents (SVOCs/PAHs and VOCs) could be associated with discharges or releases from the site. These CoCs should be considered for any sediment sampling in the area. It should be stressed that the identification of CoCs does not imply that the facility has had any releases or is the source of sediment contamination.

Lewiston Landfill

The Lewiston Landfill (also known as the Lewiston Levee Landfill) is located on the north shore of the confluence of the Snake and Clearwater Rivers near the Port of Lewiston. Figure 2-7 shows the general location of the landfill. The Lewiston Landfill was constructed by the Corps in the early 1970s. The landfill was constructed with a liner of 3 feet of low-permeability silt material. There is no leachate collection system nor stormwater control system. Dredged materials unsuitable for levee construction, debris, industrial waste, and municipal waste were placed in the landfill prior to closure with a cap of 2 feet of low-permeability soil.

Figure 2-7. Lewiston Landfill Location



The contents of the landfill are poorly documented. An estimated 1,000,000 cubic yards of debris (concrete, bricks, glass, and metal; these materials were considered to be suitable for levee construction) was placed in the facility. A mixture of municipal and organic industrial waste comprised 100,000 cubic yards of the fill. The mixture included pulp mill sedimentation pond sludge and oil-saturated soils from several industries and the City of Lewiston municipal landfill, but did not include pesticide or PCB-containing materials. The Lewiston Landfill was closed in 1973. The closure included the placement of 2 feet of impervious material and 1 foot of gravel and rock over the wastes. The site was subsequently used as a log storage yard by the Mountain Fir Lumber Company. The bottom of the landfill is below the normal high reservoir pool level, which suggests that the deepest buried materials are saturated. The landfill is located in a natural discharge area to the Snake River from the Russell Aquifer (the Lewiston Basin sole source aquifer). In 1992, five monitoring wells were installed along the perimeter of the landfill to evaluate the potential for materials to leach from the landfill if the Lower Granite Reservoir water level was lowered. Groundwater testing of the wells indicated the presence of metals and other compounds, but in 1992, the Corps concluded that lowering the pool level in the reservoir would not cause leachate to migrate from the landfill (Corps 2010).

After an investigation of the site in 1995, the EPA decided not to recommended the site for inclusion on the National Priority List (NPL,i.e., the “Superfund list”). However the investigation did determine that contamination exists at the site. Contaminants found in the groundwater included metals and dioxins. The dioxins were suspected to be laboratory contaminants during the sampling events, and the presence of dioxins in the

landfill or groundwater was not confirmed. Similarly, low concentrations of phthalates and some other compounds were found irregularly in the well samples, again suggesting that these results reflect laboratory contamination of the samples.

In 2006, the Mountain Fir Chip Company (MFC) conducted a limited cleanup of a portion of the area on and adjacent to the landfill. The cleanup included excavation of surface soils containing oils, metals, and PAHs. The excavated soils were taken to a permitted land treatment facility. Free-phase oil was encountered during the excavation; the oil was identified as diesel fuel, motor oil, and hydraulic fluid from equipment used at the site. Oil was drummed and recycled. A clay barrier was placed on the north side of the excavation near the location of the landfill to prevent the migration of materials from the landfill onto the MFC property.

In 2010, Corps produced a study report for the Port of Lewiston, proposing land-use alternatives that would be consistent with the maintenance of a cover over the landfill. To date, no further development of the landfill property has occurred (the Corps/Port of Lewiston project was not implemented), and the property is maintained with the existing cover. No additional cleanup has been conducted. Potential CoCs associated with this property include any of the compounds previously identified during site investigations or during previous cleanup actions on or near the site: SVOCs/PAHs, VOCs, dioxins, and oils. These CoCs should be considered for any sediment sampling in the area. It should be stressed that the identification of CoCs does not imply that the facility has had any releases or is the source of sediment contamination.

Sutton's Salvage Yard

Suttons Salvage Yard is listed in the database records as an archived site that was not placed on the NPL. The site was apparently first investigated in 1987 and is subsequently listed as "not on the NPL – no further remedial action planned" (STS. 2018). The address listed on the NPL archive record does not show up in any current enforcement databases. Current aerial photos show that the address is a warehouse-type building with cars and trucks parked in lots adjacent to the structure. The property appears to be a commercial enterprise of an indeterminate sort. The property is physically located away from the river, separated by vegetated areas and a road. Based on the absence of current enforcement activity, it is presumed that any site issues were localized and have been resolved. No CoCs were identified based on the limited information available on this site. (STS. 2018.)

Nez Perce Site 5

Nez Perce Site 5 is listed as an open solid waste disposal site. The mapped location is shown upland from Clearwater River, within the Reservation forest land. The IDEQ site mapping tool does not return any sites (waste, remediation, underground storage tank, etc.) in this area, nor does the EPA Enviromapper tool. The site may be (may have been) a transient dump site (a "fly dumping site") that was not permitted and is not a recognized site. The database record dates from 2009 (STS. 2018.), and because there has been no current activity or report on the location, it would appear that there is no

active waste disposal on the property. The aerial view does not show any disturbed area or indications of a dump, so any waste materials would be expected to be localized. This site is not adjacent to the river, and it appears unlikely that the site represents a source of potential contamination. No CoCs were identified based on this site.

Oxbow Disposal Site

The Oxbow Disposal site is a state database site that was listed starting in 1989. Apparently the site was an open dump for municipal solid waste with burning of the waste materials. Because the site is listed as 700 feet from surface water (the Snake River) and the ground is rocky with shallow or no topsoil, there has been concern that the unmanaged state of the site may have led to contaminant releases to the river. The site is described as small, serving 14 residences and two parks, occupying approximately 1 acre in area and receiving 30 tons of waste per year. In 2002, the site was listed as closed, and no further information is available on the EPA website. Current aerial views of the site coordinates show vacant land with vegetation. No additional CoCs were identified from this site.

2.1.6.2 *Wastewater Dischargers*

Several entities discharge treated wastewater along the Snake River, including the City of Lewiston, the City of Clarkston, and several industries. Only major point discharges are discussed here; minor and general rule discharges such as stormwater or construction-related discharges are not discussed. General rule discharges are often transient or comparatively short duration operations and are generally assumed to not discharge significant pollutants. In contrast, the major point discharges such as wastewater treatment plants are typically operational all year and for many years, with larger flow volumes and identified CoCs for discharge monitoring. Several minor, private wastewater treatment systems were identified but are also not included in the list below. These are small systems providing service to isolated residential and recreational areas and, due to size, are assumed to have limited potential for impacts. Table 2-4 lists the largest point dischargers to the Snake River upstream of Lower Granite Dam, and downstream of the Dworshak and Brownlee Dams.

Table 2-4. Point Discharge Facilities

Site Name	Compliance Status[1/]	Comments
City of Lewiston Wastewater Treatment Plant (WWTP)	Compliant	This municipal wastewater treatment plant has had violations for past delayed reporting, but has no reported discharge violations for the past 3 years.
Clarkston WWTP	Compliant	This municipal wastewater treatment plant has had violations for past delayed reporting, but has no reported discharge violations for the past 3 years.
City of Asotin	Compliant	This municipal wastewater treatment plant has had violations for past delayed reporting, but has no reported discharge violations for the past 3 years.

Site Name	Compliance Status[1/]	Comments
City of Lewiston Water Treatment Plant	Compliant	This municipal wastewater treatment plant has had violations for past delayed reporting, but has no reported discharge violations for the past year.
Lewis Clark Terminal	Compliant	This facility has been in compliance for the past 3 years.
Port of Lewiston	Compliant	This facility has been in compliance for the past 3 years.
Tidewater Terminal Co.	Compliant	This facility is currently in compliance, although it has a past non-compliance.
City of Potlatch WWTP	Current non-compliant	Within the past 3 years, the facility has had multiple violations for BOD_5 exceedances (i.e., degradable organic material discharged in too high of concentration), as well as late reporting.
Ahsahka Water and Sewer District WWTF	Current non-compliant	Within the past 3 years, the facility has had multiple discharge exceedances for E. coli and total residual chlorine.
City of Orofino WWTP	Current non-compliant	Over the past 2 years, the facility has had discharge exceedances for total residual chlorine and pH.
Riverside Water and Sewer District	Current non-compliant	Over the past 3 years, the facility has had discharge exceedances for E. coli. The facility also has permit schedule violations.
City of Orofino – Orofino WTP	Shown as non-compliant	Facility is listed as non-compliant due to a permit schedule violation; however, all discharges for the last several quarters (at least) have been fully within permit limits.
Dworshak National Fish Hatchery	Current non-compliant	The facility has had discharge exceedances for phosphorus and suspended solids. The facility is listed as having a significant violation apparently due to a schedule compliance issue.
Idaho Power Company (Brownlee Power Plant)	Compliant	The facility is listed as having no violations. This is a hydropower facility, not a treatment plant.
Iron Dyke	Compliant	This facility is a (possibly inactive) gold mine operation.
Oxbow Power Plant	Currently non-compliant	This is a hydropower facility, not a treatment plant. Violations of an indeterminate sort are noted for the past two reporting periods.

Note: 1/ Compliance information obtained from EPA. 2019.

Based on the list of dischargers, past violations, and the type of wastewaters being treated, potential CoCs were identified to include E. coli (coliform bacteria, pathogens; these are an issue for direct human contact with the sediment), free chloride (which tends to react rapidly in the environment and would be unlikely to be found in appreciable quantities), and disinfection byproducts (trihalomethane compounds in particular). The various dischargers monitor metals, nutrients (ammonia, nitrate, and phosphorus), and other compounds.

Municipal wastewater treatment plants, even though in compliance, can be sources of trace concentrations of many compounds, although the loading and fate of these compounds is not well understood. Two recent studies have looked at “emerging contaminants,” that is, compounds that are not currently regulated or recognized as systematic pollutants but that appear to have the potential to be future concerns. These compounds include pharmaceuticals, newer pesticides, and various byproducts of human activities. Morace (2012) looked at contaminants entering the Columbia River

system via point WWTP and stormwater discharges from 2008 to 2010. The goal of the study was to understand the presence and sources of the compounds as a basis for future sampling and source reduction. Sample locations were selected throughout the basin to provide a range of conditions. Samples were collected from WWTP effluent locations just before the water entered the river, and at stormwater discharge locations. Analytes included PCBs, pharmaceuticals, polybrominated diphenyl ether (a brominated flame retardant), organochlorine compounds (including “legacy” compounds that are no longer in use), pesticides, mercury, estrogen-like compounds, and other anthropogenic organic compounds. A total of 112 out of 210 compounds were detected in WWTP effluent, and 114 of 195 compounds were detected in stormwater runoff. Flame retardants and steroids were consistently detected in all WWTP effluent samples, with generally few pesticides. Caffeine and triclosan (a disinfectant used in hand soap) were also commonly detected in WWTP effluent. Stormwater, which contained much higher suspended solids concentrations, also had much more varied contaminant content, likely due to varied land uses and sources of run-off. Based on the measured concentrations, the calculated loadings to the river were small compared to the large flow of the Columbia River, and resultant concentrations in the river were estimated to be less than 1 nanogram per liter except near the Portland WWTP (which is a larger source). Although the loading of these compounds is small, the long-term impacts of continued inputs may still be significant; additional information on the presence and persistence of these compounds is needed. This study focused on the Columbia River, and similar data are not available for the lower Snake River; however, based on the findings of this study, it is anticipated that the municipal WWTPs along the Clearwater River and lower Snake River could be sources of low concentrations of a wide variety of compounds. Some of these large compounds preferentially adhere to the sediment instead of remaining in solution.

