Quality Assurance Project Plan

Total Maximum Daily Load Study: DDT and PCBs in Lake Chelan

by
Randy Coots and Brandee Era-Miller

Washington State Department of Ecology
Environmental Assessment Program
Olympia, Washington 98504-7710

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303(d) Listings Addressed in this Study:
Lake Chelan (47120I1H6) – 4,4'-DDE, PCB-1254, PCB-1260
Roses (Alkali) Lake (370XQC) – 4,4'-DDE

Waterbody Number:
Lake Chelan Waterbody Number: 1203526480372 (WA-47-9020)
Roses (Alkali) Lake Waterbody Number: 1201529479042 (WA-47-9037)

Ecology EIM Number: RCOO0004

Approvals:

Approved by:	June 27, 2003
David Schneider, TMDL Lead, Central Regional Office	Date
Approved by:	June 27, 2003
Tom Tebb, Section Manager, Central Regional Office	Date
Approved by:	June 27, 2003
Jeff Lewis, Unit Supervisor, Central Regional Office	Date
Approved by:	June 24, 2003
Dale Norton, Unit Supervisor, Contaminant Studies Unit	Date
Approved by:	June 23, 2003
Will Kendra, Section Manager, Watershed Ecology Section	Date
Approved by:	June 30, 2003
Stuart Magoon, Director, Manchester Environmental Laboratory	Date
Approved by:	June 25, 2003
Cliff Kirchmer, Ecology Quality Assurance Officer	Date
Approved by:	June 30, 2003
Randy Coots, Project Lead, Contaminant Studies Unit	Date

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Abstract

Lake Chelan is listed under Section 303(d) of the Federal Clean Water Act for non-attainment of EPA's human health criteria for 4,4'-DDE (DDT metabolite), PCB-1254, and PCB-1260 (polychlorinated biphenyls) in fish tissue. Roses Lake, tributary to Lake Chelan via Stink Creek, is also listed for 4,4'-DDE in fish and was included in the present study. The 303(d) listings are based on fish tissue studies conducted by the Department of Ecology in 1992 and 1994. These legacy chemicals are not produced or used in the United States today but persist in the environment. This quality assurance project plan describes methodology to complete a Total Maximum Daily Load (TMDL) study that will be conducted to identify potential sources of the listed pollutants and determine the maximum amount these waterbodies may assimilate without violating water quality standards. The study will determine current levels of DDT, its metabolites, and PCBs in water, sediments, and fish throughout the basin.

Background and Problem Statement

Lake Chelan and nearby Roses Lake have been listed by the state of Washington under Section 303(d) of the Federal Clean Water Act for non-attainment of the U.S. Environmental Protection Agency (EPA) human health criteria for 4,4' DDE (a breakdown product of DDT), PCB-1254, and PCB-1260 (polychlorinated biphenyls) in edible fish tissue. These listings are based on sampling conducted by the Washington State Department of Ecology (Ecology) in 1992 and 1994 (Davis and Johnson, 1994; Serdar *et al*., 1994; Davis and Serdar, 1996).

The Clean Water Act requires states to set priorities for cleaning up 303(d) listed waters and to conduct a TMDL assessment for each. A TMDL is an analysis of how much of a pollutant load a waterbody can assimilate without violating water quality standards. The Quality Assurance Project Plan (QA Project Plan) for this TMDL describes the technical study that will monitor levels of DDT compounds and PCBs in Lake Chelan and Roses Lake and form the basis for a proposal to allocate contaminant loads to these waterbodies. The technical study will be conducted by the Environmental Assessment Program (EA Program) within Ecology.

Lake Chelan Basin Waterbodies on the 1996 and 1998 303(d) Lists.

Waterbody	New WBID	Old WBID	1996 303(d)	1998 303(d)	Parameter	Medium
Lake Chelan	292NWR	WA-47-9020	Yes	Yes	**4,4'-DDE**	**Tissue**
Lake Chelan	292NWR	WA-47-9020	Yes	Yes	**PCB-1254**	**Tissue**
Lake Chelan	292NWR	WA-47-9020	Yes	No	pH	Water
Lake Chelan	292NWR	WA-47-9020	Yes	Yes	**PCB-1260**	**Tissue**
Chelan River	JI23XG	WA-47-1010	Yes	No	Fecal Coliform	Water
First Creek	CH30BE	WA-47-1012	Yes	Yes	Dissolved Oxygen	Water
Mitchell Creek	QF17YZ	WA-47-1014	Yes	Yes	pH	Water
Railroad Creek	DD44JV	WA-47-1020	Yes	No	Arsenic	Water
Roses Lake	370XQC	WA-47-9037	Yes	Yes	**4,4'-DDE**	**Tissue**
Stehekin River	HW13SG	WA-47-1030	Yes	No	Arsenic	Water

Bolded parameters are being addressed in this TMDL evaluation. A complete summary of information for each 303(d) listing for the Lake Chelan Basin can be found in Appendix A.

Basin Description

Lake Chelan is located in north central Washington State (Figure 1). It is the longest and deepest natural lake in the state and considered pristine with its ultra-oligotrophic nutrient conditions. The Lake Chelan watershed drains a 924 square mile area. The lake itself is divided into two distinct basins, partially separated by a glacial sill (Kendra and Singleton, 1987). The larger of the basins, the Lucerne Basin, contains over 92 percent of the total lake volume and reaches a maximum depth of approximately 1500 feet. The smaller Wapato Basin receives most of its

