Quality Assurance Project Plan

Columbia River Mainstem Fish Tissue and Water Quality Monitoring Framework

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Publication Information

Each study funded by the U.S. Environmental Protection Agency (EPA) must have an approved Quality Assurance Project Plan (QAPP). The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completion, the QAPP and final report will be posted on the Yakama Nation Fisheries webpage: https://yakamafish-nsn.gov/restore/projects. This QAPP describes a project selected by the EPA's Columbia River Basin Restoration Funding Assistance Program (CRBRP) – Middle and Upper Columbia River.

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Contact Information

Yakama Nation: Laura Shira (shil@yakamafish-nsn.gov)

Sky Environmental: Sherrie Duncan (sherrie@skyenviron.com)

United States Geological Survey: Tim Counihan (tcounihan@usgs.gov); Patrick W. Moran (pwmoran@usgs.gov); Ian Waite (iwaite@usgs.gov)

Washington State Department of Ecology: Keith Seiders (kese461@ecy.wa.gov)

Columbia River Inter-Tribal Fish Commission: Dianne Barton (bard@critfc.org)

COVER PHOTO: Tribal fishing scaffolds on the Columbia River. PHOTO BY YAKAMA NATION FISHERIES.

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by Tim Counihan, Patrick W. Moran, Ian Waite, Keith Seiders, and Sherrie Duncan

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Approved by:

Signature: Laura K. Shira	Date: 1/25/2021
Laura Shira, Co-Project Manager, Yakama Nation	
Signature: Sherrie Duncan	Date: 1/26/2021
Sherrie Duncan, Author/Co-Project Manager, Sky Environmental	
Signature: Tim Counihan	Date: 1/26/2021
Tim Counihan, Author/Co-Principal Investigator, U.S. Geological Survey	
Signature: Patrick W Moran	Date: 1/26/2021
Patrick W. Moran, Author/Co-Principal Investigator, U.S. Geological Survey	
Signature: Ian R. Waite	Date: 1/26/2021
Ian Waite, Author/Co-Principal Investigator, U.S. Geological Survey	
Signature: Keith Seiders	Date: 1/27/2021
Keith Seiders, Author/Technical Contributor, WA State Department of Ecology	

Signature:	Date: 1/27/2021
Dianne Barton, Technical Contributor, Water Quality Coordinator, Columbia River Inter-Tribal Fish Commission	
Signature: Taylor, Nicole Digitally signed by Taylor, Nicole Date: 2021.01.28 10:04:01 -05'00'	Date: 1/28/2021
Nicole Taylor, Grant Project Officer, U.S. Environmental Protection Agency	
Signature: RAYMOND WU Digitally signed by RAYMOND WU Date: 2021.01.28 15:19:11 -08'00'	Date: 1/28/2021
Donald Brown, Quality Assurance Project Plan Manager, U.S. Environmental Protection Agency	
Signature: LON KISSINGER Digitally signed by LON KISSINGER Date: 2021.01.28 14:23:46 -08'00'	Date: 1/28/2021
Lon Kissinger, Technical Liaison, U.S. Environmental Protection Agency	

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2.0 Abstract

This project will develop a Monitoring Framework and Community Engagement and Outreach Plan to establish a long-term Monitoring Program aimed at tracking the status and trends of toxics in fish, water, sediments, and invertebrates in the Middle and Upper Columbia River mainstem. Since there is no dedicated program that specifically monitors the spatial and temporal scope of contaminants in fish and water/sediment quality in the entire mainstem, nor a public engagement and education plan, this work will cover the following two of four Columbia River Basin Restoration Program (CRBRP) priorities: Priority 1) Increased monitoring and access to data from monitoring in the Columbia River Basin. Priority 3) Promoting citizen engagement or education to promote pollution prevention. The Monitoring Framework will be a stakeholder engagement process and written document that is flexible yet conceptually inclusive of several key considerations: a) statistical design, b) costs, c) the ecological and human health impacts of chemicals of concern to stakeholders, c) inclusive of additional partners and agencies, and d) open to adaptive management. Monitoring frameworks have been a key step in several, successful long-term monitoring programs, such as the Upper Mississippi River, the National Water Quality Program, and the EPA Environmental Monitoring and Assessment Program. Further, while no new data is being collected in this planning stage, the outreach effort and Monitoring Framework is expected to easily generate sampling and monitoring plans, and ultimately catalyze formation of a larger, multi-stakeholder Columbia River Monitoring Program.

3.0 Background

3.1 Introduction and problem statement

Our goal is to develop a long-term monitoring program to assess the status and trends of contamination in fish, water, sediment, and invertebrates and other potential media in the Columbia River mainstem, from Bonneville Dam to the Canadian Border. This QAPP is prepared for the completion of Phase I (only) of this 3-phased, multi-year effort. Phase I is a scoping exercise and will produce a Monitoring Framework document with recommendations for a sampling program, data management, and adaptive management. No new data will be collected in Phase I. In addition, a Draft Community Engagement and Outreach Plan will be written to support community outreach and education. Phase I is expected to occur over a two-year period and is funded through an EPA grant with matching funds from United States Geological Survey (USGS), Washington Department of Ecology, Columbia River Inter-Tribal Commission, and Yakama Nation. Development of this Monitoring Framework is a highly collaborative process and therefore changes should be expected. A requirement of EPA's grant award is that a QAPP for Phase 1 be prepared. No field sampling or new data will be produced in Phase 1, although historical data will be compiled and evaluated to help understand contaminant variability, identify data gaps, and inform the Monitoring Framework recommendations. No final decisions will be made in Phase 1. Phase 1 will only result in recommendations for Phase 2 (development of a work plan, implementation of a pilot study, further development of the outreach plan). Phase 3 will involve full-scale implementation of a long-term monitoring program. Phase 1 recommendations will be largely de-coupled from funding availability, but will produce preliminary cost-estimates with alternatives and suggestions for prioritization of efforts. Phase 2 and Phase 3 are highly dependent upon future funding availability. A separate QAPP will be produced in Phase 2 to cover Phase 2 and 3 field work.

Numerous studies by federal, state, and other organizations since the 1980's have found elevated concentrations of contaminants in fish, sediment, and water of the mid-Columbia River and its tributaries. These are summarized in Section 3.2.2 below.

Exposure of fish, wildlife, and people to contaminants within the Columbia River Basin has caused concern (USEPA, 2009). Contaminants measured in Columbia River fish included polychlorinated biphenyls (PCBs), dioxins, furans, arsenic, mercury, and dichlorodiphenyldichloroethylene (DDE), a toxic breakdown product of the pesticide dichlorodiphenyltrichloroethane (DDT; USEPA, 2009). The Oregon Department of Environmental Quality (2012) found the Columbia River mainstem from the Bonneville Dam to the Canadian border is affected by 40 site- and species- specific Fish Consumption Advisories issued by the Washington Department of Health covering 100 percent of the Project Area. The Fish Consumption Advisories are due to elevated levels of mercury, PCBs, and pesticides in 17 species of fish (WDOH, 2019; (https://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories)). Current and past industrial discharges into the Columbia River have resulted in contamination of sediments and water (USEPA, 2009).

Many reaches of the Columbia River do not meet Washington and Oregon's water quality standards. Washington's State Department of Ecology (Ecology) has 26 Clean Water Act 303(d) listings for PCBs and pesticides, (Ecology, 2016) on the Columbia mainstem. The 303(d) list, named for the section of the federal Clean Water Act that establishes the pollution identification and cleanup process, shows which waters the state is required to develop Total Maximum Daily Load (TMDL) plans for. The TMDL process is a science-based approach for identifying and cleaning up polluted waters so they meet state water quality standards.

Efforts to address the pollution by toxic chemicals in the Columbia River have been focused mostly on tributaries through TMDLs and TMDL-like actions (see Section 3.2.2). The only TMDL for the mainstem Columbia River (and Snake River) was issued by EPA to address dioxins and furans (EPA, 1991). This TMDL led to reductions of these contaminants by pulp and paper mills which were the predominant sources. While some work continues in major sub-basins, there are no clear programs having cleanup goals or benchmarks of progress for the mainstem Columbia River.

Washington State's Department of Ecology has the only long-term monitoring program for toxics that includes the mainstem mid-Columbia River. The Freshwater Fish Contaminant Monitoring Program sampled fish at 5 sites between Grand Coulee and Priest Rapids Dams in 2013 and plans to expand the number of sites in the mainstem in coming years (Seiders and Sandvik, 2020). Ecology also conducts monthly monitoring for metals in water at four sites from the Pasco area to Northport near the Canadian border (Ecology, 2020). While these limited monitoring efforts help address some questions, the lack of a coordinated, comprehensive, and dedicated contaminant monitoring program in the Columbia River mainstem impedes evaluation and decision making regarding the health of the river.

These concerns were recognized in the Columbia River Basin Toxics Reduction Action Plan (Action Plan USEPA, 2010). The Action Plan identified 61 actions organized into 5 Initiatives that would help achieve the goal of reducing human and ecosystem exposure to toxic contaminants in the Columbia River Basin. Initiatives 3 (Conduct monitoring to identify sources and then reduce toxics) and 4 (Develop a regional, multi-agency research and monitoring program) of the Action Plan address the importance of, and need for, various monitoring actions to help realize the plan's goal.

3.2 Study area and surroundings

The Columbia River drains 674,000 square kilometers of western North America, flowing 2,000 kilometers (km) from the river's headwaters at Columbia Lake in southeastern British Columbia, Canada, to its confluence with the northeast Pacific Ocean near Astoria, Oregon. In terms of drainage area, the Columbia River is the 39th largest river basin in the world (Vörösmarty and others, 2000), but it ranks within the top twenty with respect to mean discharge of primary rivers entering seas or oceans (Meade, 1996). By discharge volume, the Columbia River is the largest river to enter the northeast Pacific Ocean and conveys 77 percent of the total runoff from western North America (Hickey, 1998). The river basin is high and steep compared to other large rivers; of the 50 largest rivers entering seas or oceans, it has the seventh highest mean elevation and the fifth highest slope (Vörösmarty and others, 2000).

The Columbia River basin drains several physiographic provinces, including the middle and northern Rocky Mountains, Columbia Plateau, Cascade Range, and Pacific Border (Benito and O'Connor 2003; Fenneman and Johnson, 1946). The basin includes parts of British Columbia, Canada; most of Idaho; large parts of Oregon and Washington; and small areas of Montana, Wyoming, Utah, and Nevada. The Columbia River estuary forms the border between Washington and Oregon and bisects the Portland-Vancouver metropolitan area. Within the estuary, the river crosses the Cascade Range and Pacific border provinces (Evarts et al. 2009).