A second study looked at the presence of pharmaceuticals and other waste-related compounds in sediment in the Columbia River. Nilsen, Furlong, and Rosenbauer (2014) collected surficial bed sediment samples from 23 locations in the Columbia River and several tributaries. Thirty-nine compounds were detected in variable concentrations, with higher detections in tributaries and urban streams than in the main Columbia River. Compounds frequently detected included p-cresol, benzophenone, p-nonylphenol, bisphenol A, galoxolide, tonalide, triclosan, 4-tert-oxtylphenol, butylated hydroxyanisole, and 1,4-dichlorbenzene. Of these compounds, p-nonylphenol and p-cresol were found in the highest concentrations (> 1,500 micrograms per kilogram [µg/kg] as a total measured at all sites); other compounds were found at lower concentrations. Future sediment sampling in the lower Snake River should consider using an expanded list of organic compounds beyond the “typical” PAHs to include compounds detected in WWTP and stormwater discharges, and in sediment samples in these referenced studies. Deeply shoaled sediment, especially material that has accumulated over many years, may represent a reservoir of contaminants from many sources that preferentially adhere to the sediment particles.

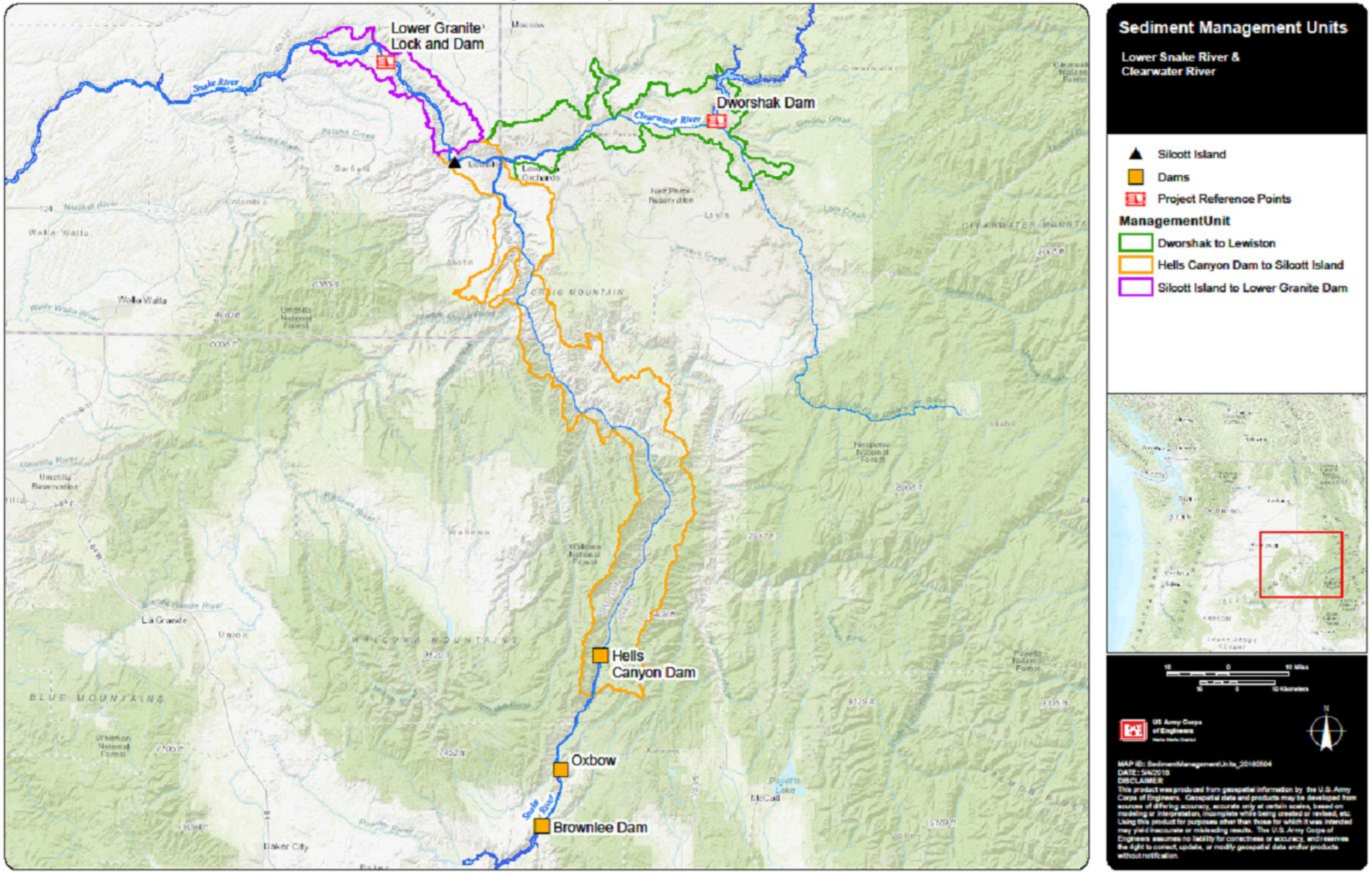
2.1.6.3 *Other Land Uses*

Various other land uses and commercial sites identified during the database search have the potential to produce pollutants that could accumulate in sediment if the materials were to be discharged into the Snake River and Clearwater River system. Those businesses include many small operations with underground storage tanks, (commercial) pesticide users, dry cleaners (solvent users), (abandoned and active) mines, air emission sources, waste producers, and handlers for various types of materials and wastes, asbestos sites, former/current PCB locations, brownfield sites (sites with completed remediation activities), and many other operations. A wide range of potential pollutants is associated with these varied commercial operations, including metals, organic compounds (PAHs/SVOCs/VOCs, dioxins, PCBs, pesticides, oils, and fuels), and nutrients and common salts (ammonia, nitrate/nitrite, sulfate/sulfite, phosphorus). Although specific sources were not identified at this time, because of the potential for past or future discharges to the river, any sediment analysis should include the list of potential pollutants above.

2.2 MANAGEMENT AREAS AND EXISTING DATA

The general area of the confluence of the Clearwater and Snake Rivers, including the Ports of Lewiston and Clarkston, has historically been maintained by dredging and is anticipated to require future dredging. Two management units for the upstream (frequently dredged) areas are identified: the Lewiston Management Unit, including the Clearwater River above the confluence including the Port of Lewiston (in Idaho); and the Clarkston Management Unit for the Snake River below the confluence including the Port of Clarkston (in Washington) to Silcott Island (approximately RM 131). A third management unit is the Downstream Management Unit consisting of the Snake River downstream of RM 131 (Silcott Island) to the Lower Granite Dam, and includes shoaled areas of the river and immediately behind the dam where fine materials settle. This third area has not been dredged; however, based on the estimated sediment loading to the river, it is very likely that significant sediment accumulation is occurring. Figure 2-8 shows the three management units. Specific, smaller management units would need to be delineated in support of a specific project; however, for this overview, dividing the lake into three large management units suffices. Available data for the three management units are discussed below.

Figure 2-8. Management Units in Lower Granite Reservoir



2.2.1 Sediment Characterization Studies

Several studies provide data to evaluate the sediment quality in the Lower Granite Reservoir. A study conducted in 1997 was comprehensive in both physical extent and analyses included. The 1997 report is somewhat limited in usefulness due to the age of the data, but the comprehensive nature of this study makes it a worthwhile inclusion. This study was conducted as part of a general evaluation of conditions and data collection for the lower Snake River.

A study conducted in 2003 included samples at discrete locations where sediment accumulation was known, as well as specific analyses of bioaccumulative compounds such as dioxins (Corps 2004). This study was conducted in support of proposed dredging events along the Snake River, so the sample locations are not evenly distributed throughout the river segment, but rather represent discrete locations of interest. Only samples with fines greater than 20 percent were used for chemical analyses.

The most recent sampling events were conducted in 2013 and 2014. The Lower Snake/Clearwater Sediment Sampling (Corps 2014b) study included sediment evaluation in support of navigational maintenance activities on the lower Snake and Clearwater Rivers, upstream of the Lower Granite Dam. Eleven dredge material management units and 4 separate areas of dockface/port facilities were assessed, representing 479,926 cubic yards of sediment. For the discussion here, the results from this sampling event are discussed in terms of the management units defined above (the Lewiston Management Unit and the Clarkston Management Unit).

Data from sampling events earlier than 1997 have not been included in this discussion because these data are very limited in usefulness. Sediment is mobile; the quantity and quality of material at a given location changes over time as the sediment moves downstream. Over time, sediment quality also changes based on inputs to the river (point and non-point discharges, erosion, spills, groundwater), as well as to naturally occurring physical, chemical, and biological processes. Because discharge practices and land uses along the river have changed over the several decades since the Lower Granite Dam was constructed, it is expected that the sediment quantity and quality have changed over that period. Older data may be useful at identifying trends, but the actual numbers are normally not considered useful for statistical analysis purposes when greater than 5 years for a moderately ranked management unit (RSET Agencies 2016).

2.2.2 Physical Data

Comprehensive sampling of sediment for grain size analysis was included in the 1997 Juvenile Salmon Feasibility Study. More than 100 samples were collected upstream of the Lower Granite Dam (Corps 2002). Data were collected in transects and targeted locations where finer-grained materials were more likely to have accumulated. These data were then used to select locations for samples intended for chemical analysis. The 1997 transect and sample locations are shown in Figure 2-9 and Figure 2-10.

The 2003 sampling event included 13 potential dredge sites and one potential in-water dredged material placement site. The extent of the study covered RM 9 to 142.5 on the Snake River, as well as the Clearwater River from the confluence (RM 0) to RM 1.5. Figure 2-11 shows the sample locations in the Lower Granite Reservoir area. Many of the areas sampled found only coarser-grained materials (retained on a #230 sieve); however, a number of sediment samples from Clearwater River, confluence, and the Greenbelt Boat Basin (approximately RM 139) included higher fines (material passing a #230 sieve) and were used for chemical analyses.