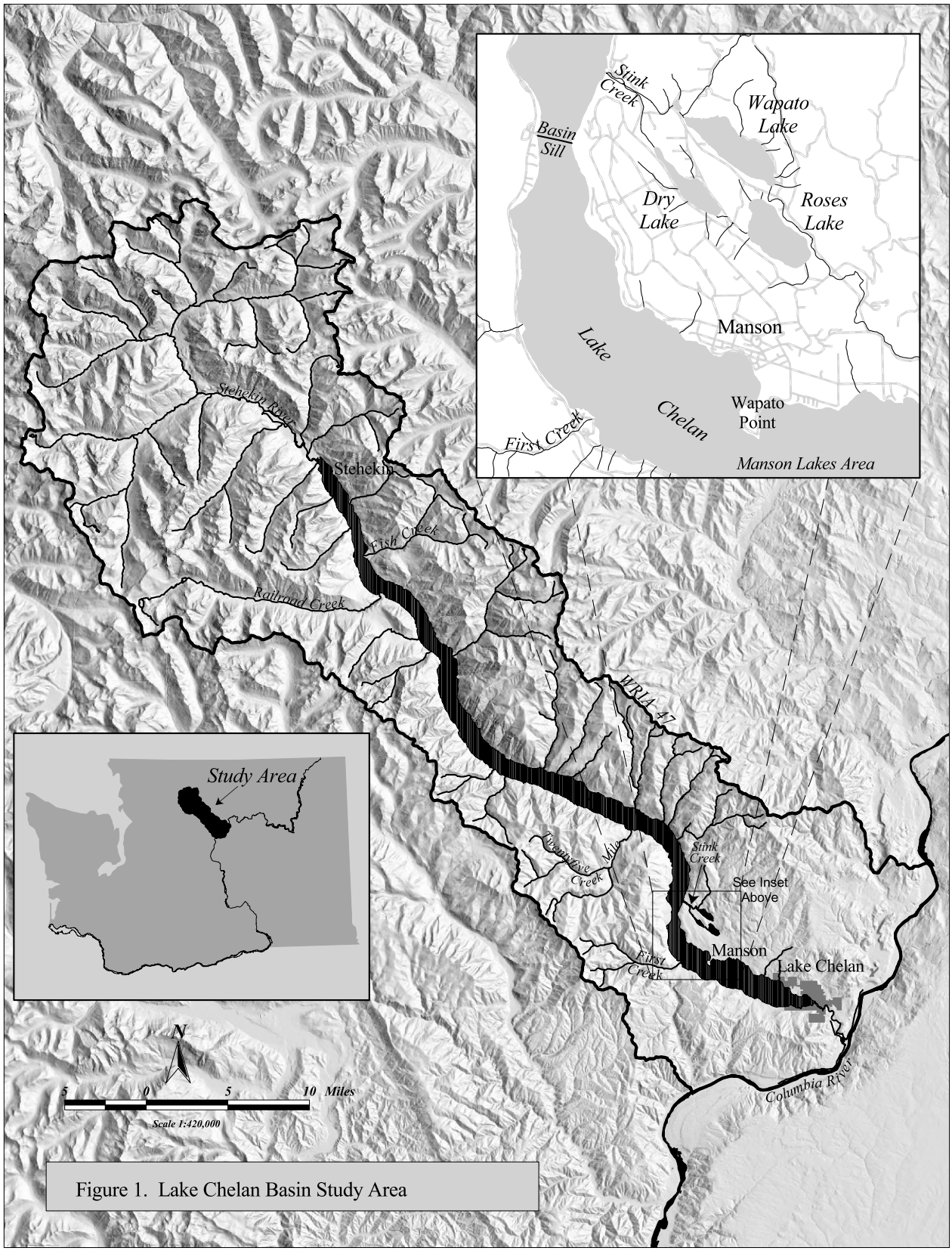

Figure 1. Lake Chelan Basin Study Area

water input from the Lucerne Basin and has a maximum depth of 400 feet. (Patmont et al., 1989). The major water sources to the lake include the Stehekin River at the northern terminus of the lake and Railroad Creek, also located in the Lucerne Basin. In addition, there are more than 50 smaller tributaries to the lake, many of which are ephemeral.

Roses Lake (Figure 1) is one of a cluster of three small lakes often referred to as Manson Lakes. These lakes are located about a mile east of the Lucerne and Wapato Basin divide and north of the city of Manson (Figure 1). The other two lakes are Wapato Lake and Dry Lake. The Manson Lakes drain by way of Stink Creek to Lake Chelan. Stink Creek discharge is made up from the combined flow of Roses Lake draining to Dry Lake via wetlands. Flowing to the northwest, this combined flow converges with the discharge from Wapato Lake and Joe Creek to form Stink Creek.

Lake Chelan uses include domestic and irrigation water supply, fisheries, power production, transportation, and water recreation. A dam was constructed at the outlet of Lake Chelan in 1927 for power production and raised the water level of the lake 21 feet.

Figure B1 in Appendix B shows land use in the Chelan Basin in the 1970's and early 1990's. Ninety percent of the basin is forested or open lands, the majority of which is managed by the U.S. Forest Service and National Park Service. Agriculture and orchard lands comprise three percent, almost all of which is located in the Wapato Basin. Irrigated fruit crops cover approximately 11,600 acres. Urban areas make up less than one percent and include the cities of Chelan and Manson in the Wapato Basin and the smaller towns of Stehekin, Lucerne, and Holden in the Lucerne Basin (Patmont et al., 1989; Lake Chelan Reclamation District, 1998; Chelan County Conservation District, 2000).

DDT and PCBs in the Lake Chelan Basin

DDT is a chlorinated insecticide that was used heavily in orchard lands throughout Washington State, including the Lake Chelan Basin, from the early 1940's until it was banned in 1972.

PCBs are chlorinated compounds that were widely used in industrial applications as insulating fluids, plasticizers, carbonless paper ink, heat transfer and hydraulic fluids, as well as a variety of other uses. EPA phased out the use and manufacture of PCBs between 1977 and 1985. Specific sources of PCBs in Lake Chelan are unknown.

DDT and its breakdown products (DDE and DDD) and PCBs have been widely shown to be persistent in the environment. In aquatic environments, these contaminants are often found in the greatest concentrations in the fatty tissues of fish and other organisms, and to a lesser extent in sediments and water. Concentrations can increase up trophic levels as they work their way up the aquatic food chain, a process known as biomagnification. The sport fishery may be at most risk, as predatory fish species are near the top of the aquatic food chain.

Existing Data on DDT and PCBs in Lake Chelan and Roses Lake

Fish Tissue

Table 1 summarizes fish tissue data on DDT and PCBs from Lake Chelan and Manson Lakes collected over the last ten years, while Table C1 in Appendix C shows existing data on fish tissue. Data are compared to the EPA National Toxics Rule (NTR) criteria for fish tissue. These human health criteria are based on EPA bioconcentration factors (BCF) and water column criteria established under the NTR (41 CFR Part 131). For example, the 32 *u*g/Kg fish tissue criterion for 4,4'-DDE was calculated by multiplying the water column criterion of 0.00059 *u*g/L by a BCF of 53,600. The fish tissue criteria apply to edible fish tissue.

Ecology first discovered elevated concentrations of DDT compounds in fish from Lake Chelan in 1982 as part of the Basic Water Monitoring Program (Hopkins and Clark, 1985). Since then, other Ecology studies have shown that DDT concentrations in Lake Chelan and Roses Lake fish tissue have remained high, exceeding NTR human health criteria.