The Columbia River is unique among the world's largest rivers in that it drains toward the leading edge of a convergent tectonic margin (O'Connor et al. 2020). This setting is responsible for the river's overall high basin elevation and slope. This unusual environment influences the estuary directly; processes such as volcanism, seismicity, and mass movements associated with plate-boundary dynamics significantly affect fluvial processes and the geomorphology of the tidally affected river corridor (Simenstad et al. 2011).

Columbia River basin hydrology results from the interaction of topography and the regional maritime climate. Most Columbia River discharge is the product of winter Pacific frontal systems moving eastward with the mid-latitude westerlies, resulting in substantial winter snowfall in the Rocky Mountains and Cascade Range followed by high spring snowmelt flows during May/June. Mean annual river discharge from 1970 to 2004, measured at river km 85 at the USGS station Columbia River at Beaver Army Terminal near Quincy, Oregon (USGS 14246900)[1] was 6,800 cubic meters per second (Naik and Jay, 2011). Approximately 25 percent of the total volume passing this station originates from west of the Cascade Range crest from a contributing area totaling just 8 percent of the total Columbia River basin (Sherwood and others, 1990). Most of this 25 percent enters from the Willamette (river km 162) and Cowlitz (river km 109) Rivers. The disproportionately higher flow from west of the Cascade Range owes to the wet maritime climate of the western Cascade Range and Pacific border provinces, where average runoff (precipitation less evapotranspiration) is 2.39 meters per year. By contrast, the interior subbasin east of the Cascade Range, which has a middle-latitude steppe climate, yields only about 0.71 meters per year (Sherwood and others, 1990).

Figure 1. Map of study area.

3.2.1 History of study area

Fish, wildlife, and people are exposed to many contaminants polluting the water and sediment of the Columbia River Basin. These contaminants come from current and past industrial discharges (point sources) to the air, land, and water and from more widespread sources such as runoff from farms and roads (nonpoint sources) and atmospheric deposition. Some contaminants, such as mercury, also come from natural sources. Even when released in small amounts, some of these contaminants can build up over time to toxic levels in plants and animals. In 1992, an EPA national survey of contaminants in fish in the United States alerted EPA and others to a potential health threat to tribal and other people who eat fish from the Columbia River Basin. The Columbia River Inter-Tribal Fish Commission (CRITFC) and its four member tribes—the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation, and Nez Perce Tribe—were concerned for their tribal members who have high fish consumption rates relative to the U.S. general population and who may incur greater exposures to/health effects from contaminants in fish in comparison to the U.S. general population.

The Columbia River Basin is primarily rural, with scattered regional population centers such as Boise, Idaho Portland, Oregon, and Yakima, Washington, Bend, Wenatchee, and the Tri-Cities area. The basin's land use is dominated by agriculture, especially near the rivers. The Columbia is one of the most hydroelectrically developed river systems in the world, generating more than 21 million kilowatts, annually. The Mid-Columbia River is bounded by two large federal hydropower dams, and contains nine others which essentially divide the mainstem into a series of large reservoirs. The Mid-Columbia River also contains the sole remaining free flowing section of the river in the US, the 82 river km section between Priest Rapids Dam and the city of Richland, known as the Hanford Reach. This reach is also significant as the site of US plutonium production for nuclear weapons for World War II. Post-production clean-up of this site began in 1989. The waste sites and facilities near the River are part of an intensive investigation and clean-up effort including radionuclides, metals, and organic chemicals.

To evaluate the likelihood that tribal people may be exposed to high levels of contaminants in fish, EPA funded the CRITFC tribes to conduct a Columbia River Basin tribal fish consumption survey, which was then followed by an EPA and tribal study of contaminant levels in fish caught at traditional tribal fishing sites (EPA, 2002). The consumption survey showed that the tribal members were eating six to eleven times more fish than EPA's estimated national average at that time of 6.5 grams per day. The fish contaminant study showed the presence of 92 contaminants in fish consumed by CRITFC tribal members and other people in the Columbia River Basin. Some of these contaminant levels were above the levels of concerns for aquatic life or human health (tribal; EPA, 2002). Contaminants measured in Columbia River fish included PCBs, dioxins, furans, arsenic, mercury, and DDE, a toxic breakdown product of the pesticide DDT.

3.2.2 Summary of previous studies and existing data

Numerous studies by federal, state, and other entities since the 1980'shave found substantial concentrations of contaminants in fish, sediment, and the water of the Columbia River and its tributaries. Toxic contamination in the Columbia Basin has been documented for many years, but most studies target specific contaminants or focus on specific reaches or tributaries. When viewed collectively, the historical efforts reveal a patchwork of objectives, sites, sampling media, fish species, collection timeframes, and analytical methods. A coordinated and comprehensive approach to addressing pollution in the mainstem would require significant resources which have not been available for such efforts. Previous investigations of contaminants are summarized below for the mainstem mid-Columbia River, major tributaries to the mid-Columbia mainstem, and the mainstem lower-Columbia River.

<u>Mid-Columbia River mainstem</u>

Most of the mainstem studies have sampled fish in order to address concerns about risks to human health from consuming contaminated fish. Table 1 summarizes many of the larger studies, from the most recent to oldest. The table indicates the timeframe, numbers of fish samples analyzed, and target analytes. Results from some of these past studies could be useful as benchmarks for comparisons to future data and to determine trends over time. Findings of major studies are summarized below.

One of the most recent efforts was Ecology's 2013 monitoring of fish in the mainstem. Washington's water quality standards to protect human health were not met for DDT, dioxins/furans, and PCBs. Concentrations of DDE and PCBs varied widely among species (Figure 2). Spatial differences were seen for DDE, with increased levels in Lake Pateros where the Okanogan River enters the Columbia River, and increasing again into Lake Entiat before decreasing in the Wenatchee Reach. However, temporal trends of DDE in fish between 2004 and 2013 could not be discerned (Seiders et al, 2015).

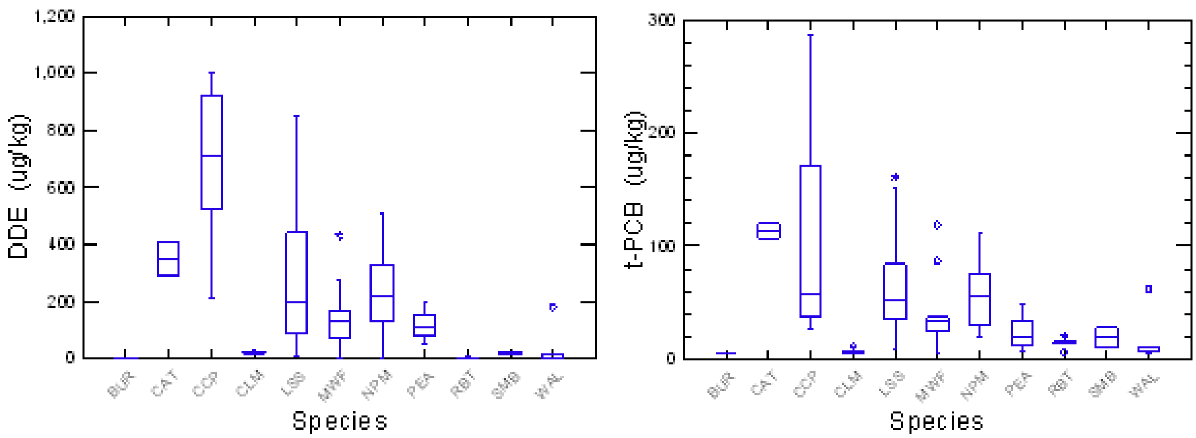

Figure 2. Boxplots of DDE and t-PCB in fillet tissue from ten species and whole tissue from one species (LSS) from the mid-Columbia River in 2013.

Species Codes in Figure 2: BUR: Burbot, CAT: Channel catfish, CCP: Common carp, CLM: Chiselmouth, LSS: Largescale sucker, MWF: Mountain whitefish, NPM: Northern pikeminnow, PEA: Peamouth, RBT: Rainbow trout, SMB: Smallmouth bass, WAL: Walleye.

One of the largest monitoring efforts in the mainstem was Department of Energy's 2008-2009 study of the Hanford Reach. This study conducted a data gap analysis and later sampled fish, sediment, and pore water from McNary Dam to the I-90 bridge at Vantage, Washington. Fish samples were contained radionuclides, numerous metals/metalloids, PCBs, and organochlorine pesticides, with PCBs and DDTs found at high frequency (Energy, 2012, Hulstrom 2011).

In 2008 and 2009, EPA Region 10 and Oregon Department of Environmental Quality (ODEQ) characterized contaminants in fish tissue from Grand Coulee to Bonneville Dam. This study found elevated levels of mercury, DDTs, and PCBs throughout the study area. Concentrations of DDTs and PCBs in resident fish between McNary and Bonneville Dams that grossly exceed ODEQ's human health criteria (Caton, 2012; Herger et al, 2016).

Contamination of Lake Roosevelt has been documented by EPA, USGS, and others, and is the subject of ongoing international negotiations to reduce pollution and clean up contamination (USEPA, 2014). Several studies conducted in this upper part of the mid-Columbia River found elevated levels of mercury and other metals, dioxins/furans, and PCBs. The most recent work focused on contamination from a large smelter operation in Trail, B.C. Sampling in 2005 and

2009 (Teck American Incorporated, 2013) was part of Phase I studies for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS). The EPA worked with the British Columbia government and Teck Cominco to complete one of the most comprehensive studies of contaminants in the mid-Columbia River mainstem. Several earlier studies characterized levels and trends of mercury, other metals, and PCBs in fish (Munn et al, 1995; EVS 1998; Munn, 2000). Dioxins and furans in wastewater from the Celgar pulp mill in BC were also the likely source of contaminated fish downstream of Grand Coulee Dam (Serdar et al, 1991).

The Mid-Columbia Toxics Assessment EPA (2009) conducted a basin-wide synthesis of four contaminant groups using existing data. The report focused on mercury, the pesticide DDT and its breakdown products, the polychlorinated biphenyl group (PCBs) of industrial compounds, and a class of flame retardants (polybrominated diphenyl ethers; PBDEs). These contaminants are among those found throughout the basin, including the Mid-Columbia River, and at concentrations that could adversely impact people, aquatic life, and wildlife. The report concluded that although PCB and DDT contamination may be declining over time, they are still present at levels of concern for both human health and fish-eating animals, and that mercury and PBDE contamination may still be increasing. Counihan et al. (2014) demonstrated that the distribution of fine sediments, total organic carbon, and contaminants in reaches of the Columbia River was correlated with reach- and stratum-specific sedimentation characteristics suggesting the importance of considering habitat characteristics when designing contaminants surveys.

Table 1. Major Contaminant Monitoring Studies in the mid-Columbia River Mainstem, from Bonneville Dam to Canadian Border.