USGS (Braun et al. 2012) collected cores for grain-size analysis along the Clearwater River and Snake River above the confluence, and in the Snake River (Lower Granite Reservoir) below the confluence. The study was conducted in support of the Programmatic Sediment Management Plan (Corps 2014a). In addition to sediment grain-size sampling, the work included multi-beam bathymetric surveying and underwater video map surveying to further describe the sediment and bed characteristics. In general, findings on grain size were similar to other studies. Sediment samples collected in the Snake River upstream of the confluence had less than 20 percent silt and clay; it is likely that the Hells Canyon Dam traps finer-grained materials along the Snake River above the confluence. The sediment samples collected in the Clearwater River upstream of the confluence had generally less than 40 percent silt and clay, although several samples had larger amounts (including one sample with more than 60 percent silt and clay). The change in velocity at the confluence results in sediment deposition of the coarser-grained materials; samples taken in that area were variable but generally had less than 20 percent silt and clay. Moving downstream, the percentage of sand remains high initially (less than 20 percent silt and clay), but eventually the samples in the lower reservoir (below Silcott Island) become higher in fines. Samples taken in the lower river (approximately below RM 120) were 80 to 100 percent silt and clay.

The 2013 sampling event (Figure 2-12) included grain-size samples that were taken in each management unit as composite samples from cores. Table 2-5 summarizes the grain-size data. The 2013 sampling event showed a clear distinction in grain size between samples taken in the Clearwater River above the confluence and at the Port of Lewiston grain dock versus those samples taken below the confluence and at the Port of Clarkston grain dock. The samples taken below the confluence are still predominantly coarse grained but much less so than the samples taken above the confluence. The total solids results correspond with the location and grain size differences; the Clearwater River samples ranged from 67.6 to 77.7 percent total solids while the Snake River samples ranged from 43.7 to 70.5 percent. Coarser-grained materials (such as samples with a higher fraction of sand) tend to compact more and thus have a higher total solids content, while samples with a higher fraction of fine-grained materials (passing the #230 sieve) tend to be slow to consolidate and contain more water. As discussed previously, there is a marked increase in the percentage of sand size particles from the 1997 results to the 2013 results. This may be due to changes in the watershed related to forest fires or other groundcover changes; however, the data differences also reflect the different extent of the two studies. The 1997 data averaged over all of the river segments do not describe the variability of conditions between the

upstream and downstream portions of the river, nor the differences between the main river channel and backwater areas.