As part of a 1987 Water Quality Assessment of Lake Chelan (Patmont et al., 1989), the geometric mean for total DDT[1] in 22 fish tissue samples collected from 1982 through 1986 was compared to the nationwide geometric mean for DDT during 1980 through 1981 (Schmitt et al., 1985). Fish tissue from Lake Chelan was roughly three times higher (1,000 *u*g/Kg vs. 300 *u*g/Kg) than what was found nationally. However, the Lake Chelan DDT concentrations were comparable to concentrations found in certain other areas of Washington State, such as the lower Yakima, Middle Columbia, and Okanogan River Basins, where DDT has been used historically on orchards (Patmont et al., 1989).

More recently, EPA found DDT levels in Lake Chelan fish to be very high among over 140 other lakes tested as part of their National Fish Tissue Study (EPA, 2002 unpublished). Lake trout (mackinaw) fillet was reported with levels of 1,481 *u*g/Kg. The EPA also reported these lake trout contained PCB concentrations of 32.6 *u*g/Kg and Dioxin TEQs[2] at 1.7 ng/Kg, both at levels of concern. The study is ongoing, so the findings have not yet been published.

Very little information is available on DDT levels in Roses Lake fish. In 1992, an Ecology study found levels of DDT in rainbow trout fillets at 103 *u*g/Kg (Serdar et al, 1994). Based on Ecology data, this was slightly less than twice the state median of 60 *u*g/Kg DDT (Davis, 1996). These findings led to the 303(d) listing for 4,4'-DDE in Roses Lake.

[1] Refers to DDT as a total of 4,4' forms (*i.e.,* 4,4'-DDT + 4,4'-DDE + 4,4'-DDD).

[2] The World Health Organization and EPA have adopted a toxic equivalency (TEQ) system to estimate the toxicity of the 17 different dioxin congeners, compared to 2,3,7,8-TCDD. Each of the seventeen 2,3,7,8-TCDD congeners has been assigned a toxicity equivalence factor (TEF). The 2,3,7,8,-TCDD is considered most toxic and has a value of one. A congener 1,000 times less toxic than 2,3,7,8-TCDD would have a TEF of 0.001.

Table 1. Summary of DDT and PCB Data on Fish Tissue from Lake Chelan and Manson Lakes (ug/Kg, wet weight basis, part per billion)

Waterbody	Sample Date	Fish Species	No. Composited	Tissue Type	4,4'-DDT	4,4'-DDE	4,4'-DDD	tDDT[1]	PCB-1254	PCB-1260	tPCB[2]	Reference
Roses Lake	Aug-92	Brown bullhead	5	Whole body	6	388	86	480				Serdar et al., 1994
Roses Lake	Aug-92	Rainbow trout	5	Fillet	2	**75**	26	103				Serdar et al., 1994
Roses Lake	Aug-92	Brown bullhead	5	Fillet	2	**165**	19	186				Serdar et al., 1994
Lake Chelan	Sep-92	Largescale sucker	5	Whole body	5	133	29	167	17		17	Davis and Johnson, 1994
Lake Chelan	Sep-92	Rainbow trout	5	Fillet	2	**53**	2	57	**15**		**15**	Davis and Johnson, 1994
Lake Chelan	Sep-92	Kokanee (Sockeye)	5	Fillet	19	**398**	17	417	**12**		**12**	Davis and Johnson, 1994
Lake Chelan	Sep-92	Kokanee (Sockeye)	5	Eggs	82	1370	59	1,452	14	16	30	Davis and Johnson, 1994
Lake Chelan	Sep-94	Kokanee (Sockeye)	5	Fillet	12	**140**	12	164	**84**	**15**	**99**	Davis and Serdar, 1996
Lake Chelan	Sep-94	Rainbow trout	5	Fillet		**56**		56	**65**	**15**	**80**	Davis and Serdar, 1996
Lake Chelan	Sep-94	Smallmouth bass	5	Fillet	28	**330**	34	392	**16**		**16**	Davis and Serdar, 1996
Lake Chelan	Sep-94	Largescale Sucker	5	Whole body	53	800	93	946	34	35	69	Davis and Serdar, 1996
Wapato Lake	Sep-96	Rainbow trout (age yr 1)	8	Fillet	4	15	2	21				Johnson, A., 1997
Wapato Lake	Sep-96	Rainbow trout (age yr 2)	8	Fillet	4	28	3	35				Johnson, A., 1997
Wapato Lake	Sep-96	Rainbow trout	8	Whole body	11	50	6	67				Johnson, A., 1997
Lake Chelan	Sep-2000	Lake trout	3	Fillet	**46**	**1,394**	41	1,481				EPA National Fish Tissue Study-unpublished
Lake Chelan	Aug-2000	Largescale sucker	3	Whole body	24	728	2	754				EPA National Fish Tissue Study-unpublished
National Toxics Rule (NTR) Human Health Criteria[3]					32	32	45		1.404	1.404	5.304	

[1] = tDDT is the sum of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD

[2] = tPCB is the sum of all Aroclors detected

Bolded values exceed NTR human health criteria

Boxed values are the basis for the1998 303(d) listings

[3] = Based on EPA bioconcentration factors and National Toxics Rule water column criteria

Information on PCB concentrations in Lake Chelan fish tissue is even more limited. Fish analyzed by Ecology in 1992 and 1994 contained PCB levels ranging from 12 to 99 *u*g/Kg and were the basis for the PCB fish tissue listings for Lake Chelan in 1996 and 1998 (Davis and Johnson, 1994; Davis and Serdar, 1996).

An important issue pointed out in Ecology studies of Lake Chelan was the considerable differences in DDT levels among various species, age/size classes within the same species, lipid content, and type of tissue analysis (whole body vs. edible fillet vs. eggs).

Sediments

Table C2 in Appendix C summarize existing DDT data in Lake Chelan and Manson Lakes sediment. Sediments from Wapato and Roses Lake have historically contained the highest concentrations of DDT found in the Lake Chelan Basin, with an average DDT concentration of 1,196 *u*g/Kg (Serdar et al., 1994; Johnson, 1997). Conversely, a recent survey conducted by the Lake Chelan Reclamation District (LCRD, 2002 unpublished) and Ecology found the average DDT sediment concentration of these lakes to be two orders of magnitude lower at 46 *u*g/Kg. This apparent lowering of concentrations over a ten-year period may indicate that surface sediment concentrations in Manson Lakes have improved.

The most extensive survey of DDT concentrations in Lake Chelan sediments came from the Lake Chelan Water Quality Assessment, where concentrations of DDT were found to be twenty times higher in Wapato Basin than in the Lucerne Basin. It was concluded that DDT-laden sediments from orchard activities had spread into the Wapato Basin, but had not moved uplake into the Lucerne Basin (Patmont et al., 1989). The most recent sediment sample analyzed from Lake Chelan (1994) contained 20 *u*g/Kg DDT (Davis and Serdar, 1996). It was taken near Wapato Point, an area that the 1986-87 study found concentrations of DDT between 51 and 699 *u*g/Kg (Patmont *et al*., 1989). It may be that surface sediment concentrations in Lake Chelan have also decreased over time.