Ref #	Lead Agency	Sampling Location	Study Name	Study Goal	Study Design	Sample Period	Approx # Fish Sites	Approx # Fish Samples Analyzed	Other media	Target Analytes					
										PCB	DDx	Hg	PBDE	Dx/Fr	Other
1	Ecology	Columbia R, Northport, Grand Coulee, Vernita, Snake R near Pasco	River & Stream Water Quality Monitoring	T, C	S	1970s-present	water column only		water only			x			metals
2	Ecology	Columbia R, Rufus Woods Lake to Priest Rapids Lake	Freshwater Fish Contaminant Monitoring Program: 2013	T, C, B	S	2013	7	88	no	A, C	x	x	x	x	-
3	Energy	Columbia R, I-90 bridge to McNary Dam	Remedial Investigation for Hanford Site Releases to the Columbia River	C, R	S, O	2008 - 2010	4 areas, 110 sites	130	water, sediment, pore water	C	x	x		x	metals, pest, PAH, Rad, SVOC, VOC
4	EPA	Lake Roosevelt	Upper Columbia River CERCLA RI/FS. Additional Fish Tissue Sampling	C	S	2009	6 areas, dozens of sites	2300?	water, sediment	C	x	x	x	x	metals, PAH, pest, SVOC,
5	ODEQ	Columbia R, McNary Dam to Bonneville D	Lower mid-Columbia River Ecological Assessment	C	P, S	2009	25	25	water, SPMDs	C	x	x	x		metals, PAH

Ref #	Lead Agency	Sampling Location	Study Name	Study Goal	Study Design	Sample Period	Approx # Fish Sites	Approx # Fish Samples Analyzed	Other media	Target Analytes					
										PCB	DDx	Hg	PBDE	Dx/Fr	Other
6	EPA	Columbia R, Lake Pateros to Lake Wallula	Mid-Columbia River Fish Toxics Assessment	C, B	P	2008	18	25	water	C	x	x	x	x	metals, pest
7	EPA	Lake Roosevelt	Upper Columbia River CERCLA RI/FS Phase 1 Fish Tissue Sampling	C	S	2005	6 areas, dozens of sites	200	sediment?	A, C		x		x	metals
8	Ecology	Columbia R, Lake Pateros to below Priest Rapids Dam	Washington State Toxics Monitoring Program: 2004	C, T	S	2004	5	8	no	A, C	x	x	x	x	-
9	USGS	Lake Roosevelt	Lake Roosevelt Contaminant Trends in Sport Fish 1994 to 1998	C, T	S	1998	2	24	no	A, C		x		x	-
10	EPA, CRITFC	Columbia R	Columbia River Basin Fish Contaminant Survey, 1996-1998.	C, R	S	1996 - 1997	24 (some tribs)	300	no	A, C	x	x	hexa-only?	x	metals, PAH, pest,

Ref #	Lead Agency	Sampling Location	Study Name	Study Goal	Study Design	Sample Period	Approx # Fish Sites	Approx # Fish Samples Analyzed	Other media	Target Analytes					
										PCB	DDx	Hg	PBDE	Dx/Fr	Other
11	EPA	Lake Roosevelt	Lake Roosevelt Assessment of PCDD/Fs and PCBs in Fish Tissue 1994	C, B	S	1994	6 areas, 43 sites	35-100	?	A				x	-
12	USGS	Lake Roosevelt	Lake Roosevelt Mercury and Trace Elements in Sportfish 1994	C, B	S	1994	3	40	no			x			metals
13	WA Ecology	Columbia R, Rufus Woods Lake to Lake Wallula	PCDD/Fs in Columbia River Sportfish: Chief Joseph Dam to McNary Dam	C	S	1990	4	22	no	A, C				x	-
14	USGS	Columbia, Snake, Yakima	BEST: Contaminants and Effects on Fish in Columbia River Basin	C, T	O	2004	4-10	159	no	X	X	X			X

Study Goal abbreviations: B=benchmark, C=characterization, R=risk assessment, T=trends; and for most studies, results also used for human health risk assessment efforts. Study Design abbreviations: P=probabilistic, S=systematic, O=other. PCB abbreviations: A=aroclors, C=congeners.

References for Table 1 above using Ref #: 1- Ecology, 2020; 2- Seiders et al, 2015; 3-Energy, 2012; 4- Teck American Incorporated, 2013; 5- Caton, 2012; 6- Herger et al, 2016; 7- EPA, 2007; 8- Seiders et al, 2007; 9- Munn, 2000; 10- EPA, 2002; 11- EPA Contractor, 1995; 12- Munn et al, 1995; 13- Serdar et al, 1991.

Mid-Columbia River Tributaries

The following is for background information and context as this Phase I study is only focused on the mainstem of the Columbia River from the Canadian Border to the Bonneville Dam. Previous studies in major tributaries have been conducted mostly by Ecology, whose approach to reducing contaminants in the Columbia River focuses on addressing pollution in major tributaries (Figure 3). As tributaries are cleaned up, contaminant loading to the mainstem should decrease.

Figure 3. Map showing mid-Columbia River sub-basins with TMDL or source assessment projects underway.

In the Yakima River, for example, early studies found that DDT and other pesticides from agricultural operations found their way into the river. A fish consumption advisory was issued in 1993 and 303(d) listings followed in 1994. The 303(d) listings prompted TMDL technical studies in the 1990s to the 2000s. These studies were followed by pollution reduction plans with implementation of those plans continuing to this day. Monitoring from 1997 to 2003 showed decreases in turbidity in major tributaries of the lower Yakima River (EPA, 2005). In 2009, reductions in fish tissue DDT levels prompted Health (Health, 2009) to remove DDT from its Fish Consumption Advisory. Trend monitoring by Ecology in 2014 (Seiders et al, 2016) also showed progress in reducing DDT and PCB levels in fish between 1992 and 2014 at several sites (Figure 4).

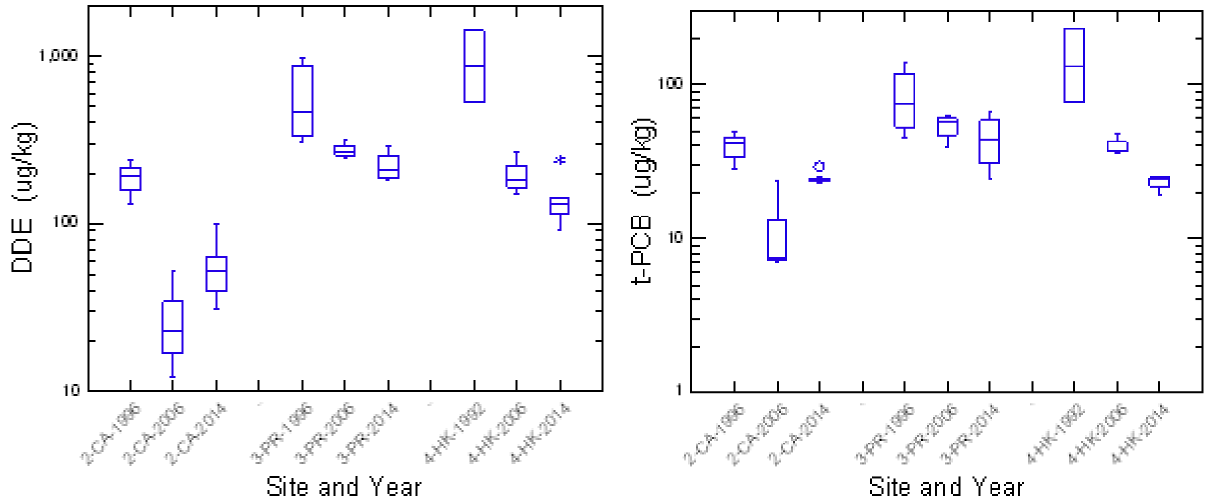

Figure 4. Boxplots for DDE and PCBs in whole largescale suckers from 1996 to 2014 for three sites: 2-CA = Yakima Canyon, 3-PR = Prosser, 4-HK = Horn Rapids-Kiona.

Tackling pollution as is occurring in the Yakima basin continues in other tributaries. Table 2 summarizes Ecology's response and monitoring efforts related to toxic chemicals in Columbia River tributaries and can serve as a reference or index to efforts to reduce contamination of the mainstem. Long term monitoring of contaminants in the Columbia River should take into account pollutant contributions from its tributaries, especially the Okanogan, Yakima, and Walla Walla Rivers which likely contribute substantial sediment-bound DDT and other contaminants to the mainstem.

Table 2. Summary of pollution response actions and monitoring efforts in Columbia River tributaries.

Tributary	Major Chemicals of Concern	303(d) listing [A]	Fish Consumption Advisory	TMDL Technical Study (ref #)	TMDL Clean Up Plan (ref #)	post-TMDL and other study (ref #)
Spokane River	metals, PCBs, PBDEs	1996	2001	2003-2007 (1)	2016 (2)	2012 (3), 2014 (4), 2015-2016 (5), 2016 (6), 2016-2017 (7), 2018 (8)
Okanogan River	DDT	1998	2011	2001-2002 (9)	2006 (10)	2008 (11), 2017 (12)
Lake Chelan	DDT, PCBs	1998	2006	2001-2002 (13)	2008 (14)	2010 (15)
Wenatchee River	PCBs, DDT	2004	2007	B	B	2010 (15), 2014-2015 (16), 2016-2017 (17)
Mission Creek (Wenatchee R)	DDT	1996	-	2003 (18)	2007 (19)	-
Yakima River	DDT	1994	1993	1994-1995 (20), 2006 (21), 2007-2008 (22)	2003 (23)	2014 (24, 25)
Snake River	DDT, PCBs	2004	-	B	B	2009 (26), 2019 (27)
Palouse River (Snake R)	DDT, CPs	1984	-	2005 (28)	2007 (29)	2007-2008 (30), 2016 (31), 2018 (32)
Walla Walla River	DDT, CPs, PCBs	1996	2006	2002-2003 (33)	2006 (34)	2014 (35)

Notes:

A - All waterbodies are expected to be listed for mercury during Washington's next Water Quality Assessment in 2021.

B - Monitoring continues even though TMDL or TMDL-like action have not yet been taken.

References for Table 2 using Ref #: 1- Serdar et al, 2011; 2- LimnoTech, 2016; 3- Seiders et al, 2014; 4- Era-Miller, 2015; 5- Era-Miller and McCall, 2017; 6- Wong, 2018; 7- Era-Miller et al, 2019; 8- LimnoTech, 2019; 9- Serdar, 2003; 10- Peterschmidt, 2006; 11- Newell, 2011; 12- Seiders, 2017; 13- Coots and Era-Miller, 2005; 14- Anderson and Peterschmidt, 2008; 15- Seiders et al, 2012; 16- Hobbs and Friese, 2016; 17- Hobbs, 2018; 18- Serdar and Era-Miller, 2004; 19- Anderson, 2007; 20- Joy and Patterson, 1997; 21- Johnson et al, 2007; 22- Johnson et al, 2010; 23- Creech, 2003; 24- Seiders et al, 2016; 25- Friese et al, 2015; 26- Seiders et al, 2011; 27- Seiders, 2020; 28- Johnson et al, 2007; 29- Johnson et al, 2007; 30- Lubliner, 2009; 31- Coots, 2017; 32- Seiders, 2018; 33- Johnson et al, 2004; 34- Gray et al, 2006; 35- Hobbs and Friese, 2015.