Figure 2-9. 1997 Sediment Sampling Locations and Grain Size – East

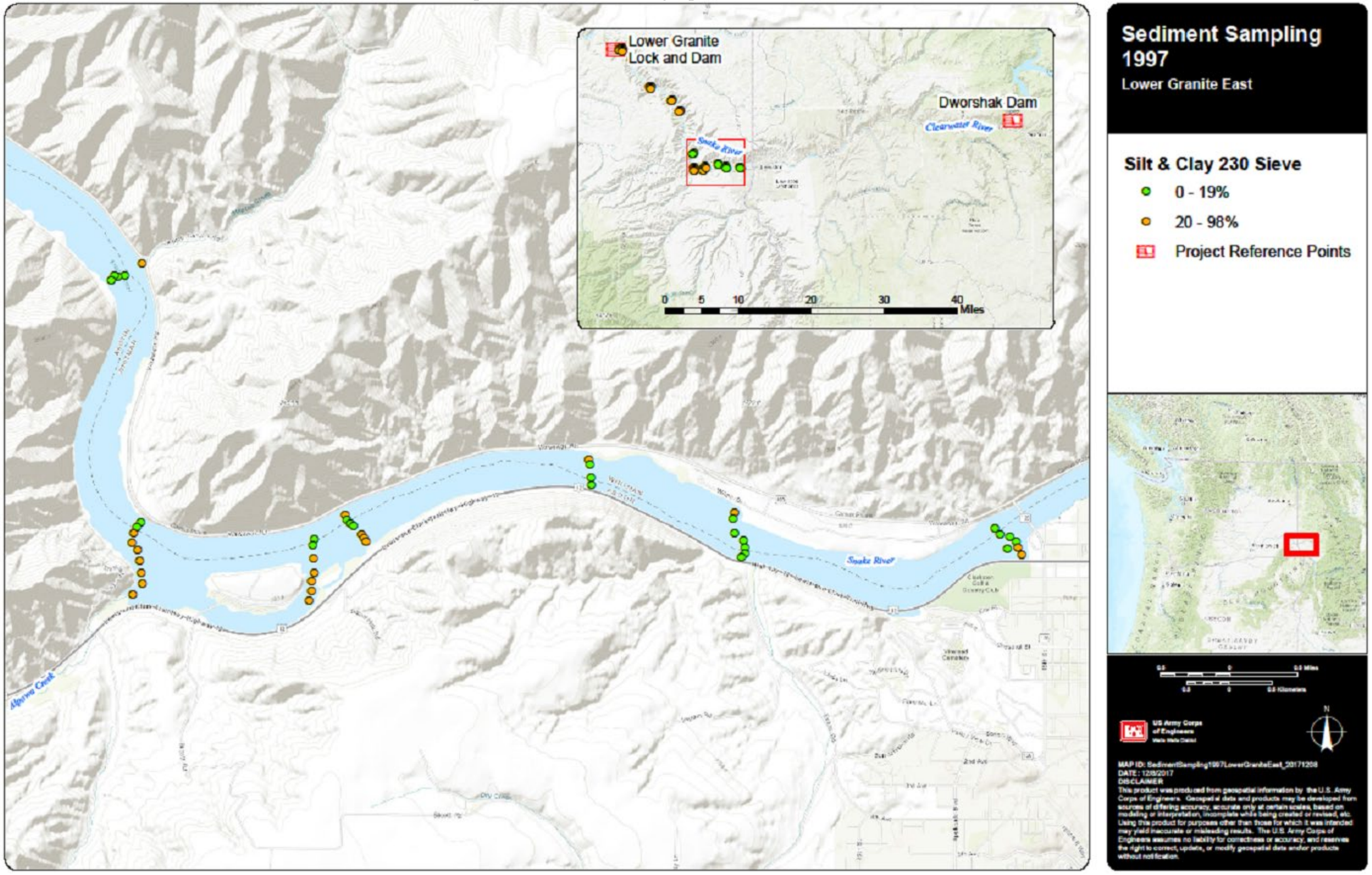


Figure 2-10. 1997 Sediment Sampling Locations and Grain Size – West

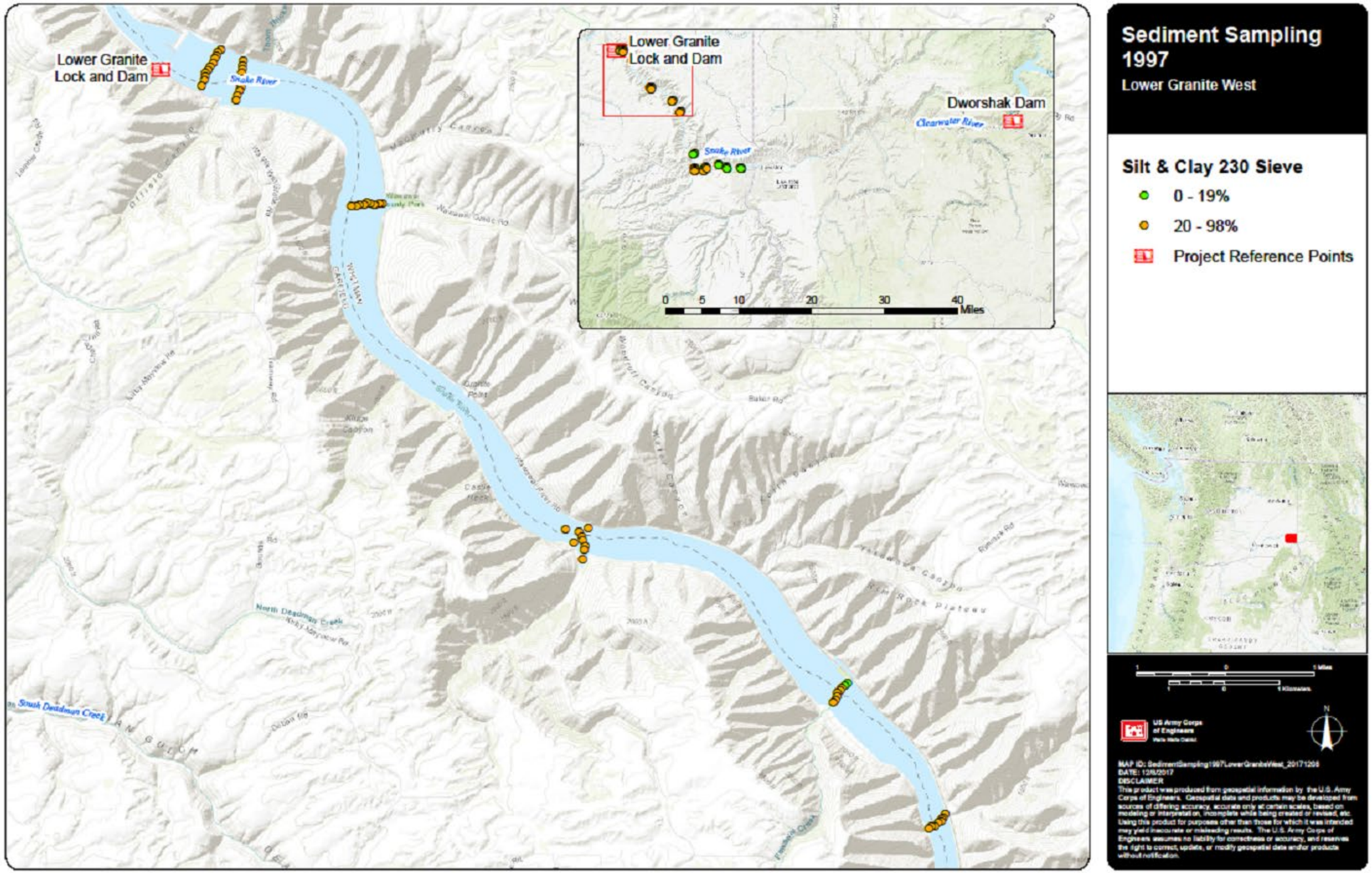


Figure 2-11. 2003 Sediment Sampling Locations

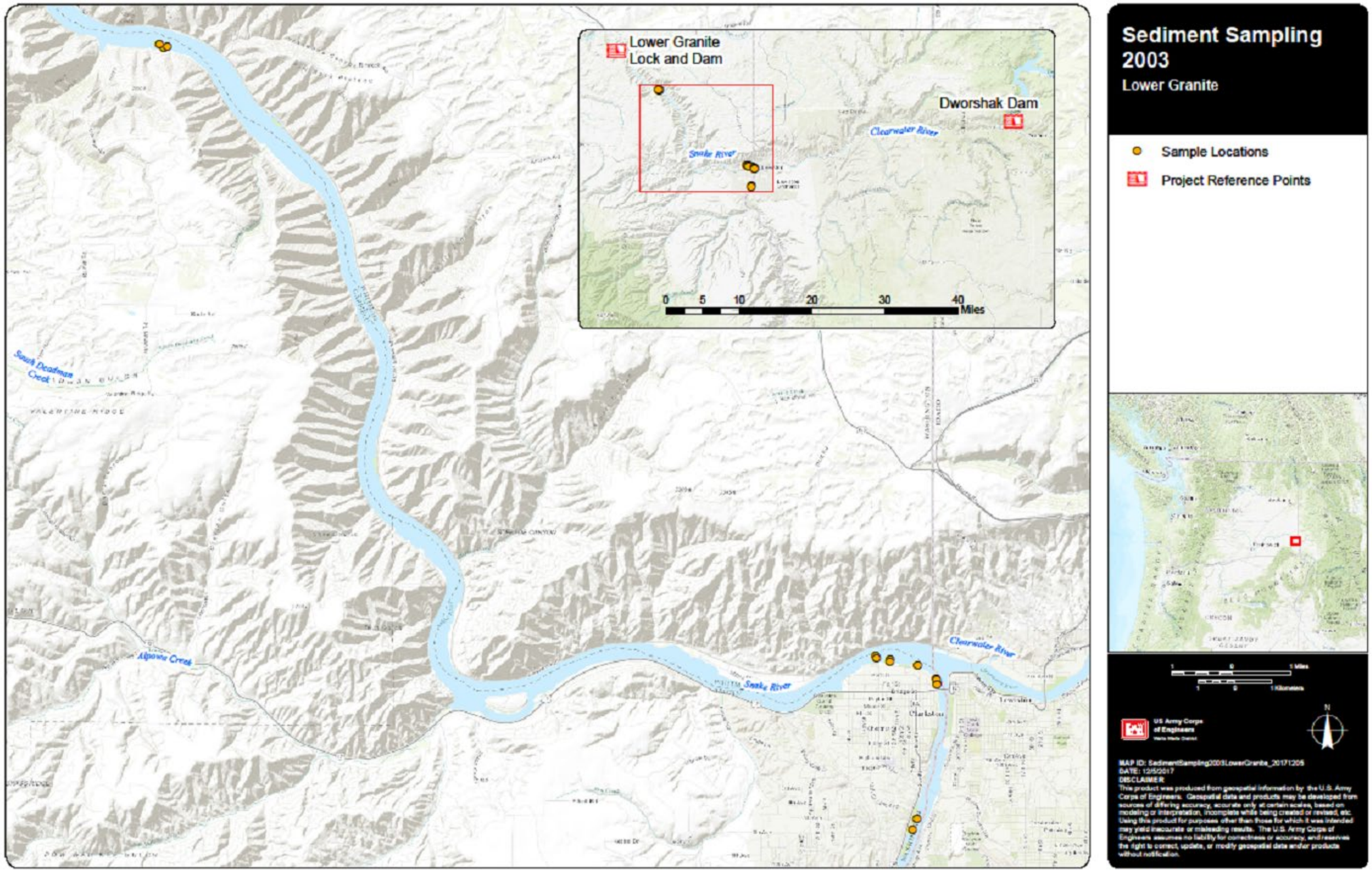


Figure 2-12. 2013 Sediment Sampling in Lower Granite Reservoir

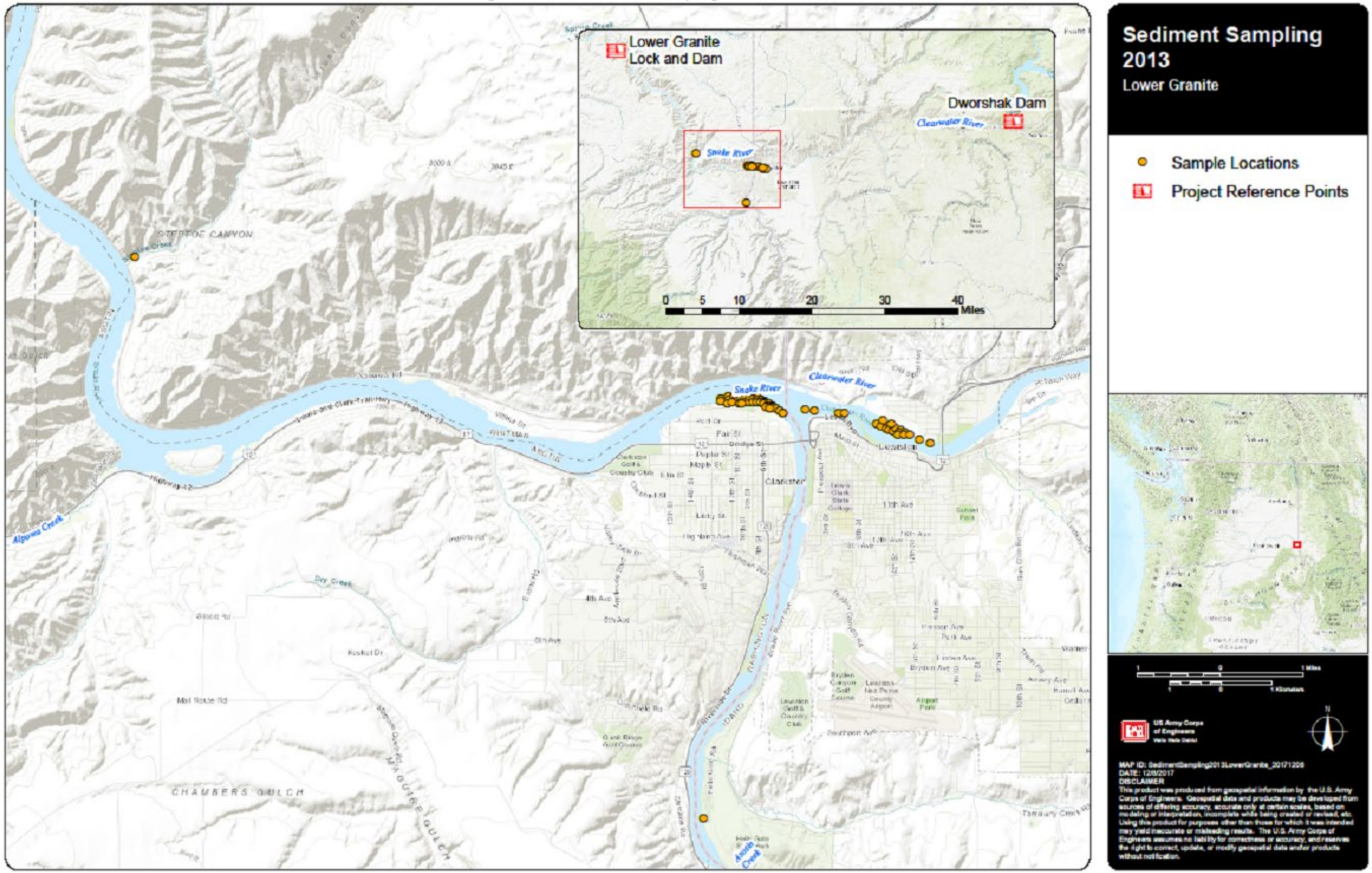


Table 2-5. Summary of Grain Size Analyses from Previous Sampling Events in Lower Granite Reservoir

Sample Identification	% Sand	% Silt	% Clay
2013 Dredged Material Management Units (DMMUs) 1–6 composite (Snake River) samples[1/]	69.4–92.5	2.7–16.5	4.7–14.2
2013 DMMUs 7–11 composite (Clearwater River) samples	92.4–98.4	0.8–4.3	0.4–3.1
2010 Snake River above the confluence[2/]	>80%	<20%	<20%
2010 Clearwater River above the confluence	–	–	–
2010 Lower Granite Reservoir	<20%	>80%	>80%
2003 Clearwater River[3/]	51.8–99.8	0.2–48.2[1/]	0.2–48.2[1/]
2003 Greenbelt boat basin	40.7–99	1.0–59.1	1.0–59.1
1997 Lower Granite average (104 samples)	26.9	20.1	52.4
1997 Lower Granite RM 107–109[4/]	1–48	52–98[6/]	52–98[6/]
1997 Lower Granite RM 110–119	1–96	4–98	4–98
1997 Lower Granite RM 120–129	32–100	0–68	0–68
1997 Lower Granite RM 130–137[5/]	3–100	0–96	0–96

Notes: 1/ Corps (2014b). 2/ Braun et al. (2012). 3/ Corps (2004). 4/ Corps (2002). Lower Granite Dam is at approximately RM 107. 5/ Confluence with the Clearwater River is at approximately RM 137. 6/ For this study, the total materials passing a #230 standard sieve were presented as a single value for each sample.

It is difficult to draw overall conclusions on the grain-size data because the data are so widely scattered. In general, the coarser-grained materials settle out first and tend to accumulate near the confluence of the Clearwater and Snake Rivers. Finer-grained materials travel farther downstream and accumulate in quiet pools and backwater areas along the river, including within the deep pool at the Lower Granite Dam. Any proposed project would require a site-specific consideration of the sediment conditions, including the physical characteristics of the sediment.

2.2.3 Chemical Data

Past sampling events, notably the 1997 and 2003 events, did not include chemical analysis of every sample taken. Rather, only samples with fine-grained materials were sampled because many compounds adhere to the fine particle surface. In general, gravels and coarse sands are a priori considered clean while fine-grained materials are expected to have the highest concentrations of anthropogenic compounds. The SEF assigns a very low management unit ranking to materials that have >80 percent sediment retained on a #230 standard sieve and have < 0.5 percent TOC content (RSET Agencies 2016). In general, the #230 standard sieve is considered the dividing size between larger discrete sand and gravel particles, and smaller silt and clay particles.

For the 2003 study, only samples with a total volatile solids content greater than 5 percent and more than 20 percent passing a standard U.S. #230 standard sieve were subjected to chemical analysis. (Note that this does not meet the current definition of “very low” management unit risk, which requires < 0.5 percent TOC; however, the above definition was used for the purpose of selecting samples for chemical analysis rather than management unit ranking.) As a result, two samples on the Clearwater River near the confluence, three samples near the Port of Clarkston, one sample near the Port of

Lewiston, and four samples near RM 116 were analyzed for the full range of chemical compounds.