A recent Ecology report evaluated freshwater sediment quality threshold values for possible regulatory use in Washington State (Ecology, 2002). Eight existing data sets were compiled from agency staff in the United States and Canada known to be active in regulating sediments. The analysis considered only ecological effects, not human health effects. The freshwater sediment quality document shows a range of numerical criteria for DDT from 1.2 to 570 *u*g/Kg. This may help put Lake Chelan and Roses Lake sediment DDT levels into perspective, and illustrate the uncertainty about what the criteria should be.

Water

Table 2 compares data on DDT in water from Lake Chelan and tributaries collected in 1996 to the present. No PCB data are available for water. The DDT data are compared to Washington State Aquatic Life Standards for acute and chronic toxicity (WAC Chapter 173-201A) and the NTR human health water column criteria. The Aquatic Life Standards apply to the total of DDT, DDE, and DDD, whereas the NTR criteria apply to both DDT and metabolites. The data in the table are reported in ng/L (parts per trillion).

Table 2. Summary of DDT Data in Water from Lake Chelan and Tributaries (ng/L, part per trillion)

Sample Date	Waterbody	4,4'-DDT	4,4'-DDE	4,4'-DDD	tDDT[1]	Reference
May-96	Knapp Coulee Creek (site G4)		**110**		**110**	CCCD[2] report "Lake Chelan WQ Project 2000"
Jun-96	Unnamed drainway (site 3)		**110**		**110**	CCCD report "Lake Chelan WQ Project 2000"
Jul-97	Unnamed drainway (site 3)			**150**	**150**	CCCD report "Lake Chelan WQ Project 2000"
Jun-2002	Prince Ck - Sawtooth Widerness	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Unnamed culvert discharge (NS13)	**0.95**	**3.5**	0.21	**4.66**	Ecology preliminary sampling - not published
Jun-2002	Lake Chelan	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Unnamed - At Veroske's (NS16)	**4.8**	**8.6**	**1.9**	**15.3**	Ecology preliminary sampling - not published
Jun-2002	First Creek	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Stink Creek	0.24U	**1.2**	0.25	**1.45**	Ecology preliminary sampling - not published
Jun-2002	Wapato Lk + Joe Ck outflow	0.25U	0.35	0.17	0.52	Ecology preliminary sampling - not published
Jun-2002	Twentyfive Mile Creek	0.17U	0.17U	0.17U	0.17U	Ecology preliminary sampling - not published
Jun-2002	Railroad Creek	0.17U	0.17U	0.17U	0.17U	Ecology preliminary sampling - not published
Jun-2002	Fish Creek - At Moore Point	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Stehekin River	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
WAC 173-201A - Acute					1100	
WAC 173-201A - Chronic 24 hour average					1.0	
National Toxics Rule (NTR) criteria		0.59	0.59	0.84		

[1] = tDDT is the sum of 4,4' -DDT, 4,4' -DDE, and 4,4' -DDD

Bolded values exceed one or more of the applicable criteria

[2] = Chelan County Conservation District

U = not detected at the value shown

In general, water column concentrations of DDT in Lake Chelan and its tributaries have been low. In June 2002, through preliminary sampling for the present DDT/PCB TMDL by Ecology, Lake Chelan and several tributary water samples were analyzed for DDT. No DDT forms were found above the 0.16 ng/L detection level in Lake Chelan or in tributary samples from the Lucerne Basin, including the Stehekin River. DDT was found above detection limits in three small discharges to the Wapato Basin: a small drainage sampled at Veroske's bus stop along Highway 150 (DDT = 15.3 ng/L), a small culvert roughly 0.2 miles east of the entrance to Crystal View development along Highway 150 (DDT = 4.66 ng/L), and Stink Creek (DDT = 1.45 ng/L).

Much higher DDT concentrations were found in a study conducted by the Chelan County Conservation District (CCCD) in 1996 and 1997 along the south shore (Chelan County Conservation District, 2000). They reported DDT concentrations up to 150 ng/L; this was ten times higher than Ecology's June 2002 samples. These unusually high concentrations were from samples collected during run-off from agricultural drainages that included orchard lands. The concentrations are two orders of magnitude higher than the chronic aquatic life standard of 1.0 ng/L and the NTR criterion of 0.59 ng/L.

No useful data exists on PCB concentrations in water from Lake Chelan, Manson Lakes, or tributaries. Like DDT, concentrations are expected to be very low in water.

Problem Statement

Historical uses of DDT in agriculture and of PCBs have resulted in these persistent chemicals working their way up the Lake Chelan food chain to levels exceeding EPA's human health criteria in edible fish tissue. This TMDL technical study will determine what DDT and PCB loading to Lake Chelan and Roses Lake will result in edible fish tissue meeting EPA human health criteria for 4,4'-DDE, PCB-1254, and PCB-1260.

Goals and Objectives

The overall goal of the project is to develop an understanding of the levels and distribution of DDT and PCBs in the Lake Chelan Basin, and how contaminants can be reduced to acceptable levels in the lake fishery. The specific objectives of the study are to:

- Determine current DDT and PCB concentrations in edible fish tissue.
- Assess current levels of DDT and PCBs in water and sediments in Lake Chelan from tributary and storm drain inputs.
- Construct a history of DDT and PCB inputs to Lake Chelan sediments with the intent of estimating future levels.
- Develop numeric water quality targets that will result in fish meeting the EPA human health criteria.
- Propose load allocations that will support the water quality targets.

The study area will include all of Water Resource Inventory Area (WRIA) 47. Water sampling will be conducted in tributary and storm drain discharges to the Wapato Basin, and the major tributaries to the Lucerne Basin. Tributary and storm drain sampling locations will be limited to discharge points. No point sources will be sampled; none were identified as potential sources of DDT or PCBs to Lake Chelan. Field work will be conducted from spring through winter of 2003.

Data generated from the study will allow an assessment of risk to human health from consumption of Lake Chelan and Roses Lake fish. The Washington State Department of Health (WDOH) has agreed to review this sampling plan and evaluate the fish tissue data to determine if a fish advisory is warranted (Dave McBride, Office of Environmental Health Assessments, 2002 Personal Communication).

Sampling Design

Fish

The purpose of collecting fish tissue samples is to: 1) determine current levels of DDT and PCBs in edible fish tissue; 2) compare current levels in fish tissue to the EPA's National Toxics Rule Criteria for Human Health to determine if criteria are still being exceeded; 3) determine if EPA's National Toxics Rule Criteria for Human Health water quality criteria is appropriate for Lake Chelan or if site specific water quality standards are needed; and 4) provide data to the WDOH for a human health assessment and the need for a fish consumption advisory.