Columbia River Estuary

The following is for background information and context as this Phase I study is only focused on the mainstem of the Columbia River from the Canadian Border to the Bonneville Dam. The lower Columbia River, below Bonneville Dam, which supports the largest human population in the basin, has also been the focus of numerous studies (Fuhrer et al. 1996, Tetra Tech 1996, Nilsen and Morace 2014). These studies have sampled targeted locations based on a variety of factors, including historical data and site accessibility. One exception is a 1999 EPA Environmental Monitoring and Assessment Program study conducted in the Lower Columbia River (Hayslip et al. 2006). This study used a sample design that made statistical reach-wide estimates, which is comparable to other EPA and USGS sample designs of the Mid-Columbia study (Caton, 2012; Counihan et al, 2014, Hayslip and Herger, 2008a). Nilsen et al. (2014) investigated food web transport pathways in the Columbia River Estuary and documented bioaccumulation of certain contaminants and potential negative effects in multiple levels of the ecosystem, including fish consumers. Understanding what habitats are contaminated, in the context of the fate and transport of contaminants, and how contaminants are transferred through the food web to fish consumed by humans, may help identify mitigation opportunities.

3.2.3 Parameters of interest and potential sources

The main parameters of interest are four toxic contaminants: DDT, mercury, PBDEs, and PCBs. These were identified as the pollutants of greatest concern in the Columbia River by EPA's State of the River Report (EPA, 2009). Other contaminants that may be considered because of past concerns, such as polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs). These parameters, potential sources, and actions by Ecology to address some of them are summarized below.

Mercury

Mercury is widespread in the environment, being released to the atmosphere from varied sources and transported globally. Mercury readily volatilizes, such that 95 percent of atmospheric mercury is in the elemental form. Natural sources of mercury include weathering of mercury-bearing rocks and soil, volcanic activity, forest fires, and degassing from water surfaces. Anthropogenic sources include combustion of fossil fuels, metal production, and industrial processes. Major sources of mercury in the Columbia River are varied. Mining and smelting operations in the upper Columbia River (Lake Roosevelt) have led to elevated mercury levels in fish resulting in fish consumption advisories (Health, 2012) and EPA Superfund status with comprehensive Remedial Investigation and Feasibility Studies (RI/FS) (EPA, 2004). Other potential sources include atmospheric deposition (global) as well as from more localized sources, such as recently shuttered coal-fired power plant in Boardman, OR.

Concern with mercury's neurodevelopmental health risks led to legislative action by Washington State in 2002. The legislature directed the Departments of Ecology and Health to develop a plan targeting mercury as the first priority pollutant in the state's Strategy to Continually Reduce Persistent, Bioaccumulative Toxins (PBTs) in Washington State (Gallagher, 2000). This led to the Washington State Mercury Chemical Action Plan (Peele, 2003) which identifies sources of mercury in Washington, current institutional structures related to mercury, and strategies for reducing mercury in the environment.

PCBs

PCBs are a group of 209 synthetic chemicals whose production in the United States was virtually banned in 1979 due to their toxicity and persistence in the environment. PCBs were manufactured in complex mixtures to attain desirable properties for varied applications, such as fire-retarding properties for lubricating and electrical transformer oils. These mixtures were manufactured under many names, the most common being the “Aroclor” series. Throughout the world, PCBs are found in air, soil, waters, and biota. PCBs have low solubility in water yet have a high affinity for sediments and animal fats; they readily bioaccumulate in the aquatic food chain (EPA, 1999). The major source of PCBs in the environment is from historical manufacturing, storage, use, and disposal practices (ATSDR, 2000). PCBs are associated with a range of adverse human health effects including cancer and immune system impacts related to PCB metabolite effects on thyroid function. Some PCBs cause toxicity similar to that of polychlorinated dioxins and furans PCDD/Fs. This is discussed in the section on PCDD/Fs.

Concern with these health risks led Ecology and Health to develop a Chemical Action Plan for PCBs. Washington’s PCB Chemical Action Plan (Davies, 2015) identifies sources of PCBs in Washington, current institutional structures related to PCBs, and strategies for reducing PCBs in the environment.

While there have been few efforts to locate sources of PCBs in the mainstem Columbia River, identification of sources in major tributaries is ongoing as a result of studies conducted by Ecology and others. Fish from the Spokane and Wenatchee rivers have some of the highest levels of PCBs found in the state. In the Spokane River, past TMDL study efforts and more recent work by the Spokane River Regional Toxics Task Force involves locating sources and determining loadings. Potential sources being investigated include municipal and industrial wastewater discharges, stormwater, spills, and groundwater (LimnoTech, 2019).

In the Wenatchee River, monitoring efforts led to the discovery of several electrical transformers (Figure 5) in the river and sampling results identified two chemically distinct sources of PCBs to the river (Hobbs and Friese, 2016; Hobbs, 2018).

Figure 5. Electrical transformers found in the Wenatchee River near Cashmere.

Hydroelectric facilities on the Columbia and Snake rivers are also sources of PCBs. Electrical transformers were found in the river at the Bonneville Dam's Bradford Island complex (URS, 2012). Past practices of dumping such transformers in the river contributed to the fish consumption advisory due to PCB contamination in this area (Oregon Health Authority, 2012). Spills and leaks from electrical transformers at other dams have also occurred. In 2012, the U.S. Army Corps of Engineers reported an 800-gallon spill of PCB-contaminated oil to the Snake River at Ice Harbor Dam, just upstream of the confluence with the Columbia River. A previous spill of PCB-contaminated transformer oil also occurred at The Dalles dam in 2010 (The Oregonian, 2012). The full extent of PCB contamination from such facilities may be a challenge to determine.

<u>DDT</u>

Chlorinated pesticides have been used for decades as insecticides in agricultural and home environments. These compounds have low solubility in water and are not readily metabolized or excreted. They are readily stored in fat tissue and biomagnify to high concentrations in the food web. Many are neurotoxins and are suspected or known carcinogens (EPA, 2000). Many of these compounds (e.g., DDT, chlordanes, and dieldrin) were banned from use in the United States during the 1970s and 1980s as their hazards became evident. Due to their high persistence, chlorinated pesticides continue to be found in fish and wildlife throughout the world.

Many of the Columbia River's major tributaries have elevated levels of chlorinated pesticides, especially DDT, in their soils, river sediment, and freshwater fish due to historical and current agricultural practices. Ecology has developed TMDLs to address these problems in the Yakima River, Mission Creek (tributary of Wenatchee River), Lake Chelan, Okanogan River, Palouse River, and the Walla Walla River. These tributaries continue to be a source of DDT and other contaminants to the mainstem Columbia River. Trend monitoring of fish by Ecology in major tributaries and the mainstem suggest signs of decreasing concentrations in some species, yet large decreases are not yet evident (Newall 2011, Seiders et al, 2011, 2015, 2016).

PBDEs

Polybrominated diphenyl ethers (PBDEs) are a group of chemicals used as flame retardants in electronics, plastics, building materials, and textiles. There are 209 theoretically possible congeners of PBDEs. Like PCBs, PBDEs are resistant to physical, chemical, and biologic degradation and some bioaccumulate in aquatic environments. PBDEs appear to be transported and distributed in the global environment similarly to PCBs. Information on the possible health impacts of PBDEs comes from animal toxicity studies. These studies indicate that PBDEs are associated with developmental neurotoxicity, thyroid hormone disruption, reproductive effects, and liver changes (Darnerud et al., 2001; Birnbaum et al., 2004). Recent studies estimate diet as the main route of exposure to PBDEs for the general public (Harrad et al., 2004).

Due to limited research on the possible consumer health risk from PBDEs, concern remains about the effects of these compounds on humans and biota. PBDEs were the focus of Washington's second Chemical Action Plan (Ecology et al, 2006) to be developed under the state's PBT Initiative.

Little work has been in the Columbia River basin to locate sources of PBDEs. Because of the prevalence of PBDEs in consumer products, sources could be numerous and diverse. The Spokane River has some of the highest concentrations of PBDEs in Washington's freshwater fish species (Johnson et al, 2006). A fish consumption advisory issued by Health (2007) was based in part on PBDEs.

PCDD/Fs

Dioxins and furans, commonly used terms for polychlorinated dibenzo-p-dioxins and dibenzofurans, or PCDD/Fs, are unintended byproducts of combustion processes, chlorine bleaching in paper production, and contaminants in some chlorinated pesticides. Like PCBs, they are highly persistent and widely distributed in the environment. Adverse health effects have been associated with the digestive, endocrine, immune, nervous, and reproductive systems. The dioxin compound, or congener, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is the most potent animal carcinogen EPA has evaluated and is a probable human carcinogen (ATSDR, 1998). There are 17 PCDD/F toxic congeners, and they have different levels of toxicity compared to 2,3,7,8-TCDD, the most toxic form. All of these congeners have the same mechanism of action, which allows the human and ecological risks posed by PCDD/F mixtures to be evaluated jointly. To assess the cumulative risks to human and environmental health of PCDD/F mixtures, the concentration of each PCDD/F congener present is expressed in terms of the concentration of an index compound, 2,3,7,8-TCDD that has the same level of toxicity. For example, a congener that was 10-fold less toxic than TCDD would have a "toxicity equivalent factor or TEF" of 0.1, and would have a TCDD "toxic equivalent concentration or TEQ" of 0.1 x the concentration of that congener. Various TEFs have been developed over time as a result of research into the toxicity of individual congeners. Unique TEFs are available for humans and other species. The 2005 World Health Organization TEFs are used in summarizing results because they are based on recent research and are internationally accepted. These TEFs are described by Van den Berg et al. (2006). The overall toxicity of a mixture of PCDD/F may then be determined by summing the TEQ of all congeners present.

Some PCBs may have dioxin-like toxicity. Their contributions to the toxicity of PCDD/F mixtures are assessed in the same way as noted above. The major source of PCDD/Fs in the Columbia River has been pulp and paper mills in Canada, Idaho, and Washington. A TMDL for PCDD/Fs (was developed for the Columbia and Snake River mainstems (EPA, 1991) which led to reductions in discharges of PCDD/Fs from these facilities. The mill in Celgar, B.C. was a significant source dioxins and furans to the upper- and mid-Columbia River until wastewater treatment processes were improved.

3.2.4 Regulatory criteria or standards

NOT APPLICABLE.

3.3 Water quality impairment studies

NOT APPLICABLE.