Data from past studies are summarized in Table 2-6 through Table 2-8. A range of concentrations is given to show the variability in the data, as opposed to a single average concentration. When a single value is given, all samples express the given result. Non-detectable concentrations are presented as “less than reporting limit” with the symbol “<” used for “less than” and the reporting limit given as a number. Data qualifiers have been dropped for this presentation; only data considered acceptable have been reported. Data are compared to the benthic screening levels presented in the Sediment Evaluation Framework. The “Screening Level 1” (SL1) correspond to concentrations below which adverse effects to benthic communities are not expected.

2.2.3.1 *Organic compounds*

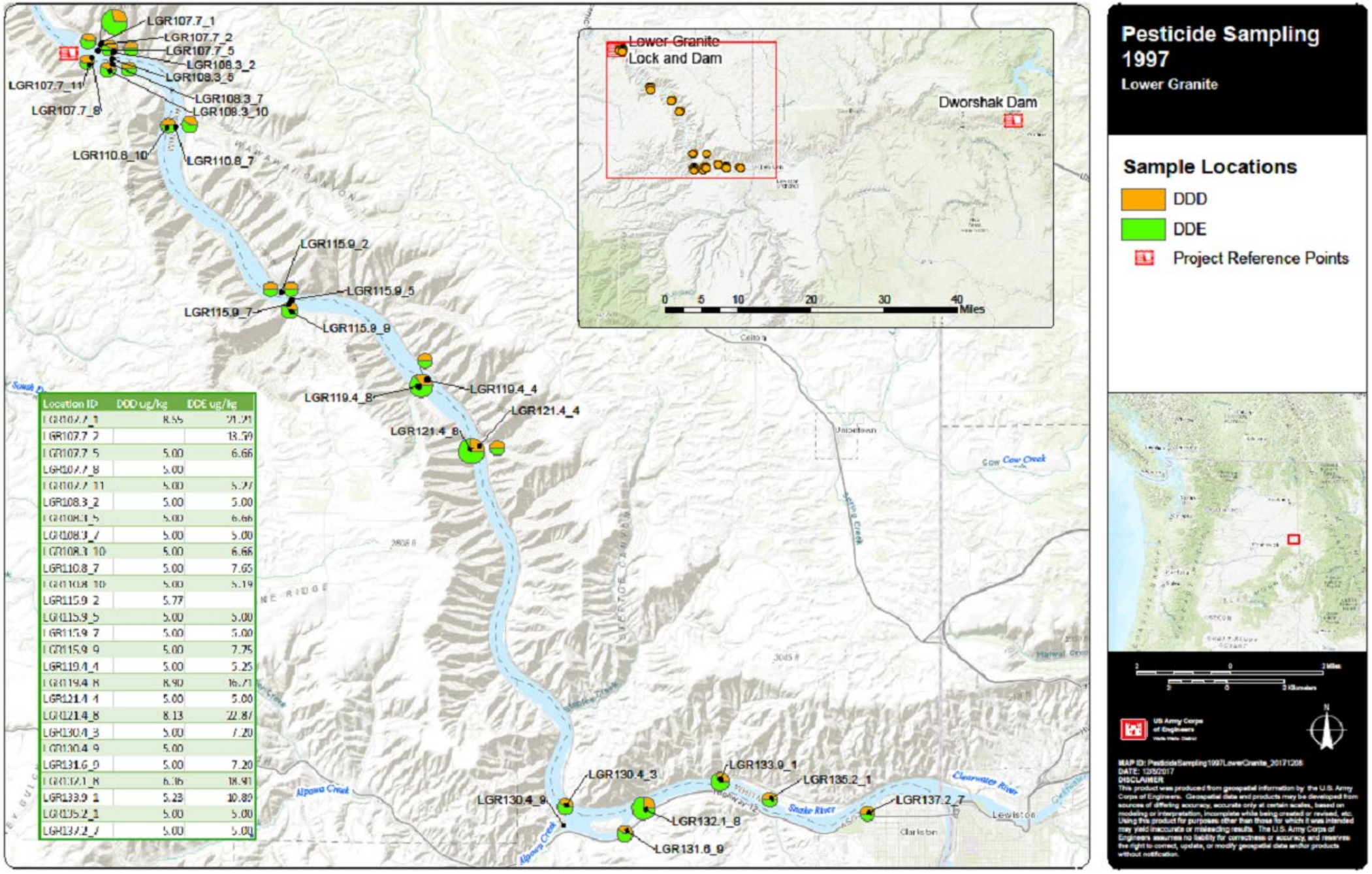
Table 2-6 shows the organic compounds present in past sediment samples. A clear pattern is evident for the 2013 sampling results, with the compounds present in the finer-grained materials downstream of the confluence, but not present in the predominantly coarser-grained materials upstream of the confluence. In addition, the single phenol result in the Snake River that was above the SEF screening level was found in the sample with the least (69.4 percent) sand. The organic compounds are clearly associated with the finer-grained sediment.

A second confirmatory sampling event was performed a few months after the original August 2013 event. The second event, in November, only included sampling from the Snake River below the confluence, where previously elevated phenol and 4-methylphenol concentrations were found. This sampling event confirmed the presence of 4-methylphenol at concentrations above the screening level. An evaluation of these data by Kreitinger (2014) found that although the concentrations exceeded the screening values, the compounds were likely associated with the microbial degradation of organic materials in the anaerobic sediment conditions. None of the sediments were found to be toxic to benthic macroinvertebrates during biological testing. It was concluded that the materials were suitable for placement within the aquatic environment.

The 1997 sampling event included a wide range of pesticides from various chemical families, as well as dioxins, semi-volatile compounds, and petroleum hydrocarbons. It was expected that this study would find no pesticides because the use of many of these compounds had already been halted or greatly reduced. Contrary to expectations, several pesticides were present at low levels (Figure 2-13). Pesticides were measured in the 2003 study, although the study extent was not as large as the 1997 event. Lindane was the only pesticide found, and it was found only in a few samples. A difference in reporting limits, compounds included in the analysis, and the size of the study may have impacted the findings. The continued presence of pesticides in sediment is a potential source for the continued presence of these compounds in fish tissues.

Figure 2-14 shows the 1997 dioxin results; the presence of dioxins is attributable to past dioxin discharges by various industries, as noted in the TMDL study for the Columbia River watershed. Figure 2-15 and Figure 2-16 show the 2003 dioxin results. For the 2003 study, low concentrations of several dioxins were present (0.129 to 38.48 ng/kg) at RM 116, the port of Clarkston, and the Snake River below the confluence. There are no screening levels for the dioxins; however, the presence of dioxins and related compounds is attributed to anthropogenic influences, as shown by the existing TMDL study for the Columbia River Basin (including the Snake River). These compounds have not been systematically studied in recent years, but they are persistent in the environment. Changing industrial practices (such as those noted in the Columbia River TMDL for dioxins) and discharge standards should have reduced input of these compounds to the river.

Figure 2-13. 1997 Pesticide Results in Lower Granite Reservoir



Location ID	DDD ug/kg	DDE ug/kg
LGR107.7_1	8.55	21.21
LGR107.7_2		13.59
LGR107.7_5	5.00	6.66
LGR107.7_8	5.00	
LGR107.7_11	5.00	5.27
LGR108.3_2	5.00	5.00
LGR108.3_5	5.00	6.66
LGR108.3_7	5.00	5.00
LGR108.3_10	5.00	6.66
LGR110.8_7	5.00	7.65
LGR110.8_10	5.00	5.19
LGR115.9_2	5.77	
LGR115.9_5	5.00	5.00
LGR115.9_7	5.00	5.00
LGR115.9_9	5.00	7.75
LGR119.4_4	5.00	5.25
LGR119.4_8	8.90	16.71
LGR121.4_4	5.00	5.00
LGR121.4_8	8.13	22.87
LGR130.4_3	5.00	7.20
LGR130.4_9	5.00	
LGR131.6_9	5.00	7.20
LGR132.1_8	6.16	18.41
LGR133.9_1	5.23	10.89
LGR135.2_1	5.00	5.00
LGR137.2_7	5.00	5.00