Past Ecology studies have found high levels of DDT and PCBs in edible fish tissue and are the basis for the 303(d) listings for Lake Chelan and Roses Lake. Persistent toxic chemicals in the environment pose a challenge for water quality managers. It may be that removal of DDT and PCBs from the basin is impractical, and that monitoring contaminant levels and educating the public on ways to reduce their exposure is as much as local water quality managers can hope to achieve. Current and more extensive information is needed on these chemicals to evaluate the potential risks of fish consumption to humans.

Collection and analysis of fish tissue samples will target three geographical areas: Wapato Basin, Lucerne Basin, and Roses Lake. These areas represent the urban/industrial population center of the Wapato Basin; the rural, mostly natural and unpopulated area of the Lucerne Basin; and the agriculturally dominated drainage of Roses Lake.

To help determine what species of fish to collect for tissue samples, Washington State Department of Fish & Wildlife (WDFW) biologists in the area were contacted. Discussions and recommendations for target species were based on a number of issues such as sport species most often caught and consumed, previous fish collections, availability, and 303(d) listings.

According to the WDFW (Art Viola, Personal Communication) the three most commonly caught and consumed sport fish species from Lake Chelan are mackinaw trout, commonly called lake

trout (*Salvelinus namaycush*), Kokanee, landlocked sockeye salmon (*Oncorhynchus nerka*), and rainbow trout (*O. mykiss*). In addition to the three most often consumed species, burbot (*Lota lota*) will also be sampled and analyzed. Burbot are bottom dwellers and the only member of the freshwater cod family. Usually consumed when caught, burbot have a high quality white flesh. The burbot fishery has experienced an increased interest in recent years.

Fish consumption patterns are less clear in Roses Lake. The WDFW currently plants three fish species in Roses Lake: rainbow trout, brown trout (*Salmo trutta*), and black crappie (*Pomoxis nigromacultus*). Other species of possible interest include: largemouth bass (*Micropterus salmoides*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*). Rainbow trout, brown trout, and black crappie will be targeted for fish collection. If fish numbers are too low for any of the targeted species, the other species of interest will be evaluated for collection. The intent is to collect and analyze enough samples from three sport species to allow WDOH to determine if a health advisory is warranted.

Skin-on muscle fillets will be analyzed for DDT, PCBs, and percent lipids. The DDT analysis will include 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD. PCBs will be analyzed as Aroclor equivalents[3], with a subset of the samples analyzed for individual PCB congeners. The subset for congener analysis will be selected based on a review of the sample results and NTR criteria exceedences. The non-planar PCB compounds are much less toxic than planar PCBs and may be important to WDOH's health risk assessment. Lipid analysis will be used for assessing the bioconcentration potential between and within fish species.

In addition to the above mentioned analyses, dioxins will also be analyzed in a subset of tissue samples. Although not 303(d) listed, the EPA's National Fish Tissue Study found dioxins at levels of potential concern in Lake Chelan fish (EPA, 2002 Unpublished). Ecology will take the opportunity to evaluate dioxin levels in the sport fishery. Results from the dioxin in fish analysis will be forwarded to the WDOH to determine if a health advisory is warranted for Lake Chelan.

Each fish tissue sample sent to the laboratory will be a composite of five fish. For each of the four proposed fish species from Lake Chelan, 50 fish (10 composites) will be collected and analyzed, for a total of 200 fish. Fish collection will be distributed between both Wapato and Lucerne Basin. Fish tissue samples from Roses Lake will also be composites of five fish each. A minimum of 5 fish (1 composite) will be collected for each of the three targeted species, for a total of 15 fish. Every effort will be made to collect fish in numbers that will satisfy WDOH requirements to determine if a fish advisory is warranted.

Table 3 below summarizes distributions of targeted fish species and proposed locations for sample collection. Table D1 in Appendix D presents an overview of all proposed sampling for the study.

[3] Monsanto developed and sold PCB mixtures under the trade name Aroclors. PCBs are typically analyzed as equivalent concentrations of commercial Aroclor mixtures (*e.g.*, PCB-1260) or as individual compounds, referred to as PCB congeners.

Table 3. Distribution of Fish Species and Proposed Locations for Sample Collection.

Location	Species	Tissue Type	Number of Composites
Lake Chelan:			
Wapato Basin	Lake Trout	Skin-on Fillet	7
	Kokanee	Skin-on fillet	7
	Rainbow Trout	Skin-on fillet	7
	Burbot	Skin-off fillet	7
Lucerne Basin	Lake Trout	Skin-on Fillet	3
	Kokanee	Skin-on fillet	3
	Rainbow Trout	Skin-on fillet	3
	Burbot	Skin-off fillet	3
Roses Lake:	Rainbow Trout	Skin-on fillet	1
	Brown Trout	Skin-on fillet	1
	Black Crappie	Skin-on fillet	1

Sediment

A combination of surface sediments and core samples will be collected to: 1) determine the spatial extent of DDT and PCB contamination in Lake Chelan; 2) assess current impacts from selected tributaries to the lake; 3) evaluate historical trends in contaminant loading to the lake and sedimentation rates for the Wapato and Lucerne Basins; and 4) estimate when water quality targets (primarily fish tissue) for the lake are expected to be obtained.

Limited data, previously discussed, suggests levels of DDT and PCBs may be declining, but current levels and the spatial extent of contamination is unknown. Sediment sampling in the past has targeted drain outlets in the Wapato Basin and a few tributary discharges in the Lucerne Basin. A comprehensive look at sediment concentrations for target analytes in the lake should be completed. It may be that surface sediments are primarily responsible for the DDT and PCB levels found in fish tissue.

Tributary Sediments

Surface sediments will be collected adjacent to major tributaries to assess if contaminants are continuing to be discharged into the lake and determine if DDT and PCBs are associated with Lucerne Basin drainages.

Surface sediments from the alluvium of five tributary discharges to Lake Chelan will be analyzed for DDT, PCBs, TOC, and grain size. The sediment survey will collect a total of five composite (three individual grabs per composite) samples, one each from Stink Creek, First Creek, Twentyfive Mile Creek, Railroad Creek, and the Stehekin River sediments in Lake Chelan (Figure B2, Appendix B). No loading estimates will be available from sediment samples. The presence or absence of the target analytes in surface sediments will help prioritize where in the basin pollution control activities might be required.

Sediment Transect

A comprehensive look at DDT and PCBs in surface sediments throughout Lake Chelan has not been conducted. Only one sample for PCBs in sediments has been analyzed and the few data on DDT levels from the Lucerne Basin are over 15 years old (Table C2, Appendix C).