3.4 Effectiveness monitoring studies

NOT APPLICABLE.

4.0 Project Description

4.1 Project goals

Our goal is to develop a framework for long-term monitoring and assessing the status and trends of contamination in fish, water, sediment, and invertebrates and other potential media in the Columbia River mainstem, from Bonneville Dam to the Canadian Border. The Monitoring Framework will provide recommendations for data management including long-term storage and information sharing, and adaptive management to promote understanding and improve future decision making over the long-term, including updating with new and emerging science and community needs.

4.2 Project objectives

Our objectives are to work collaboratively with the Project Team and key stakeholders (States, Tribes, Federal Agencies) and others to: 1) develop a monitoring design and framework for assessing the status and trends in contaminants in fish, water, sediment, and invertebrates, and 2) develop a Draft Community Engagement and Outreach Plan to support community outreach and education.

The objectives for this project are listed as major tasks in Work Plan; tasks A1-A3, B1-B12, C1. The major objectives related to the collection and analysis of available data are those in B-series of tasks of the Work Plan:

1. Define objectives and questions that the status and trend monitoring program will answer.
2. Identify historic studies and data to support the development of the monitoring design.
3. Assess availability of data identified in Task 2; compile available data; analyze data to determine sample variability.
4. Identify and evaluate monitoring design options.
5. Address monitoring design questions about sample selection process, sampling locations, sampling frequency, sample sizes.
6. Seek input on monitoring designs.
7. Draft Monitoring Framework Report for Project Team.
8. Review then revise Monitoring Framework Report for review by stakeholder group.
9. Finalize Monitoring Framework Report and submit to EPA.

A subtask of the first objective is to state objectives and questions that the monitoring framework will address. The following are **examples of objectives**, which would need to be refined for more specificity regarding location, media, COC, and temporal/spatial extent as part of this Phase 1 effort:

- Determine concentrations of DDT, mercury, PBDEs, and PCBs in four media (fish, sediment, water, invertebrates).
- Characterize temporal trends in concentrations of the four target analytes in each of the four media for locations where historical data are usable.
- Characterize spatial trends in concentrations of the four target analytes in each of the four media for locations where historical data are usable.

These are **examples of questions** to be considered during the development of the monitoring framework:

- Is the river getting cleaner, dirtier, or staying the same?
- Are contaminant concentrations in freshwater fish decreasing, increasing, or staying the same?
- How have suspended sediment concentrations and loads changed over time?

In Phase 2 of the project where monitoring plans are developed, objectives and questions would be refined and focused for more specificity regarding location, media, COC, and temporal/spatial extent.

4.3 Information needed and sources

Information about toxic contaminants in the mainstem middle Columbia River will be assembled from existing studies. The main sources of information and data are expected to be acquired from federal, tribal, and state entities. As described in Section 3.2.2 above, a number of studies have focused on toxic contaminants in the mid-Columbia River. Geographic Information System (GIS) software layers created as part of several past studies (Caton, 2012; Herger et al, 2016; Counihan et al, 2014) may also be acquired if they are still relevant to developing a monitoring framework.

4.4 Tasks required

Project tasks, activities, deliverables, timeline and milestones are listed in Table 3.

Table 3. Phase 1 (Year 1 and 2) Work Plan Tasks, Deliverables, Timeline, and Milestones.

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
	Grant Start Date			0	10/1/2020
A	**Project Management and Coordination**				
1	**Convene Project Team, refine workplan, develop QAPP**	**-**	**-**	0-4	**-**
1a	Refine Work Plan	Refined workplan with adequate detail to use in QAPP	Table of tasks, outputs, timeframes, roles	0-1	11/10/2020
1b	Develop QAPP for Phase 1	Draft QAPP	Draft QAPP to EPA	0-2	12/10/2020
1c	Revise/finalize QAPP	Final QAPP	Final QAPP approved by EPA	2-4	2/1/2021
2	**Grant Management**	**This Table 1 workplan will be inserted into QAPP to provide summary of Grant Management Timeline and Deliverables**	**Quarterly, Semi Annual and Annual reporting**	**0-23**	ongoing
	Project Start Date	**-**		***0***	***10/1/2020***
	Project End Date	**-**		***23***	***9/30/2022***
2a	Quarterly Check-in call	**-**	Call with EPA Project Officer and Grantee Key Contacts; Start by 1/1/2021	Every 3 months	2/1/2021
2b	Semi Annual Report Due - Months 1-6	**-**	Semi Annual Progress Report; Start by 4/1/2021	Every 6 months	5/1/2021

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
2e	Report Review and Quarterly Check-in call - Months 1-6	-	Call with EPA Project Officer and Grantee Key Contacts; Start by 4/1/2021	Every 6 months	5/1/2021
2f	Quarterly Check-in call	-	Call with EPA Project Officer and Grantee Key Contacts; Start by 7/1/2021	Every 3 months	8/1/2021
2g	Semi Annual Report - Months 7-12	-	Semi Annual Progress Report; Start by 10/1/2021	Every 6 months	11/1/2021
2h	Report Review and Quarterly Check-in call - Months 7-12	-	Call with EPA Project Officer and Grantee Key Contacts; Start by 10/1/2021	Every 6 months	11/1/2021
2i	Quarterly Check-in call	-	Call with EPA Project Officer and Grantee Key Contacts; Start by 1/1/2022	Every 3 months	2/1/2022
2j	Semi Annual Report - Months 13-18	-	Semi Annual Progress Report; Start by 4/1/2022	Every 6 months	5/1/2022
2k	Report Review and Quarterly Check-in call - Months 13-18	-	Call with EPA Project Officer and Grantee Key Contacts; Start by 4/1/2022	Every 6 months	5/1/2022

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
2l	Quarterly Check-in call	-	Call with EPA Project Officer and Grantee Key Contacts; Start by 7/1/2022	Every 3 months	8/1/2022
2m	Final Project Progress Report within 90 days	-	Final Project Progress Report; Start by 9/30/2022	0-23	12/29/2022
3	**Project Awards & Oversight**	-		**0-23**	**ongoing**
B	**Columbia River Mainstem Fish Tissue and Water Quality Monitoring Framework**				
1	**Define objectives and questions that the status and trend monitoring program will answer**		**Summary document**	2-4	**2/15/2021**
1a	Define monitoring objectives	Table of monitoring objectives	Draft table	2-4	**2/15/2021**
1b	Define key questions for each media (fish, sediment, water, invertebrates)	Table of monitoring questions	Draft table	2-4	**2/15/2021**
1c	Solicit feedback from key stakeholders on objectives and questions developed by the Project Team	Incorporate stakeholder feedback into draft table describing monitoring objectives and questions	Updated draft table	2-5	3/15/2021
2	**Identify historic studies and data to support the development of the monitoring design**		**Summary document* with table summarizing relevant historic studies: e.g. name, author, timeframe, location, target analytes,**	2-5	3/15/2021

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
			sample sizes, data location.		
2a	Define process for identifying studies.	Description of how studies will be identified (e.g., expert knowledge, inquiries to various organizations (e.g., federal, tribal, state, local gov'ts; NGOs).	Summary document (section ~ 1-2 paragraphs) - draft	2-5	3/15/2021
2b	Describe how information about studies will be shared with the Project Team.	Description of how information will be tracked, stored, and accessed.	Summary document (section ~ 1-2 paragraphs) - draft.	2-5	3/15/2021
2c	Develop criteria for including studies	List criteria (e.g., addresses media, toxic parameters of concern; QAPP available; report available which describes methods; peer review, etc.).	Summary document (section ~ 1-2 paragraphs) - draft	2-5	3/15/2021
2d	Identify relevant historic studies	Apply criteria developed in 2c and develop list of studies.	Draft table of relevant studies.	2-5	3/15/2021
3	**Assess availability of data identified in Task 2; compile available data; analyze data to determine sample variability**		**Summary of data analyses characterizing the variability in contaminant concentrations and other relevant metrics; Summary of data gaps and related needs.**	5-9	7/15/2021
3a	Outreach to organizations in possession of data from studies identified in Task 2.	Assess availability of data from relevant studies identified in Task 2.	Summary document (section ~1-2 paragraphs) - draft.	4-6	4/1/2021

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
3b	Describe how data will be compiled, managed, and accessed.	Description of data management plan.	Summary document (section ~ 1-2 paragraphs /table) - draft. Database or spreadsheet populated with historical data.	4-9	7/15/2021
3c	Describe methods used to analyze historical data.	Description of methods to analyze historical data with consideration of 1) data characteristics to focus on (e.g., concentrations, variability), 2) spatial and temporal aspects, 3) different sampling media, sampling and analytical methods, 4) data reductions (e.g., how calculate total PCBs), and 5) species and tissue types (for biota).	Summary document (section) - draft. Summarize methods and results of analyses and discuss how they can be used to facilitate the development of a monitoring design.	4-9	7/15/2021
3d	Analyze historical data.	Describe historical data analyses.	Summary document (section) - draft. Summarize historical data analyses noting spatial and temporal data gaps.	4-9	7/15/2021
4	**Identify and evaluate monitoring design options**		**Draft document that reviews monitoring design options and their pros/cons for assessing contaminant concentration trends.**	7-12	10/15/2021
4a	Identify monitoring design options and develop evaluation criteria	List of potential monitoring designs that will be evaluated (e.g., probabilistic, systematic, etc.). Designs from previous	Summary document (section) - draft. Describe design	7-12	10/15/2021

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
		studies in the mainstem Columbia River will be considered (e.g., CRITFC 1999, EPA 2005/2009, EPA/ODEQ 2008/09, Energy 2009, Ecology 2013). Description of how different monitoring designs will be evaluated. List of criteria for evaluation (e.g. pros/cons, ability to achieve objectives and answer questions identified in Task 1 with statistical rigor).	concepts and examples from other studies.		
4b	Evaluate monitoring design options and discuss how the options will, or will not, address the objectives and questions defined in Task 1.	Apply criteria developed in Task 4a and provide summary.	Summary document (section) - draft. Summarize different design options and recommend a monitoring design.	7-12	10/15/2021
5	**Address monitoring design questions about sample selection process, sampling locations, sampling frequency, sample sizes**		**Summary document that reviews monitoring design options for assessing contaminant concentrations trends and conducts a feasibility study on monitoring design alternatives.**	8-13	11/15/2021
5a	Define key factors affecting the representativeness of samples that need to be addressed in monitoring design considerations.	Table or summary of factors for each media (e.g., for fish: species, site fidelity and seasonal migration, size and age; for sediment: depositional environment, grain size, organic content).	Summary document/table (section) - draft	8-13	11/15/2021
5b	Describe what pilot studies for program implementation might look like.	Describe pilot study objectives and how they could inform the implementation	Summary document (section) - draft	8-13	11/15/2021