Figure 2-14. 1997 Dioxin Results for Lower Granite Reservoir

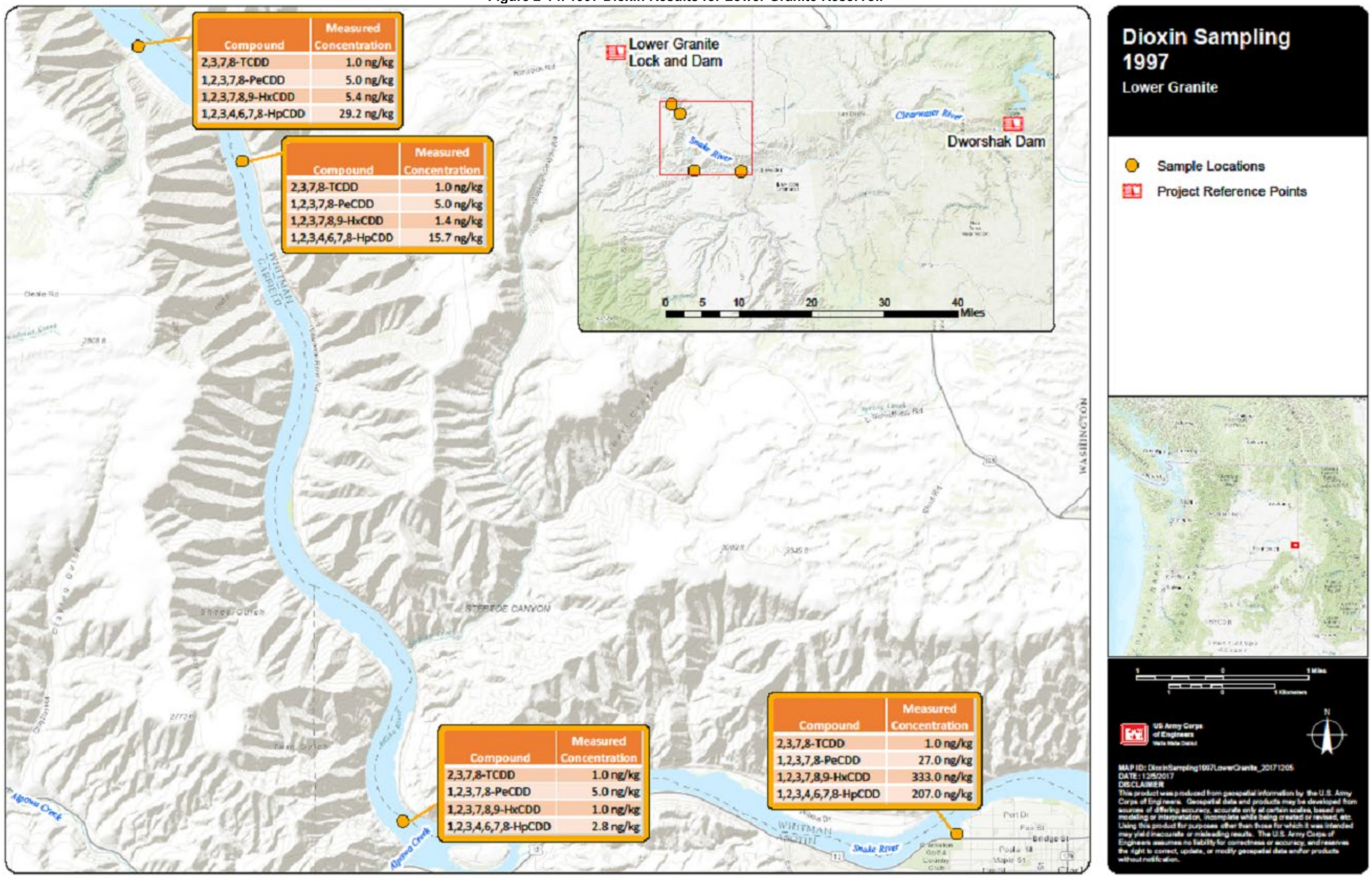
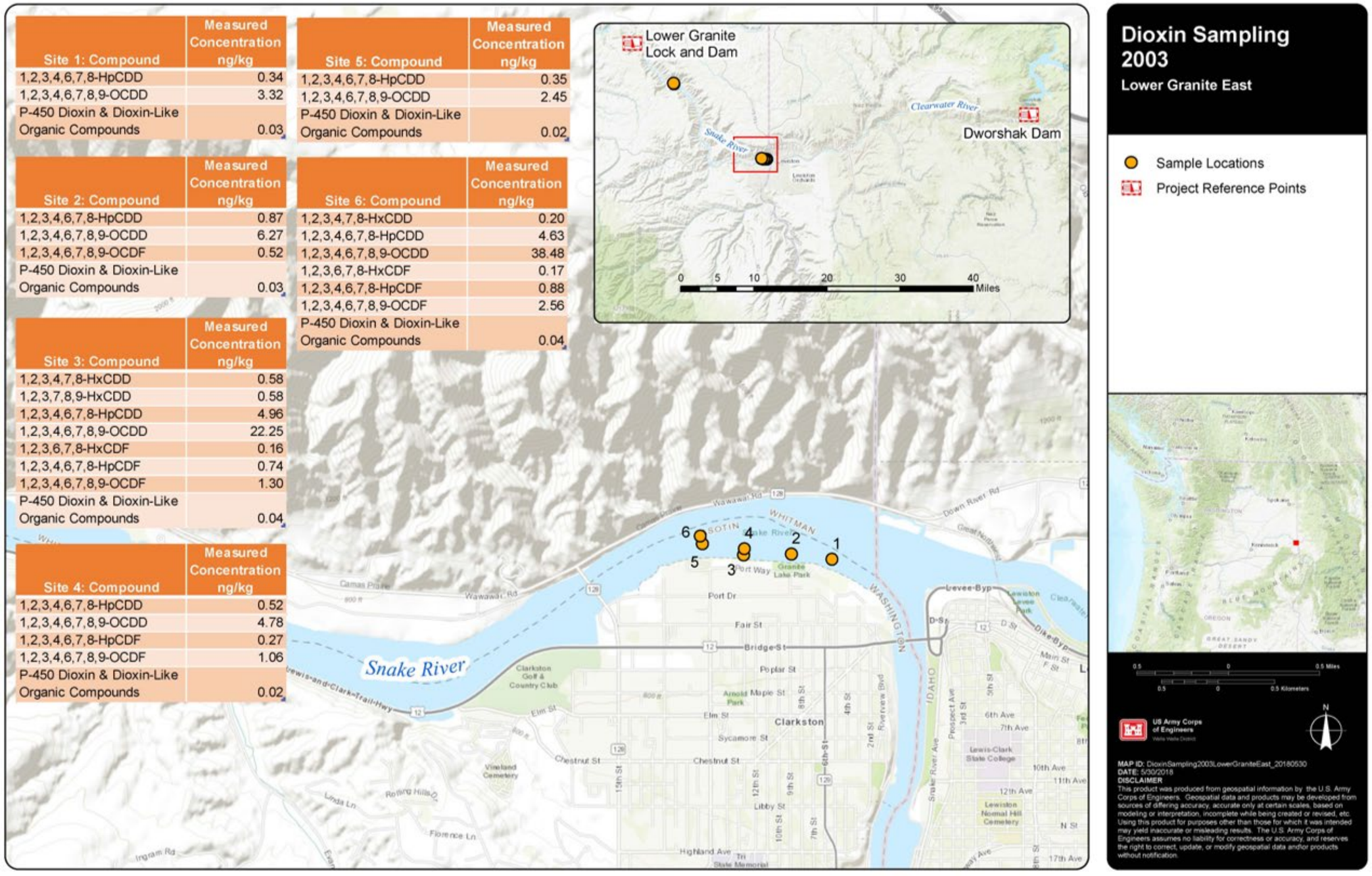


Figure 2-15. 2003 Dioxin Results for East Lower Granite Reservoir



Site 1: Compound	Measured Concentration ng/kg
1,2,3,4,6,7,8-HpCDD	0.34
1,2,3,4,6,7,8,9-OCDD	3.32
P-450 Dioxin & Dioxin-Like Organic Compounds	0.03

Site 2: Compound	Measured Concentration ng/kg
1,2,3,4,6,7,8-HpCDD	0.87
1,2,3,4,6,7,8,9-OCDD	6.27
1,2,3,4,6,7,8,9-OCDF	0.52
P-450 Dioxin & Dioxin-Like Organic Compounds	0.03

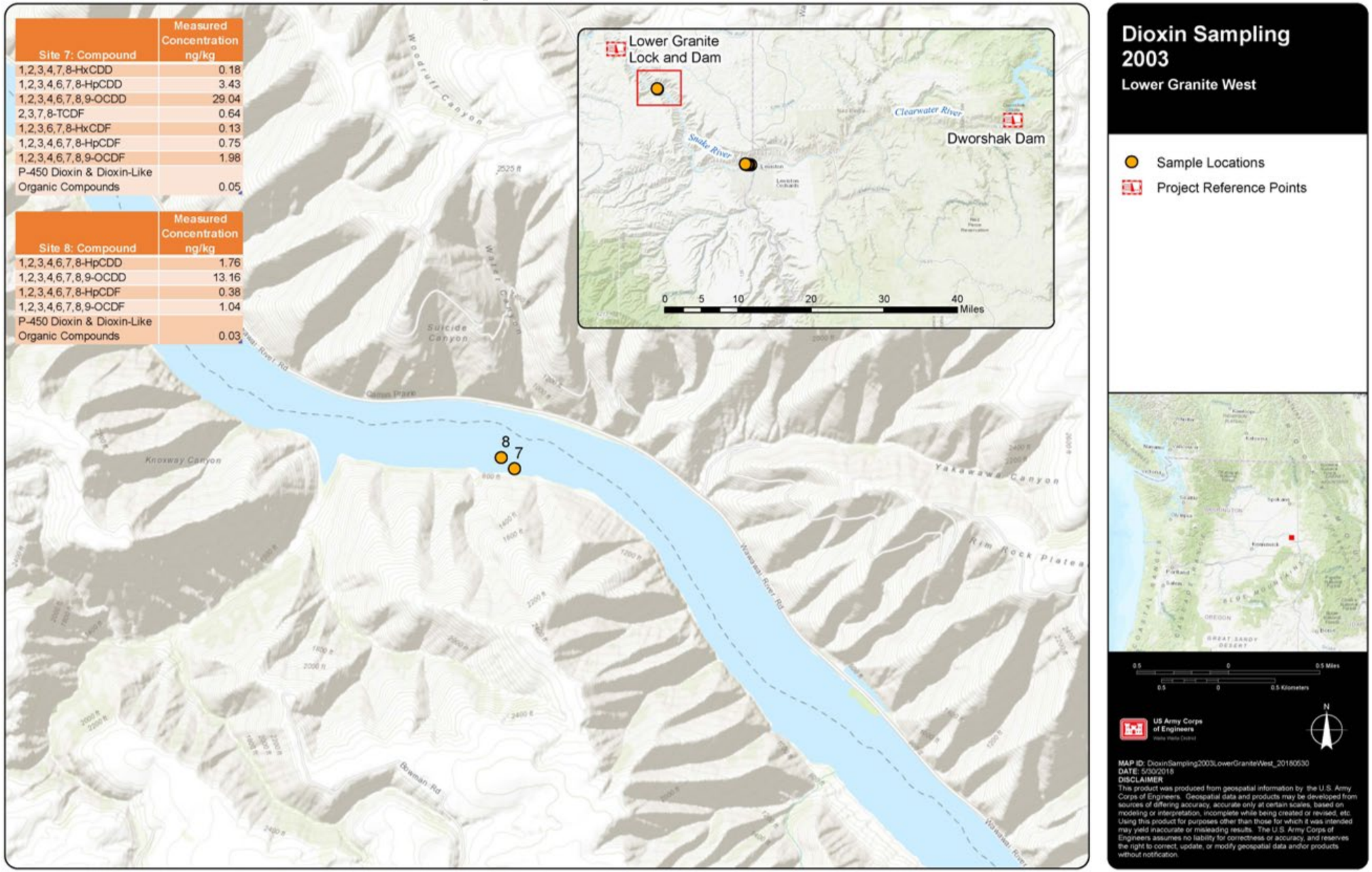
Site 3: Compound	Measured Concentration ng/kg
1,2,3,4,7,8-HxCDD	0.58
1,2,3,7,8,9-HxCDD	0.58
1,2,3,4,6,7,8-HpCDD	4.96
1,2,3,4,6,7,8,9-OCDD	22.25
1,2,3,6,7,8-HxCDF	0.16
1,2,3,4,6,7,8-HpCDF	0.74
1,2,3,4,6,7,8,9-OCDF	1.30
P-450 Dioxin & Dioxin-Like Organic Compounds	0.04

Site 4: Compound	Measured Concentration ng/kg
1,2,3,4,6,7,8-HpCDD	0.52
1,2,3,4,6,7,8,9-OCDD	4.78
1,2,3,4,6,7,8-HpCDF	0.27
1,2,3,4,6,7,8,9-OCDF	1.06
P-450 Dioxin & Dioxin-Like Organic Compounds	0.02

Site 5: Compound	Measured Concentration ng/kg
1,2,3,4,6,7,8-HpCDD	0.35
1,2,3,4,6,7,8,9-OCDD	2.45
P-450 Dioxin & Dioxin-Like Organic Compounds	0.02