To fill this data gap, 15 composite surface sediment samples will be distributed along a longitudinal gradient from Lake Chelan. Results from other studies have shown the Wapato Basin to be the area of concern, and pesticides have not migrated uplake (Patmont et al., 1989). A total of ten sediment samples will be collected from the Wapato Basin, and five samples from the Lucerne Basin. Starting in the Wapato Basin near the lake outlet in Chelan River, sediment samples will be collected roughly every 1.25 mile uplake to the basin sill (Figure B2 in Appendix B). Collection of the five sediment samples from the Lucerne Basin will begin near Stehekin and will be distributed to represent much larger segments of the lake since it is expected that conditions will be homogenous. Results from the surface sediment transect will allow an evaluation of a longitudinal concentration gradient throughout the lake.

Sediment sample locations are shown on Figure B2 in Appendix B, and their associated coordinates are presented in Appendix E, Table E1.

Sediment Cores

Decades have passed since the manufacture and use of DDT and PCBs was banned in the United States. Over time, concentrations of these persistent chemicals are expected to decline. However, data are not available to evaluate contaminant trends in Lake Chelan. To determine historical levels and sedimentation rates of these toxics, sediment cores will be collected from Lake Chelan--one site each in the Wapato and Lucerne Basin. Cores will be collected at the deepest point possible in each basin. Deep locations should give the best chance of sampling fine sediments in undisturbed areas.

Analyzing discrete sediment layers will show the history of DDT and PCB deposition. These data coupled with other information may be used to predict future concentrations in sediment deposits over time.

A 50 cm box core will be used for collecting sediment cores. One centimeter horizons will be sampled from the cores. Horizons will be analyzed for DDT, PCBs, ^{210}Pb, ^{137}Cs, total Pb, and TOC. The final selection of horizons to be analyzed for DDT and PCBs will be determined after

core dating using ^{210}Pb and ^{137}Cs techniques. Horizons not initially analyzed will be archived for potential analysis at a later date.

Sediment core sample locations are shown on Figure B2 in Appendix B, and their associated coordinates are presented in Appendix E, Table E2. Table D1 in Appendix D presents an overview of all proposed sampling for the study.

Water

Water samples will be collected to: 1) identify sources of DDT and, to the extent possible, PCBs; 2) assess compliance with aquatic life and human health criteria; and 3) to calculate pollutant loading.

A recent sampling effort by Ecology, conducted June 10-12, 2002, evaluated water column concentrations of DDT compounds in Lake Chelan and tributaries or drains entering the lake; 11 sites were sampled for DDT, DDE, and DDD. One water sample each was collected from the Chelan River near the lake outlet and from each major tributary. Two culverts were found flowing to the lake and were also sampled during the survey. The Ecology Manchester Environmental Laboratory (MEL) analyzed the samples using the "large volume injection" technique to achieve detection limits of 0.16-0.17 ng/L. Sample locations are identified in Table E3 in Appendix E, while the results are summarized in Table C3 in Appendix C.

DDT compounds were detected in three of the 11 sites sampled. Results from a small drainage sampled at Veroske's bus stop along Highway 150, a small culvert roughly 0.2 miles east of the entrance to Crystal View development along Highway 150, and Stink Creek exceeded the National Toxics Rule (NTR) criteria for DDT (Figure B3, Appendix B). Detected concentrations of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD ranged from 0.00017 to 0.0086 *u*g/L (0.17 - 8.6 ng/L). No DDT compounds were detected in drainages to the Lucerne Basin above Stink Creek. These data likely represent the low loading period of the year for DDT inputs to Lake Chelan. Antecedent precipitation was very low prior to sampling and very few tributaries were discharging in the Wapato Basin. It is likely the majority of DDT loading to the lake occurs during rain events and/or spring snowmelt.

To quantify DDT loads entering the lake, water samples will be collected from 13 tributaries, 15 drains, and the Chelan River near the lake outlet. Because Ecology did not find detectable concentrations in drainages up-lake from Stink Creek, the major tributaries in the Lucerne Basin will be sampled only once, while other sites will have samples collected on three occasions.

Other toxic studies conducted by Ecology have attempted to use surrogate parameters as predictor variables as a means to develop TMDLs. A study on the lower Yakima River was successful correlating TSS, turbidity, and DDT (Joy and Patterson, 1997). A more recent study on the upper Yakima River (Joy, 2002) found equivocal results. Because DDT binds strongly to the organic carbon fraction of particulate matter, relationships can at times be developed between these parameters. Significant advantages may be gained using surrogate parameters when developing a TMDL. TSS and turbidity are very easy to sample and inexpensive to analyze, versus the cost of chlorinated pesticides using low level techniques. When significant

correlations are found, TMDL targets can be set for the reduction of TSS or turbidity, which will in turn meet the state criteria for DDT. TSS and turbidity are much more able to be related to land use practices and management activities and have associated water quality standards. Samples for TSS and turbidity will be collected from discharges to Lake Chelan to test this relationship.

Water samples will be collected following rain events of March through May 2003. Ecology will coordinate with local groups for information regarding initiation of sampling. Samples will be collected when drainages around the Wapato Basin are discharging. Many of the agricultural sub-basins do not discharge except during runoff events. Results from runoff sampling will be used to establish a loading regime for the lake. Pollutant loads are calculated by multiplying the pollutant concentration by the instantaneous stream flow. The USGS maintains a long term gaging station on the Stehekin River. For streams where a flow measurement by wading is not an option, flow will be estimated as a percentage of the Stehekin River discharge, based on the ratio of the drainage area for the Stehekin River compared to the drainage area for the sample site.

In addition to DDT, samples for TSS and turbidity will be collected. Flow, specific conductance, and temperature will be measured by field meter and thermometer. Locations of water sample sites are provided on Figure B3, in Appendix B.

The Lake Chelan Reclamation District is currently conducting a study on the Manson Lakes (Cross, 2002), which will generate data that will be used to augment this Ecology TMDL study. Surface water input to the lakes will be sampled for DDT and ancillary parameters.

Semi-Permeable Membrane Devices

Water column data is generally unavailable for DDT and PCBs from the lake. Because of their low solubility, quantification of DDT and PCB concentrations in the lake water column will require special sampling methods and low-level analysis. Semipermeable membrane devices (SPMDs) will be used to quantify the pollutants of interest. SPMDs are passive samplers which concentrate hydrophobic organic chemicals and provide a time weighted average of the bioavailable fraction (dissolved) of the contaminants of concern and estimation of the biological exposure and bioconcentration potential.