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
		phase of the monitoring program. Describe how invertebrate, substrate, and water monitoring could provide context to fish tissue contaminant monitoring.			
6	**Seek input on monitoring designs**		**Outreach and meetings with Working Group**	6-15	1/1/2022
6a	Define how reviews, discussions, and decisions will be documented or captured for the record.	Define how reviews, discussions, and decisions will be documented or captured for the record.	Summary document (section ~ 1-2 paragraphs) - draft	6-15	1/1/2022
6b	Solicit feedback from key stakeholders on the recommended monitoring designs	Provide key stakeholders document produced in Task 4 and request comments. Incorporate stakeholder feedback	Summary document (section ~ 1-2 paragraphs) - draft	6-15	1/1/2022
7	**Rough draft Monitoring Framework Report for Project Team**	**-**	**Draft document**	9-16	2/1/2022
8	**Project Team review rough Draft; address issues and revise**	**-**	**Review comments, discussions**	16-17	3/15/2022
9	**Draft 1 Monitoring Framework Report**	**-**	**Draft document**	18-19	4/1/2022
10	**Project Team review Draft 1**	**-**	**Review comments, discussions, possible meetings**	17-18	4/15/2022
11	**Draft 2 Monitoring Framework Report**	**-**	**Draft document**	18-19	5/1/2022
12	**Peer review of Draft 2**	**-**	**Review comments, discussions, possible meetings**	19-22	8/15/2022

Task ID	Task Description	Information to inform and be included in QAPP	Outputs/Deliverables/ Milestones (from Grant Application)	Timeline (month #)	Approx Date Due
12A	Internal review and final edits	-	Meeting	23	9/15/2022
13	**Final Monitoring Framework Report**	-	**Final document for submittal to EPA**	21-23	9/30/2022
C	**Community Engagement Plan**		**Draft and Final, w/ stakeholder collaboration**	0-12	10/31/2021
1	**Outreach/Collaboration with Project Team, Working Group and community**		**Draft for submittal to EPA w/ stakeholder collaboration**		ongoing
C1a	Project Team subgroup convenes (YN & CRITFC)	Draft/Final QAPP section. Goals (monitoring plan development technical outreach, tribal outreach) and process descriptions.	Meeting/Summary of Goals and Process Descriptions	0-4	12/10/2020 2/1/2021
C1b	Grant awardees subgroup collaboration	-	Meeting	0-5	3/30/2021
C1c	Develop Draft Community Engagement Plan - v1	-	Draft Community Engagement Plan - v1	0-8	6/30/2021
C1d	Review by project team and interested collaborators	-	Comments	8-9	7/1/2021
C1e	Develop Draft Community Engagement Plan - v2	-	Draft –v2 Community Engagement Plan for submittal to EPA	9-12	10/31/2021

The review of monitoring designs (Task B.4) used in the Columbia River will help inform the selection of designs to be used to meet project objectives. Because there may be multiple objectives, different monitoring designs may be needed to meet the unique needs of each objective.

The two monitoring designs that have been used in past studies within the mainstem Columbia River are systematic and probabilistic. Most studies have used a systematic design where sites, sample media, sample sizes, and analytes were selected in order to focus resources on specific issues and inform cleanup actions. Several efforts have been made in the study area to create spatial frameworks for use in probabilistic study designs. The probabilistic designs are used to generate data so that inferences can be made for a broader spatial scale.

The spatial products from two probabilistic design efforts could inform the development of monitoring frameworks which Phase 1 of this this project aims to do. Review of past work by EPA and USGS will determine if any of the spatial framework delineation that was created can be used or whether this project will need to repeat those efforts.

The mid-Columbia Ecological Assessment conducted by EPA and ODEQ used a sampling framework of sites that were chosen using EPA's Environmental Monitoring and Assessment Program approach. This approach used an unequal selection probability randomized design that is unbiased to select sample sites. For the 2008-2009 study (Caton, 2012; Herger et al, 2016) sample locations were selected from a river-centerline GIS data layer (or "sample-frame") developed from the National Hydrography Database (Hayslip and Herger, 2008a, 2008b). This survey design was also characterized as a Generalized Random Tessellation Stratified (GRTS) for a linear resource and includes reverse hierarchical ordering of the selected sites (Olsen, 2007). Other study design factors also guided the selection of sites, such as needed sample size and desired stratification. For the EPA/ODEQ effort, a total of 50 sites were selected, and were stratified by state such that 19 sites were in Washington and 29 sites were in Oregon.

The USGS created a different sampling frame to inform development of an integrated approach to monitoring (Counihan, et al, 2014). This effort also used a GRTS approach, along with digital elevation models of the river channel and adjacent upland area in order to generate sites based on areal extent rather than just linear extent. The resultant site list retains randomization and spatial balance across the area delineated. Sample frames were developed for three mainstem reservoirs created by dams: Bonneville, The Dalles, and John Day. Information for these sample frames were then incorporated into the Monitoring Sample Designer tool developed by the Pacific Northwest Aquatic Monitoring Partnership in order to be available to other researchers who want to create a list of sites to meet individual project needs.

Additionally, sampling designs may be created to evaluate conditions at locations relevant to targeted impacts (e.g., concentrations of contaminants in fish harvested at traditional tribal fishing sites).

4.5 Systematic planning process

NOT APPLICABLE.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 4 shows the responsibilities of those who will be involved in this project.

Table 4. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Name: Laura Shira Organization: Yakama Nation Fisheries Phone: 509.985.3561	Project Co-Manager	Co-manages grant activities, provides technical supports.
Name: Sherrie Duncan Organization: Sky Environmental Phone: 253.255.8634	Project Co-Manager, Sub-contractor to YNF	Co-manages grant activities. Provides technical support.to YNF.
Name: Tim Counihan Organization: USGS Phone: 509-538-2981	Principal Investigator	Technical lead on the development of the Monitoring Framework; report.
Name: Patrick Moran Organization: USGS Phone: 253-552-1646	Principal Investigator	Technical lead on the development of the Monitoring Framework; report.
Name: Ian Waite Organization: USGS Phone: 503-251-3463	Principal Investigator	Technical lead on the development of the Monitoring Framework; report.
Name: Keith Seiders Organization: WA Ecology Phone: 360-407-6689	Natural Resources Scientist	Contributor.
Name: Dianne Barton Organization: CRITFC Phone: 503-238-0667	Water Quality Coordinator	Contributor.
Name: Nicole Taylor Organization; EPA Phone: 206-553-8322	Project Officer	Review QAPP.
Name: Donald Brown Organization; EPA Phone:206-553-0717	QAPP Manager	Review and approve QAPP.

Staff	Title	Responsibilities
Name: Lon Kissinger Organization; EPA Phone: 206-553-2115	Technical Liaison	Review and approve QAPP and assist in obtaining technical support from EPA and other stakeholders as needed.

QAPP: Quality Assurance Project Plan

CRBRP: Columbia River Basin Restoration Funding Assistance Program

WQX: Water Quality Exchange

5.2 Special training and certifications

Dianne Barton is the Water Quality Coordinator at the Columbia River Inter-Tribal Fish Commission (CRITFC) where she provides technical expertise related to water quality, environmental toxics, regulatory processes, and fate and transport of contaminants. CRITFC is a technical support and coordinating agency for its member tribes' fisheries management programs. Dianne serves as the Chairman of the National Tribal Toxics Council (NTTC) which is an EPA tribal partnership group for the Office of Pollution Prevention and Toxics. Key issues for the NTTC include advocacy for programs to minimize the disproportionate exposure of tribal members to toxic chemicals, increasing tribal capacity to monitor natural resources for toxic chemicals, and enhancing tribal consultation on chemical risk management and pollution prevention policies. Dianne holds a Ph.D. in Geochemistry from the University of Arizona and is a member of the Bad River Band of Lake Superior Chippewa.

Tim Counihan is a Lead Research Fishery Biologist for the USGS Western Fisheries Research Center with 26 years of experience conducting research on the Columbia River Ecosystem and large rivers in the U.S. He is currently the chair of a forum that consists of federal, private, state, and tribal entities that are trying to prevent invasive mussels from establishing and spreading in the Columbia River Basin. As chair of this forum, he is leading efforts to coordinate and design a monitoring program for invasive mussels in Idaho, Montana, Oregon, and Washington and the Canadian province of British Columbia. He is also the technical lead of a USGS lead forum of scientists conducting monitoring on large rivers in the U.S. The Large River Monitoring Forum is working to identify ways to improve monitoring of large rivers through scientific investigation and collaboration. He has published papers on a wide array of topics including research on ways to improve sediment contaminant monitoring programs in the mainstem Columbia River and how contaminants are transferred through the Columbia River Ecosystem.

Sherrie Duncan is a Fisheries Biologist/Restoration Ecologist with over 28 years of experience providing technical expertise and project management for natural resource and salmon recovery projects and monitoring programs throughout the watersheds of Washington and the greater Pacific Northwest. She has extensive experience in the assessment of environmental effects analyses on fish and water resources in eastern Washington. For the past 12 years, Sherrie has provided technical support to the Yakama Nation for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Natural Resource Damage Assessment and Restoration (NRDAR) projects and state-led assessments and cleanups of hazardous waste sites throughout the Columbia Basin. Sherrie has provided technical support and project management on natural resource damage assessments and injury studies; ecological and human health risk assessments; environmental planning and impact assessment; site investigations and cleanup; permitting, restoration and monitoring and adaptive management. She is a proven leader of multidisciplinary teams and has participated on numerous technical advisory groups addressing watershed protection and restoration focused on the recovery of listed salmonids. Sherrie is a technical contractor with Yakama Nation who will be assisting with project management.

Patrick Moran is a Biologist and Ecotoxicologist with the US Geological Survey's Washington Water Science Center (WA WSC) in Tacoma, WA. For the past 18 years Patrick has served as a Project Manager and supported Technical Advisor on projects specific to both Washington State and Nationally. In Washington state, he managed several, multi-year projects addressing water quality, fisheries, and human fish consumption with partners like the National Park Service, the Stillaguamish Tribe, the Department of Defense, and the Washington Department of Ecology. His technical expertise in water quality has been utilized in long-term oversight and review roles on the Hanford Site, the Upper Columbia River site, Portland Harbor and the Blackbird Mine through requests from the Department of the Interior, NOAA, EPA Region 10, EPA Office of Water, Washington Department of Ecology and Washington Department of Health. Within the USGS, Patrick has served as the WA WSC's water quality specialists, on the USGS National Water Quality Assessment Program's Cycle 3 Design team and on their Regional Stream Quality Assessment Team. He has supported, advised and graduated two graduate students and has co-authored over 30 peer reviewed publications.