Site 6: Compound	Measured Concentration ng/kg
1,2,3,4,7,8-HxCDD	0.20
1,2,3,4,6,7,8-HpCDD	4.63
1,2,3,4,6,7,8,9-OCDD	38.48
1,2,3,6,7,8-HxCDF	0.17
1,2,3,4,6,7,8-HpCDF	0.88
1,2,3,4,6,7,8,9-OCDF	2.56
P-450 Dioxin & Dioxin-Like Organic Compounds	0.04

Figure 2-16. 2003 Dioxin Results for West Lower Granite Reservoir



Site 7: Compound	Measured Concentration ng/kg
1,2,3,4,7,8-HxCDD	0.18
1,2,3,4,6,7,8-HpCDD	3.43
1,2,3,4,6,7,8,9-OCDD	29.04
2,3,7,8-TCDF	0.64
1,2,3,6,7,8-HxCDF	0.13
1,2,3,4,6,7,8-HpCDF	0.75
1,2,3,4,6,7,8,9-OCDF	1.98
P-450 Dioxin & Dioxin-Like Organic Compounds	0.05

Site 8: Compound	Measured Concentration ng/kg
1,2,3,4,6,7,8-HpCDD	1.76
1,2,3,4,6,7,8,9-OCDD	13.16
1,2,3,4,6,7,8-HpCDF	0.38
1,2,3,4,6,7,8,9-OCDF	1.04
P-450 Dioxin & Dioxin-Like Organic Compounds	0.03

Low concentrations of other organic compounds, including acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthese, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, di-benzo(a,h)anthracene, fluoranthene, indenzo (1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene were found sporadically in the 2003 samples. These compounds do not have benchmarks published in the SEF (RSET Agencies 2016) although the EPA has published benchmarks for these compounds (EPA 2006). In general, low concentrations of these compounds are indicative of anthropogenic influences on the sediment and may indicate systematic sediment quality issues. Subsequent sampling in 2013 found lower concentrations of anthropogenically sourced compounds than earlier studies, however it is likely that pesticides and other organic compounds persist within the system in areas that have not been dredged, including in fine-grained materials that have accumulated downstream of the confluence dredging areas and behind the Lower Granite Dam.

Table 2-6. Summary of Organic Compounds Measured in Sediments in the Lower Granite Pool and River Segment

Compound (µg/kg dry weight)	Screening Level 1[1/]	EPA Freshwater Sediment Screening Benchmarks[2/]	2013 Snake River[3/]	2013 Clearwater River[3/]	2003 Maximum[4/]	1997 Average[5/]
Phenol	120	420	12.0–170	<20	–	–
4-methylphenol	260	670	340–4,900	<19	–	–
Benzoic acid	2,900	650	61–890	<190	–	–
Dibenzofuran	200	415	14.0–<19	<19	–	–
Glyphosate	–[6/]	–	–	–	–	14.85
Aminomethyl-phosphonic acid (AMPA)	–	–	–	–	–	8.28
4,4'-DDD	310	4.88	<2.0	<1.0	<50	3.06
4,4'-DDE	21	3.16	<1.9	<1.6	<50	6.48
4,4'-DDT	100	4.16	<2.0	<1.0	<50	1.72
Aldrin	9.5	2	<0.98	<0.50	<50	0.87
Total petroleum hydrocarbons (TPH)	3,600[7/]	–	–	–	173–403	58

Notes: 1/ Sediment Evaluation Framework screening level. 2/ EPA (2006). 3/ Corps (2014b). 4/ Corps (2004). 5/ Corps (2002). 6/ No screening level or constituent not measured. 7/ Screening level for TPH-residual.

2.2.3.2 *Metals and Inorganic Compounds*

Table 2-5 summarizes the metals results found in the 1997, 2003, and 2013 sampling events. All metals are below the screening levels for aquatic organisms and appear consistent across the studies. Sources of the metals are likely a combination of naturally occurring and anthropogenic sources. Aluminum, iron, and manganese are naturally occurring in the igneous rocks and soils of the Snake River watershed (Corps 2002). These compounds are typically less of a concern for aquatic life, and they were not measured in past studies.

Table 2-7. Summary of Metals Measured in Sediments in the Lower Granite Pool and River Segment

Compound (mg/kg dry weight)	Screening Level 1[1/]	2013 Snake River[2/]	2013 Clearwater River[2/]	2003 Average[3/]	1997 Average[4/]
Antimony	150	<10	<7	1.5	---[5/]
Arsenic	14	<10	<7	1.8	5.2
Cadmium	2.1	0.3–0.5	0.3	<0.2	0.1
Chromium	72	10.8–21.0	5.6–7.4	9.4	23
Copper	400	10.2–17.1	4.3–6.8	12.4	29.8
Lead	360	3.0–8.0	<3–12.0	4.7	12.9
Mercury	0.66	<0.05	<0.03	0.04	0.1
Nickel	26	8.0–13.0	4.0–5.0	3.9	16.6
Selenium	3	<1.0	<0.7	2.5	1.5
Silver	0.57	<0.7	<0.4	<0.5	<0.4
Zinc	3200	33.0–59.0	21.0–36.0	30.8	61.4

Notes: 1/ Sediment Evaluation Framework screening level. 2/ Corps (2014b). 3/ Corps (2004). 4/ Corps (2002). 5/ Constituent not measured.

Ammonia and total sulfides were measured in sediment samples, as well as the percentage of organic carbon. These parameters are used to inform the biological testing and to provide a more complete view of the sediment conditions. Ammonia can be toxic to aquatic life at high concentrations, however ammonia is found predominantly at pH greater than 9.3 (as opposed to the less toxic ammonium ion) which is much higher than the pH of the Snake River.

Table 2-8. Compounds Measured in Sediments in the Lower Granite Pool and River Segment

Compound	2013 Snake River[1/]	2013 Clearwater River[1/]	2003 Clearwater River and Lower Granite pool[2/]	1997 Average[3/]
Ammonia (mg/kg)	17.0–69.8	0.25–13.6	18.5–128 0.61 (0.2% fines)– 153 (15.1% fines)	75.7
Total sulfides (mg/kg)	1.7–125	<1.34–2.77	–[4/]	–
Total organic carbon (%)	0.67–6.84	0.23–0.72	1.72–8.14 TVS: 0.27–8.15	5.2

Notes: 1/ Corps (2014b). 2/ Corps (2004). 3/ Corps (2002). 4/ Constituent not measured in study.

2.2.4 Biological Data

The 2013 sampling event found phenol and 4-methylphenol above the screening value given in SEF. Whether naturally occurring or from anthropogenic sources, these compounds can impact aquatic organisms. For this reason, biological testing (10-day *Hyalella azteca* and 20-day *Chironomus dilutus*) was conducted as part of the 2013 sediment evaluation. Reference samples from upstream Snake River (within the Hells Gate State Recreation Area) and from tributaries (Steptoe Creek and Beaver Creek) were also tested. All tested sediments had a *Hyalella azteca* mortality less than 5 percent, and all samples passed the 10-day mortality testing. All test sediments were well below the criteria for the 20-day *Chironomus dilutus* testing and passed. All the DMMU sediment samples had at least 91 percent of the growth found in the relevant reference sample in the 20-day *Chironomus dilutus* growth testing, and thus passed. In short, no sediment issues were identified during the biological effects testing.

2.2.5 Elutriate Data

No elutriate data were found for recent sediment sampling events. Because the most recent sediment data only contained low concentrations of contaminants, it is assumed that the elutriate would also be of generally good quality. Nutrients and suspended solids are typically concerns with direct return of untreated water; these issues (as well as the broader chemical quality of the elutriate) would need further investigation for any specific planned dredging event.

2.3 CHEMICALS OF CONCERN

2.3.1 Sources of Chemicals of Concern

Compounds of potential concern that were identified in the 2013 sampling event include 4-methylphenol and phenol. These two compounds were identified in the Snake River (below the confluence) management unit at concentrations above the SL1. Both of these compounds can originate in natural and human sources, and both can be frequently found in the environment. Sources can include forest products and wood processing, paper and pulping processes, livestock manure, pesticide degradation, algae, the decomposition of aquatic vegetation, the burning of wood and fossil fuels, smoke, and processed foods. Due to the ubiquitous nature of these compounds, it is not possible to identify a specific source within the watershed, and the sediment contamination likely results from multiple low-level sources (Kreitinger 2014). Because these compounds may originate in anthropogenic sources and could cause issues at higher concentrations, future testing should include these and possibly other phenolic compounds.

A number of metals were detected in 2013 and in earlier studies, but at concentrations below the SL1. These compounds include cadmium, chromium, copper, lead, nickel, and zinc. Some of these compounds, such as nickel, are compounds associated with elevated tissue levels in the 303(d) list. Because these compounds were found in the past, potentially have human activity origins including current point dischargers, and can impact aquatic organisms, future testing should include these compounds. Ammonia and sulfides were also present; these compounds are not themselves considered problematic, but they are measured in part to inform bioassay testing regarding the potential for non-treatment effects (RSET Agencies 2016). Some organic compounds were also detected at concentrations below the SL1: benzoic acid and heptachlor (the heptachlor results were rejected due to data quality issues, and the presence of heptachlor cannot be confirmed.) Heptachlor is also included in the 303(d) list and should be included in future testing.

Compounds not detected in 2013 include antimony, arsenic, mercury, selenium, silver, phthalates aside from phenol and 4-methylphenol, dibenzofuran, pesticides, and PCBs. Pesticides not found include DDT and metabolites, chlordane compounds, toxaphene, and other agricultural use products, many of which are persistent in the environment although no longer used. Because a large percentage of the watershed is used for cropland and other agricultural activities and because some of these compounds are

historically present, pesticide compounds should be considered for testing in the future, particularly in fine-grained sediments and in areas not previously dredged. A number of these pesticides and metals are listed on the 303(d) list for elevated tissue levels; fish can bioaccumulate compounds in the sediment via the consumption of benthic organisms.

Several sites are potential sources of PAHs, metals, VOCs and other anthropogenic compounds. Site may have been remediated but still have low concentrations of compounds of potential concern. Low concentrations of metals and organic compounds can also be discharged in wastewater, and there are a number of point dischargers upstream of the Lower Granite Dam. The point sources also are potential sources of bacteria, which could be a concern if sediment is to be placed upland where direct human contact is likely. Less data are available for non-point and stormwater dischargers; these streams can be sources of low levels of automotive fluids, metals, pesticides, nutrients, and suspended solids.

Water discharges may be sources of pharmaceuticals, pesticides, and other trace anthropogenic organic compounds. There is little information available on the sources, magnitude, and fate of these compounds. Because the lower Snake River receives input from several wastewater treatment plants and from stormwater (point and non-point discharges), it is recommended that the typical list of organic compounds tested in sediment be expanded to include emerging contaminants of concern. Particularly in deeply shoaled sediment, contaminants may have accumulated over a long period of time.