SPMDs are made up of a flat low-density polyethylene tube (91 x 2.5 cm) containing triolein, a neutral lipid. When submerged in water, only the dissolved fraction of the lipophilic contaminants are diffused through the membrane wall and concentrated. SPMDs are usually deployed for 20-30 days. After retrieval, the SPMDs are extracted and analyzed for the chemicals of interest. EAP has used SPMDs in the past for detecting PCBs in water from the Spokane River in 1993-94 and PCBs and chlorinated pesticides in the Walla Walla River in 2002-03 (EILS, 1995; Johnson and Era, 2002).

In conjunction with the contaminant concentration in triolein laboratory calibration data, Permeability/Performance Reference Compounds (PRCs) spiked into the triolein, and field temperature data are used to estimate the average dissolved concentrations in the water column (Huckins et al., 2002).

For the Lake Chelan TMDL study, SPMDs will be deployed at two locations: one mid-Wapato Basin and one upper Lucerne Basin at an approximate depth of 200 feet. These sites are shown on Figure B3, in Appendix B. Three periods will be targeted: April, July, and October. April and October were chosen to represent run-off periods, while July was selected as a comparison from the dry season. Deployment will be for 28 days. SPMD extracts will be analyzed for DDT, DDE, DDD, and PCB Aroclors, with a subset of samples analyzed for PCB congeners.

Temperature will be monitored and logged every 30 minutes throughout each SPMD deployment using Tidbit temperature probes. Ancillary parameters will also be collected at the beginning and end of each deployment period for turbidity and total organic carbon (TOC).

Table D1 in Appendix D presents an overview of the sampling strategy proposed for the study.

Data Quality Objectives

All laboratories used for analysis of study samples are expected to meet quality control (QC) requirements of methods selected for the project. Table 4 shows the measurement quality objectives (MQO) for organochlorine compounds. Table 5 has the reporting limits required to meet project objectives.

MQOs may be difficult to achieve for results near the limits of detection. You would expect relative accuracy to decrease when concentrations are near reporting limits. Best professional judgment will be used for decisions to qualify or reject data when results exceed MQOs near reporting limits.

Table 4. Measurement Quality Objectives.

Matrix	Analysis	MQO
Fish Tissue	4,4'-DDT, 4,4'-DDE, 4,4'-DDD	25-150% surrogate recovery
	PCB Aroclors	25-150% surrogate recovery
	PCB congeners	25-150% labeled congeners
	PCB congeners	25-150% unlabeled congeners*
	Dioxins	25-150% surrogate recovery
Sediment	4,4'-DDT, 4,4'-DDE, 4,4'-DDD	25-150% surrogate recovery
	PCB Aroclors	25-150% surrogate recovery
Water	4,4'-DDT, 4,4'-DDE, 4,4'-DDD	25-150% surrogate recovery
SPMD extracts	4,4'-DDT, 4,4'-DDE, 4,4'-DDD	25-150% surrogate recovery
	PCB Aroclors	25-150% surrogate recovery

* recovery of a standard solution of 27 congeners.

Table 5. Required Reporting Limits.

Analyte	Fish Tissue	Sediment	Lake and Tributary Water	SPMD Extracts
DDT Analogs	0.5 *u*g/Kg	1 *u*g/Kg	0.33 ng/L	1-5 ng
PCB Aroclors	2.5 *u*g/Kg	5 *u*g/Kg	na	5-25 ng
PCB Congeners	10-50 ng/Kg	na	na	1 ng
Dioxins	0.07 ng/Kg	na	na	na
TSS	na	na	1 mg/L	na
Turbidity	na	na	1 NTU	na
TOC	na	1 %	1 mg/L	na
Grain Size	na	0.1 %	na	na
Conductivity	na	na	1 *u*mhos/cm	na
Percent Lipids	0.1 %	na	na	na
Total Pb	na	2 mg/Kg, dry	na	na
^{210}Pb	na	1 dpm/g*	na	na
^{137}Cs	na	-	na	na

na = not applicable.

* dpm = disintegrations per minute.

Representativeness

The QA Project Plan has been developed to ensure data are representative of conditions in Lake Chelan and Roses Lake. The sampling methods, equipment, and collection timing will ensure representativeness. Water samples will be depth/width integrated to the extent possible. Surface water inputs to the Wapato Basin identified during field reconnaisance and preliminary sampling will be sampled during run-off events to estimate a loading regime for the lake. Sediment sample sites were selected to show the DDT and PCB contaminant gradient throughout the lake and evaluate if these pollutants are currently being discharged by major tributaries in the basin. Fish species were selected in consultation with the WDFW (to represent the four species most often caught and consumed) in addition to addressing the 303(d) listings. Both basins in Lake Chelan will be represented.

Completeness

The amount of useable data obtained through this study will be maximized by careful planning/coordinating field surveys and employing standardized protocols for sample collection and analysis. All personnel involved with sample collection will be familiar with EAP's routine procedures for pesticide sampling in water, PSEP (1996) sediment sampling procedures, and the WAS field sampling and measurement protocol manual (WAS, 1993).

Comparability

Sampling, quality assurance, and analytical methods were selected to generate results that would be as consistent and comparable with previous studies as possible. New methods for sample collection and analysis are being implemented to achieve lower detecton limits.

Field Procedures

Fish

Fish sampling in Lake Chelan will require multiple collection methods to get the number and types of fish required. To the extent possible, fish samples will be collected using a Smith-Root Model SR16 electrofishing boat. The habits of some of the targeted species do not lend themselves to electrofishing techniques. Mackinaw are a deep-water fish that will likely require sampling by hook and line. Also, burbot are bottom dwellers and have historically been fished by set line but can be jigged at certain times of the year. Due to the size of Lake Chelan, and the large number of fish needed for the WDOH human health assessment, it is likely Ecology will rely on assistance from the WDFW and locals for fish collection.

According to the WDFW, the local Sportsman Association and Yacht Club have each expressed interest in sponsoring a Lake Chelan mackinaw derby in May 2003. Ecology will coordinate with derby sponsors, asking for donations of derby fish to the study. Information will be placed in the local newspaper prior to the derby asking for help in fish collection, and will provide information on how to handle fish for use in the study. Derby participants will be asked for legal sized mackinaw, kokanee, rainbow, or burbot fish. Any fish taken for the study will be weighed and measured in the field. Information will be recorded as to the time, location of the catch, and who made the catch.

Only fish of legal size will be collected for analysis. For species with no size limit, only fish large enough to reasonably be expected to be consumed will be used.

All fish collected for analysis will be given a unique identification number that corresponds to the data entered into field logs. Fish will be double wrapped in aluminum foil, with the dull side contacting the fish, and sealed in zip-lock bags. All fish samples will be kept in the dark on ice until return from the field. Once back from the field, fish samples will be frozen to -18^{o} C until processed.