Keith Seiders is a Natural Resources Scientist with Ecology's Environmental Assessment Program, Toxics Studies Unit. He has led Ecology's Freshwater Fish Contaminant Monitoring Program since 2001. This program characterizes toxic contaminants in fish tissue in order to identify trends, inform fish consumption risk assessments, and conduct Clean Water Act Section 303(d) assessments. Much of this program's work is in major sub-basins of the Columbia River where Ecology has TMDLs and similar efforts to address toxic contaminants in fish. Keith has also assessed toxics in water and sediment and provided technical assistance to others seeking help with monitoring toxics in the environment. Prior to fish tissue work, Keith's monitoring experience at Ecology since 1988 has included evaluating the effectiveness of non-point pollution control programs, conducting TMDL studies, and supporting NPDES Class II permit compliance inspections at large municipal and industrial wastewater treatment plants.

Laura Klasner Shira is an environmental engineer (PE) and hydrologist with 17 years of experience working in environmental cleanup (private environmental consultant, state regulator and cleanup site manager, and tribal fisheries scientist and advocate). Laura currently works for the Yakama Nation Fisheries Program, Superfund Division. Much of her work focuses on priority cleanup sites within the Columbia River Basin (ex. Portland Harbor, Bradford Island) with some involvement in outreach and policy issues related to water quality. In addition to environmental cleanup, Laura's prior experience includes 2 years of graduate school with a focus on hydrologic controls of nutrient cycling and 7 years as a secondary education math and science teacher.

Ian Waite is an aquatic ecologist with the USGS Oregon Water Science Center working on complex bioassessments in the PNW region and around the country since 1992. He was a key team member that produced the Lower Columbia River Estuary Ecosystem Classification system (USGS 2011-1228) and of the multi-disciplinary team that worked on understanding contaminants across a complex food web (water, sediment, invertebrates, fish, osprey) in the lower Columbia river that resulted in multiple journal articles and an innovative rigorous sampling design. Ian specializes in sampling design, data analysis, modeling, and stream bioassessments across a wide variety of spatial scales. Ian has a Ph.D. in aquatic entomology and an M.S. in fisheries.

5.3 Organization chart

NOT APPLICABLE. See Table 4.

5.4 Proposed project schedule

See Table 3 in Section 4.4 for proposed project schedule detail.

5.5 Budget and funding

Table 5. Budget Detail

Object Code Description	Budget Line Items	Hrs	Rate	TOTAL
PERSONNEL				**38,623.15**
Wage, Regular Full-Time	Superfund Section Planner, Rose Longoria	180	50.70	9,126.00
	Environmental Engineer I, Laura Shira	180	48.86	8,794.80
	Toxicologist, Bob Dexter	95	56.57	5,374.15
	Governmental Relations Liaison	120	40.56	4,867.20
	Projects Controller	60	31.50	1,890.00
	Lead Superfund Accountant	300	28.57	8,571.00
FRINGE	Fringe Benefits			**11,200.71**
TRAVEL	Per Diem/Lodging/Airfare/other			**2,700.00**
	Per Diem/Lodging/Airfare/other			**2,500.00**
Rental	GSA Rental / GSA Mileage			200.00
EQUIPMENT	Capital Purchase, >$5,000			**0**
SUPPLIES				**0**
CONTRACTUAL				**33,000.00**

Object Code Description	Budget Line Items	Hrs	Rate	TOTAL
Professional Services	Law Office of Thomas Zeilman			3,000.00
	Sky Environmental			30,000.00
CONSTRUCTION				**0**
OTHER				**80,763.00**
	USGS – OR Water Science Center			28,900
	USGS – WA Water Science Center			24,420
	USGS – Western Fisheries Research Center			26,143
Leases	Office Lease			1,000.00
Cellular Phone	Cellular Phone			150.00
Insurance	Veh. Lia. Comp. Coll.			150.00
	DIRECT COSTS			**166,286.86**
	IDC (20.05%)			**33,340.52**
	SUB-TOTAL			**199,627.38**
	COST-SHARE			**52,000**
	TOTAL			**251,627.38**

Table 6. Work Plan Tasks and Activities (for more detail see Table 1 in Section 1.C.)

Task and Budget	Anticipated Outputs/Deliverables
Review, compilation, and analysis of historical studies and data	Budget: $10,000
Framework and collaboration	Budget: $180,000
Community Engagement and Outreach Plan	Budget: $10,000
Outreach	Budget: $31,764.38
Project management	Budget: $20,000

Table 7. Cost Share, Subawards, and Contractor Support Summary

	FTEs	Grant Subaward	Cost Share	Total
Yakama Nation	0.45	$108,914.79	$11,249.59	$120,164.38
Ecology	0.07	$0	$7,000	$7,000
CRITFC	0.06	$0	$9,000	$9,000
USGS – OR Water Science Center	0.1	$28,900	$13,600	$42,500
USGS – WA Water Science Center	0.1	$24,420	$12,080	$36,500
USGS – Western Fisheries Research Center	0.1	$26,143	$10,457	$36,600

6.0 Quality Objectives

6.1 Data quality objectives[1]

In support of this project, the project team will perform review of existing data. We will review local and regional governmental and non-governmental sources for available data that describe contaminants if fish and other media in the study area. Factors that the project team will consider in reviewing gathered information are described in Table 8**.**

Table 8. Quality Criterion and Definitions

Quality Criterion	Description/Definition
Completeness	All data reviewed will be checked to ensure presentation of results are complete.
Relevance	Data sources specific to the topic being investigated will be considered for use. Sources that most closely represent the topic/data of interest are the most relevant.
Reliability	The information/data source is reliable. For example, this criterion includes at least one of the following acceptance specifications: • The information or data are from a peer-reviewed, government, or industry-specific source. • The source is published. • The author is engaged in a relevant field such that competent knowledge is expected (i.e., the author writes for an industry trade association publication versus a general newspaper). • The information was presented in a technical conference where it is subject to review by other industry experts.
Representativeness / Content	The information/data source is representative in its content. Examples of source content can include extent of data (e.g., what geographical area does it cover, over what period) and level of documentation describing the generation of the data.

6.2 Measurement quality objectives

NOT APPLICABLE.

[1] DQO can also refer to ***Decision*** Quality Objectives. The need to identify Decision Quality Objectives during the planning phase of a project is less common. For projects that do lead to important decisions, DQOs are often expressed as tolerable limits on the probability or chance (risk) of the collected data leading to an erroneous decision. And for projects that intend to estimate present or future conditions, DQOs are often expressed in terms of acceptable uncertainty (e.g., width of an uncertainty band or interval) associated with a point estimate at a desired level of statistical confidence.

6.2.1 Targets for precision, bias, and sensitivity

NOT APPLICABLE.

6.2.1.1 Precision

NOT APPLICABLE.

6.2.1.2 Bias

NOT APPLICABLE.

6.2.1.3 Sensitivity

NOT APPLICABLE.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

NOT APPLICABLE.

6.2.2.2 Representativeness

NOT APPLICABLE.

6.2.2.3 Completeness

NOT APPLICABLE.

6.3 Acceptance criteria for quality of existing data

Phase 1 of this project will use data collected through monitoring efforts conducted by others as described in Section 4 above. No new data will be collected in this Monitoring Framework development. Sources of data and information will include original data sets and report from the entity authoring the study or databases that house the study data. Such databases will likely include EPA's STORET, USGS's NWIS, and Ecology's Environmental Information Management (EIM) database. Data and associated documentation (e.g., project plans, project reports, and laboratory data reports) will be reviewed to assess their usability in this project.

Acceptance criteria for studies and data are described in Table 8 above.

While no new data will be generated or collected as a part of this study, data quality and associated detection levels in the reviewed, historical data will be an important consideration and documented during the review. Data quality will be tracked and scored according to a 3-part scoring system as, A)- Data of high quality with associated Quality Assurance/Quality

Control (QA/QC) data provided and passed approval by a dedicated QA reviewer, B) some QA/QC data provided, but documented QA/QC review not demonstrated or unknown, C) QA/QC unavailable and/or not provided. Likewise, detection levels associated with historical data will be tracked and included with the original data retrievals. However, for the purposes of estimating means, variance and central tendencies, all reported data, including estimated but not imputed data, will be utilized.

Consideration of the current state of the science in human and ecological risk assessment will also be pertinent when considering the usefulness of past data- primarily as non-detected values- and using it to prioritize future planning. (i.e. Non-detections of important compounds well above their current screening levels will not be considered evidence of absence.) As a guide to the adequacy of the detection levels of previous data, current drinking water and dietary screening values from EPA sources (National Primary and Secondary Drinking Water Regulations (EPA, 2020), and the Regional Screening Level for Resident Fish Table (EPA, 2018) will be consulted. For sediments, Washington State Department of Ecology's Sediment Management Standards (Ecology, 2013) and Ecology's Sediment Quality Guidelines (Ecology, 2011) will also be utilized for data adequacy consideration, see Table 9 below. These tables highlight some of the most likely surface water and fish tissue contaminants to be encountered during review of the Columbia River pollution literature. In cases were multiple congeners or salts of a given compound were listed in either of the Screening Level sources, the lowest of those values was used here. As the values listed in EPA (2020) and EPA (2018) are for the screening level themselves, the ideal yet reasonable expectation for data review is set here as one-half the screening value. Of course, lower detection levels will be recommended whenever economically and feasibly possible. Additionally, a second column of data quality specific to 'detection level adequacy' will be recorded during the literature review. Detection levels that are one-tenth or more below the screening level will be coded as higher quality (an analogous A score), those that are within 1/10 and 1X of the Screening level will be given a B score, and those values that exceed the current screening values will be given a C score. A discussion of both the associated data quality and detection level adequacy scores of historic data will be discussed in the discussion section of the report for consideration along with the report's conclusions and future recommendations.

Table 9. Optimal Detection Levels (as One-Half of the Screening-Level^) sought for Human Health considerations, selected pollutants only.

Pollutants	Water (ug/L)	Tissue (ug/kg)	WA Sediment Freshwater Standard (mg/Kg)
Mercury	0.031	7^{+}	0.66
PCBs as lowest Aroclor	0.02	1.05	110
PCB- as PCB126	5E -6	0.00055	
DDD	0.003	8.5	310
DDE	0.3	6	21
DDT	0.5	6	100
PBDEs	0.007	0.55	NA

^ Values here from EPA 2020 and EPA 2018-THQ=0.1, are one-half of the lowest of those listed, if multiple congeners or salts are provided, for a given pollutant.

6.4 Model quality objectives

NOT APPLICABLE.

7.0 Study Design

7.1 Study boundaries

The project encompasses the approximately 600 mile stretch of the Columbia River mainstem from Bonneville Dam to the Canadian border. See Figure 1.

7.2 Field data collection

NOT APPLICABLE.

7.2.1 Sampling locations and frequency

NOT APPLICABLE.

7.2.2 Field parameters and laboratory analytes to be measured

NOT APPLICABLE.

7.3 Modeling and analysis design

NOT APPLICABLE.