2.3.2 Local Land Use, Development and Trends

Asotin County, Washington, is the location of Lower Granite Dam as well as the city of Clarkston (one of the larger communities within the watershed). This area has experienced an approximate 5 percent population increase since 2000 (Washington Office of Financial Management 2017). This is a slower rate of growth than other urban areas in the state and represents a natural increase in population but not dramatic changes in land use or industry. A large portion of the Snake and Clearwater watersheds upstream of the Lower Granite Dam are reservation or park lands; these land uses are not expected to change over the next two decades. The other large land use in the area is agricultural; agricultural uses are expected to continue to be a significant land use in the area. Because land use is not expected to change dramatically, the recent past population trend of a slow increase is expected to continue. Land-use patterns, which include the large population center at the confluence of the Snake and Clearwater Rivers, would be expected to remain constant. Improvements in agricultural practices, such as improved erosion control or changes in pesticide and fertilizer use, could change non-point inputs to the Snake River, but the nature of the inputs is expected to remain similar over time.

2.4 CONCEPTUAL SITE MODEL

The SEF defines management area rank based on lines of evidence; a rank can range from very low to high (RSET Agencies 2016). The management units evaluated in this report were ranked following the SEF methodology. The Lewiston and Clarkston management areas are ranked moderate based on past data and the port locations, which include fueling and berthing facilities. Based on past data, the sediment near the confluence is expected to contain concentrations of chemicals known to cause bioaccumulation or an adverse response in biological testing, and there are identified potential sources of pollution that could impact the sediment so that chemical quality cannot be a priori assumed. The Downstream Management Unit that includes shoaled areas along the Snake River downstream of RM 131, as well as sediment accumulated behind the dam, has very little data and is expected to contain finer-grained materials. The Downstream Management Unit is ranked moderate to high due to a lack of information, as well as the potential for upstream materials to have migrated downstream and moved finer-grained materials containing low concentrations of chemicals of concern.

A conceptual site model was developed based on the current and anticipated future conditions. The conceptual site model discussed below assumes similar hydraulic conditions as they currently exist. Specifically, it is assumed that erosion and sediment loading, although possibly decreasing over time due to soil conservation practices, will continue with sediment accumulation near the confluence of the Snake and Clearwater Rivers, as well as near the Lower Granite Dam and in low-flow or backwater areas along the channel. Periodic dredging, mostly near the confluence at Lewiston and Clarkston, will likely be required for navigational maintenance. The anticipated sediment placement is in water as beneficial use for habitat. Upland unconfined placement of sediment is also considered for completeness, although this is not likely to be the selected alternative unless aquatic placement is not possible. Additional conceptual models may be required to address study alternatives.

Table 2-9 shows the conceptual site model for dredging and placement activities. In this conceptual site model, complete pathways are labeled “C.” These include pathways for the exposure of benthic organisms and fish (potentially including threatened or endangered fish species) during dredging and aquatic placement, and pathways for the exposure of birds and mammals for upland unconfined placement. Complete but insignificant pathways include those for birds and mammals, those for dredging and aquatic placement, and those for all receptors due to the water release for upland placement. Incomplete pathways include those for aquatic receptors (fish and benthic organisms) during upland placement activities. The release mechanisms and exposure pathways are discussed further, below. Additional conceptual models may be required to address possible future projects.

Table 2-9. Conceptual Site Model for Dredging and Placement Activities

Source of Contaminants	Release Mechanism(s)	Exposure Route	Receptors and habitat				
			Benthic Invert	Fish	ESA species1/	Birds/Mammals	Humans
Dredge pathways							
Sediment →	Suspended sediment (water column) →	Direct contact →	C	C	C	I	I
		Dietary → tissue →	C	C	C	I	I
	Generated residuals (fallback, sloughing) →	Direct contact →	C	C	C	I	I
		Dietary → tissue	C	C	C	I	I
	Undisturbed residual →	Direct contact →	C	C	C	I	I
		Dietary → tissue →	C	C	C	I	I
Unconfined aquatic placement pathways							
Sediment →	Suspended sediment (water column) →	Direct contact →	C	C	C	I	I
		Dietary → tissue →	C	C	C	I	I
	Placed material surface →	Direct contact →	C	C	C	I	I
		Dietary → tissue →	C	C	C	I	I
Upland unconfined placement pathways							
Sediment →	Water release →	Direct contact →	I	I	I	I	I
		Dietary → tissue →	I	I	I	I	I
	Placed material surface →	Direct contact →	X	X	X	C	I
		Dietary → tissue →	X	X	X	I	I

Notes: C = complete pathway for receptor; I = complete but insignificant pathway for receptor; X = incomplete pathway for receptor. 1/ Some salmon species and other fish are considered threatened and endangered within the Columbia River Basin. Endangered species are not called out further in this discussion because the exposure of aquatic species is considered overall, and the exposure mechanisms are not anticipated to differ.

2.4.1 Secondary Media and Release Mechanisms

The release mechanisms would include the suspension of solids in the water column during dredging, as well as residual material left at the surface of the water/sediment interface (including both fallback material and undisturbed sediment below the dredging cut). For sediment placement in aquatic habitat areas, the release mechanisms are similar: sediment mixing with the water column and the material at the water/sediment interface. Either of these situations could result in the release of contaminants from the sediment surface into the water column. Fish and benthic invertebrates would be exposed to compounds in the water and/or sediment. Many of the compounds of interest, such as large organic compounds, are sparingly soluble in water and tend to bioaccumulate in fatty tissues.

2.4.2 Exposure Routes and Completeness

The potential exposure routes include direct contact for benthic species and fish. It is unlikely that humans will have significant direct contact with high concentrations of suspended sediment or with residuals. The dredging and the placement areas are not

beaches, and humans are typically prohibited from entering the water near dredging and placement operations. Birds and mammals are unlikely to congregate near these operations while equipment is active. Direct contact impacts can be at least partially mitigated by dredging and placing sediment outside migration periods for the anadromous fish populations and outside spawning periods for all fish.

Indirect exposure pathways exist for all species due to the potential for bioaccumulation in the tissues of fish and benthic invertebrates. This pathway is well documented because compounds historically found in the sediment are also identified in fish tissues in the Snake River as part of the 303(d) compliance reporting. However, the relative size of the historical dredging and placement areas compared to the portion of the river is small and does not represent a significant fraction of the fishing area. This pathway may need future reconsideration if large-scale sediment disturbance is planned.

For upland unconfined placement, the aquatic pathways are complete but insignificant. Water is typically settled or filtered prior to discharge, which has the effect of removing most of the contaminants (which tend to adsorb to the particle surface). If the dredge water is discharged as a turbid stream to the river, the relative volume of water would be very small compared to the volume of the river. Some water will percolate into the ground; although this water may eventually migrate to the surface waters of the river, the original infiltration will be very diluted by the time it travels to the river and will be filtered by the soils through which it migrates. Placing the sediment upland effectively prevents any benthic or aquatic organism exposures. Typically, sediment placement sites are not open to the public so that direct human contact is limited and insignificant. Wildlife may enter the site, particularly birds that view the freshly deposited sediment as a mudflat area for resting or nesting.

SECTION 3 - SUMMARY

3.1 SEDIMENT QUALITY

Sediment within the Lower Granite pool varies in particle size and quality. A substantial sediment load enters this segment of the river, and the materials settle as the particles move downstream. The upper end of the segment, near the confluence of the Clearwater and Snake Rivers, tends to have coarser-grained sediment with a higher percentage of sand. Finer-grained materials accumulate further downstream from the confluence.

Overall, the sediment quality in Lower Granite pool is moderate, with at least low levels of pesticides and metals present in the areas where sediment data have been collected. Some of these compounds could be present at higher concentrations in materials that have accumulated over many years and that have not been sampled or dredged, such as behind the dam. In the recent past, the materials in the two management units near the confluence have been of acceptable quality for open water placement, although potential contaminant sources exist within both management units. The overall quality of the third management unit, the downstream portion of the river including materials accumulated behind the dam, has not been recently tested and is essentially undefined. Because of the variable nature of the sediment grain size, it is anticipated that the sediment contaminant concentrations will also vary (with finer-grained materials having higher concentrations). The third management unit that is downstream tends to have finer-grained sediment and may tend to have higher concentrations of contaminants.

3.2 RECOMMENDATIONS

Insufficient data exist to draw conclusions regarding the quality of sediment that has accumulated behind Lower Granite Dam and along the Snake River above the dam. No recent sediment sampling results exist for these areas. Data for the areas near the confluence indicate potential anthropogenic impacts, mainly for fine-grained sediment, although the most recent sediment testing documented that the materials near the confluence were suitable for use in open water habitat creation. Comprehensive sediment characterization, including elutriate testing and potentially biological testing, is needed to fully characterize the sediment conditions.

3.2.1 Conceptual Site Model

Conceptually, sediment that has accumulated in Lower Granite pool would be removed by dredging. The material would be placed in water along shallow areas to form habitat if the sediment quality is suitable. Sediment could also be placed upland for beneficial use. It is recommended that specific management units be developed for proposed dredging areas or for sediment shoals that would be disturbed by a proposed project (and that may be removed proactively or that may be allowed to migrate downstream.) Sediment sampling should include cores (segmented for chemical analysis) to represent the full range of sediment conditions for shoaled materials.

3.2.2 Chemicals of Concern

The chemicals of concern for Lower Granite pool include pesticides, PAHs, volatile organic compounds, nutrients, and metals. The list of chemicals of concern for Lower Granite pool includes those detected before that are persistent; compounds previously found at levels above the screening levels listed in the SEF; and compounds associated with point sources such as pesticides (currently used pesticides and banned pesticides and metabolites), dioxin, polycyclic aromatic hydrocarbons, PCBs, phthalates, metals, and nutrients. Due to the lack of data for some portions of the pool, and due to the presence of potential sources within the Lower Granite drainage area, the sampling should include a comprehensive sampling plan throughout the reservoir. The reporting limit for all compounds should be less than the level 1 screening levels presented in the SEF. Sediment samples should be cores to obtain representative material from the entire depth of shoaled areas. Sediment testing should include elutriate testing for the same compounds because in-water placement of the sediment would be desired.

3.3 CONCLUSIONS

Historically, the sediment in Lower Granite pool is of variable quality. Sediment most recently dredged was of suitable quality for open water placement as habitat, but trace concentrations of anthropogenic compounds were present. Some portions of the pool have not been systematically characterized in the recent past, and the sediment quality is not well defined. Future sediment sampling is needed for any alternatives that would mobilize shoaled sediment or require dredging or other sediment disturbance.

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