7.3.1 Analytical framework

NOT APPLICABLE.

7.3.2 Model setup and data needs

NOT APPLICABLE.

7.4 Assumptions of study design

NOT APPLICABLE.

7.5 Possible challenges and contingencies

Delays due to corona virus orders and restrictions are a real challenge. Our contracting for subawards has been delayed as has our efforts to develop a QAPP. We will continue to work to stay on track.

7.5.1 Logistical problems

Delays due to corona virus orders and restrictions are a real challenge. Our contracting for subawards has been delayed as has our efforts to develop a QAPP. We will continue to work to stay on track.

7.5.2 Practical constraints

Delays due to corona virus orders and restrictions are a real challenge. Our contracting for subawards has been delayed as has our efforts to develop a QAPP. We will continue to work to stay on track.

7.5.3 Schedule limitations

We were delayed in developing our QAPP. The corona virus orders have resulted in additional delays. We are hoping to obtain an approved QAPP by January 31, 2021 so that we can get back on track. We will continue to work to stay on track.

8.0 Field Procedures

8.1 Invasive species evaluation

NOT APPLICABLE.

8.2 Measurement and sampling procedures

NOT APPLICABLE.

8.3 Containers, preservation methods, holding times

NOT APPLICABLE.

8.4 Equipment decontamination

NOT APPLICABLE.

8.5 Sample ID

NOT APPLICABLE.

8.6 Chain of custody

NOT APPLICABLE.

8.7 Field log requirements

NOT APPLICABLE.

8.8 Other activities

NOT APPLICABLE.

9.0 Laboratory Procedures

9.1 Lab procedures table

NOT APPLICABLE.

9.2 Sample preparation method(s)

NOT APPLICABLE.

9.3 Special method requirements

NOT APPLICABLE.

9.4 Laboratories accredited for methods

NOT APPLICABLE.

10.0 Quality Control Procedures

This work will be conducted with extensive collaboration and coordination with the entities presented in this QAPP and a broader group of stakeholders and community members including the Columbia River Working Group. Problems or issues encountered during the project will be addressed immediately by discussing with appropriate experts to identify a timely solution.

10.1 Table of field and laboratory quality control

NOT APPLICABLE.

10.2 Corrective action processes

In the event that it is identified that analysis or modeling results do not meet Measurement Quality Objectives (MQOs) or performance expectations, or if some other unforeseen problem arises, the project team will convene to decide on next steps that need to be taken to improve project performance. The project team may also decide to call on other partnering technical experts in the region.

11.0 Data Management Procedures

While historical data will be compiled and analyzed for Phase 1 of this project, no data will be transferred to federal or state databases (e.g., STORET, EIM). However, historical data will be collected, stored, managed, analyzed, and summarized to meet Phase 1 objectives. Commonly accepted data management practices will be used to manage and analyze data, such as the use by project ream members of local spreadsheets, databases, GIS platforms, and paper file systems. While not yet determined, creation of some type of a repository is desired for project documents and electronic files (e.g., MS Office Word/Excel/Access, statistical software, GIS).

11.1 Data recording and reporting requirements

NOT APPLICABLE.

11.2 Laboratory data package requirements

NOT APPLICABLE.

11.3 Electronic transfer requirements

NOT APPLICABLE.

11.4 Data upload procedures

NOT APPLICABLE.

11.5 Model information management

NOT APPLICABLE.

12.0 Audits and Reports

12.1 Audits

NOT APPLICABLE.

12.2 Responsible personnel

NOT APPLICABLE.

12.3 Frequency and distribution of reports

Table 3 shows the schedule for reporting efforts for Phase 1 of this project.

12.4 Responsibility for reports

Table 3 above shows the parties responsible for reporting efforts of this Phase 1 project.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

NOT APPLICABLE.

13.2 Laboratory data verification

NOT APPLICABLE.

13.3 Validation requirements, if necessary

NOT APPLICABLE.

13.4 Model quality assessment

NOT APPLICABLE.

13.4.1 Calibration and validation

NOT APPLICABLE.

13.4.1.1 Precision

NOT APPLICABLE.

13.4.1.2 Bias

NOT APPLICABALE

13.4.1.3 Representativeness

NOT APPLICABLE.

13.4.1.4 Qualitative assessment

NOT APPLICABLE.

13.4.2 Analysis of sensitivity and uncertainty

NOT APPLICABLE.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

Section 6.0 above describes the acceptance criteria for studies and data to be used in the Phase 1 effort. The determination of meeting Phase 1 project objectives will be described in project reports.

14.2 Treatment of non-detects

NOT APPLICABLE. No new data is being collected. No laboratory analysis is being conducted.

14.3 Data analysis and presentation methods

The analysis of historical data will use tools available to the project team. These tools are likely to include Excel and Access for data management and statistics, statistical software such as R for data analyses, and Arc GIS for mapping. Data analyses will likely include, but are not limited to:

- Summary statistics; particularly estimates of variability.
- Plots and tables to show characteristics of target populations in different media across the study area.
- Evaluating analytes as possible covariates in each media which can inform development of study designs and sample strategies. For example, relationships between fish size, age, and lipids to contaminant concentrations could improve the sensitivity of analyses for trends.
- The use of results from the above in the various sample designs to be evaluated.

14.4 Sampling design evaluation

The evaluation of potential sampling designs is an inherent part of this Phase 1 effort and is reflected in Tasks B.4 through B.8 in the Table 3. Evaluations of potential designs will include estimates of power, reviews by peers, and potential pilot studies.

14.5 Documentation of assessment

The work conducted during this project will be documented through development of a Monitoring Framework which will be used to inform development of a Monitoring Program for the Columbia River Mainstem.

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16.0 Appendices

Appendix A. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Anthropogenic: Human-caused.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Load allocation: The portion of a receiving water's loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading capacity: The greatest amount of a substance that a water body can receive and still meet water quality standards.

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

Point source: Source of pollution that discharges at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites where more than 5 acres of land have been cleared.

Pollution: Contamination or other alteration of the physical, chemical, or biological properties of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Salmonid: Fish that belong to the family *Salmonidae*. Species of salmon, trout, or char.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Total Maximum Daily Load (TMDL): A distribution of a substance in a water body designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a margin of safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Total suspended solids: Portion of solids retained by a filter.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

303(d) list: Section 303(d) of the federal Clean Water Act, requiring Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

90th percentile: An estimated portion of a sample population based on a statistical determination of distribution characteristics. The 90th percentile value is a statistically derived estimate of the division between 90% of samples, which should be less than the value, and 10% of samples, which are expected to exceed the value.

Acronyms and Abbreviations

Action Plan	Columbia River Basin Toxics Reduction Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRBRP	Columbia River Basin Restoration Program
CRITFC	Columbia River Inter-Tribal Fish Commission
Working Group	Columbia River Toxics Reduction Working Group

DDE	dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
GIS	Geographic Information System software
GRTS	Generalized Random Tessellation Stratified
i.e.	In other words
MQO	Measurement quality objective
ODEQ	Oregon Department of Environmental Quality
PBDE	Polybrominated diphenyl ethers
PBT	Persistent, bioaccumulative, and toxic substance
PCB	Polychlorinated biphenyls
PCDD/Fs	polychlorinated dibenzo-p-dioxins and dibenzofurans
QA	Quality assurance
QC	Quality control
RI/FS	Remedial Investigation/Feasibility Study
TCDD	tetrachlorodibenzo-p-dioxin
TEF	toxic equivalent factor
TEQ	toxic equivalent concentration
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDOH	Washington Department of Health

Units of Measurement

km	kilometer, a unit of length equal to 1,000 meters
m	meter

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data (Kammin, 2010). For Ecology, it is defined according to Washington Administrative Code (WAC); 173-50-040: "Formal recognition by [Ecology] that an environmental laboratory is capable of producing accurate and defensible analytical data."

Accuracy: The degree to which a measured value agrees with the true value of the measured property. EPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy* (USEPA, 2014).

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella (Kammin, 2010).

Bias: Discrepancy between the expected value of an estimator and the population parameter being estimated (Gilbert, 1987; USEPA, 2014).

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured (Ecology, 2004).

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards but should be referred to by their actual designator, e.g., CRM, LCS (Kammin, 2010; Ecology, 2004).

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 2014; USEPA, 2020).

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator (USEPA, 2014; USEPA 2020).

Continuing Calibration Verification Standard (CCV): A quality control (QC) sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run (Kammin, 2010).

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system (Kammin, 2010; Ecology 2004).

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

Data integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading (Kammin, 2010).

Data quality indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

Data quality objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010).

Data validation: The process of determining that the data satisfy the requirements as defined by the data user (USEPA, 2020). There are various levels of data validation (USEPA, 2009).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set (Ecology, 2004).

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 2014).

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology, 2004).

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin, 2010).

Laboratory Control Sample (LCS)/LCS duplicate: A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples. Monitors a lab's performance for bias and precision (USEPA, 2014).

Matrix spike/Matrix spike duplicate: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias and precision errors due to interference or matrix effects (Ecology, 2004).

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA, 2006).

Measurement result: A value obtained by performing the procedure described in a method (Ecology, 2004).

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (USEPA, 2001).

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology, 2004; Kammin, 2010).

Method Detection Limit (MDL): The minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results (USEPA, 2016). MDL is a measure of the capability of an analytical method of distinguished samples that do not contain a specific analyte from a sample that contains a low concentration of the analyte (USEPA, 2020).

Minimum level: Either the sample concentration equivalent to the lowest calibration point in a method or a multiple of the method detection limit (MDL), whichever is higher. For the purposes of NPDES compliance monitoring, EPA considers the following terms to be synonymous: "quantitation limit," "reporting limit," and "minimum level" (40 CFR 136).

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all parameters (Kammin, 2010; Ecology, 2004).

Population: The hypothetical set of all possible observations of the type being investigated (Ecology, 2004).

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998).

Quality assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

Quality control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

$$RPD = [Abs(a-b)/((a + b)/2)] * 100\%$$

where "Abs()" is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Relative Standard Deviation (RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$RSD = (100\% * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

Reporting level: Unless specified otherwise by a regulatory authority or in a discharge permit, results for analytes that meet the identification criteria (i.e., rules for determining qualitative presence/absence of an analyte) are reported down to the concentration of the minimum level established by the laboratory through calibration of the instrument. EPA considers the terms "reporting limit," "quantitation limit," and "minimum level" to be synonymous (40 CFR 136).

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator (USGS, 1998).

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

Sample (statistical): A finite part or subset of a statistical population (USEPA, 1992).

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method (USEPA, 2014).

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency (USEPA, 2014).

Split sample: A discrete sample subdivided into portions, usually duplicates (Kammin, 2010).

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity (Kammin, 2010).

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis (Kammin, 2010).

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning (USEPA, 2006).

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