Preparation of tissue samples will follow EPA (2000) guidance. Techniques will be employed to minimize the possibility of sample contamination. All persons processing tissue samples will wear non-talc gloves and aprons. Work surfaces will be covered with heavy grade aluminum foil. Gloves, aluminum foil, and dissection tools will be changed between composite samples.

Each composite fillet will be made up of five fish, roughly the same size. Composites made up of similar size fish will allow a review of possible correlations between contaminant levels and

fish size. The smallest fish in a composite will be at least 75% as long as the largest. Composites will be formed randomly, after sorting for similar size groups. Fillets will be prepared by scaling and removing one whole side per fish from the gill arch to the caudal peduncle. Fillets will include dark tissue along the lateral line and fat from the belly flap. Sex will be determined for each fish and structures like scales, otoliths, opercles, and dorsal spines will be collected for determination of age.

Fillets will be placed in a Kitchen Aid or Hobart commercial blender and homogenized individually to a uniform color and consistency. Tissue samples will be thoroughly mixed by hand following each of three passes through the blender. Composite samples will be made up from equal weight aliquots from each fish. Homogenates will be stored frozen (-18^{o} C) in two 8 ounce glass jars with Teflon liners, cleaned to EPA (1990) QA/QC specifications, and certified for trace organic analyses. One container will be submitted to the laboratory for analysis and the other will be archived at Ecology headquarters.

All equipment used in the preparation of tissue samples will be washed thoroughly with tap water and Liquinox detergent, followed by sequential rinses of hot tap water, de-ionized water, pesticide-grade acetone, and finally, pesticide-grade hexane. All equipment will then be air dried on aluminum foil in a fume hood prior to use. The full decontamination procedure will be repeated between subsequent composite samples.

Requirements for containers, preservation, and holding times are listed in Table 6. The chain-of-custody will be maintained.

Sediment

Surface Sediments

To the extent possible, sampling methods will follow PSEP (1996) protocols. Surface sediment samples will be collected by boat using a 0.1 m^2 stainless steel van Veen grab. All sediment stations will be located by differentially corrected GPS and recorded in field logs. Station position relative to significant on-shore structures will also be recorded.

Following collection of each sediment grab an evaluation of acceptability will be made. Information about each sediment grab will be recorded in the field log. A grab will be considered acceptable if it is not overfilled, overlaying water is present but is not overly turbid, the sediment surface appears intact, and the grab reached the desired sediment depth.

Overlying water will be siphoned off prior to sub-sampling. Equal volumes of the top 2-cm of sediment will be removed from three separate grabs per site. Stainless steel spoons and bowls will be used for sub-sampling and to homogenize sediments from each station to a uniform consistency and color. Debris on the sediment surface or materials contacting the sides of the van Veen grab will not be retained for analysis.

Homogenized sediments from each station will be placed in 4-ounce glass jars with Teflon lined lids for analysis of DDT and PCBs. Sample containers will be cleaned to EPA (1990) QA/QC

specifications and certified for trace organic analyses. Additionally, 2-ounce glass jars will be filled with homogenate for TOC analysis, while 8-ounce plastic jars will be filled for determination of grain size.

All equipment used to collect sediment samples will be washed thoroughly with tap water and Liquinox detergent, followed by sequential rinses of hot tap water, de-ionized water, pesticide-grade acetone, and finally, pesticide-grade hexane. All equipment will then be air dried and wrapped in aluminum foil until used in the field. The same cleaning procedure will be used on the grab prior to going into the field. To avoid cross-contamination between sample stations, the grab will be thoroughly brushed down with on-site water at the next sample location. Samples will be collected from the least contaminated area of the Lucerne Basin near Stehekin, down-lake to the basin sill. In the Wapato Basin sediment samples will be collected from the outflow in the Chelan River up-lake roughly every 1.25 mile to the basin sill.

Sediment samples will be placed in coolers on ice at 4^{o} C immediately following collection, and transported to the Ecology MEL within 72 hours. Requirements for containers, preservation, and holding times are listed in Table 6. The chain-of-custody will be maintained.

Sediment Cores

Sediment cores will be collected by boat using a Wildco stainless steel box corer fitted with a 13 cm x 13 cm x 50 cm acrylic liner. Patmont et al., (1989) estimated sedimentation rates for Lake Chelan average 0.36 ± 0.10 cm/yr. These rates fall within the average reported for several other Washington lakes ranging from 0.18 cm/yr to 0.45 cm/yr (Yake, 2001). Based on these sedimentation rate estimates, the corer will need to reach a minimum penetration depth between 21 cm and 38 cm. This will ensure the entire record of DDT and PCB loading to the lake will be represented.

After retrieving the core, overlying water will be carefully siphoned off and the acrylic liner removed from the corer. The sediment-filled liner will be placed on an extruder table outfitted with a gear-driven piston to push sediments up and out of the liner. Sediment layers will be sliced with thin aluminum plates to a uniform thickness of 1 cm. The acrylic liner allows for a maximum of 50 layers per core. Materials in contact with the liner will be excluded from sample. Each sample layer will be placed in 8-oz glass jars, placed in plastic bags, and stored in coolers on ice until laboratory processing.

Prior to the analysis for DDT and PCBs, layers will be analyzed for radioisotopes ^{210}Pb, ^{137}Cs, and total lead to estimate sediment age (Yake, 2001). Based on age estimates, sediments deposited before about 1920 will not be analyzed, which is prior to the development and use of DDT and PCBs. Sub-samples will be selected for analysis that represent recent conditions (top layer), background conditions which are used to calibrate the ^{210}Pb and ^{137}Cs dating (bottom layer), and equally divided layers throughout the core. Any significant identifiable markers in the cores, like an ash layer from the eruption of Mt. St. Helens, will be recorded in field books. Layers not selected for chemical analysis will be archived frozen for possible later analysis.

Sediment layers selected for analysis will be homogenized back in one of the Ecology building's wet labs. Homogenized sediments will be split into sub-samples for analysis of DDT and PCBs

(4-ounce glass jars); TOC (2-oz. glass jars); total Pb (4-oz. jars), and ^{210}Pb and ^{137}Cs (polystyrene containers) for dating.

Utensils used in collection and manipulation of core samples will be washed thoroughly with tap water and Liquinox detergent, followed by sequential rinses of hot tap water, de-ionized water, pesticide-grade acetone, and finally, pesticide-grade hexane. Equipment will then be air dried and wrapped in aluminum foil until used in the field. The same cleaning procedure will be used on the corer prior to going into the field. New acrylic liners will be used for each sediment core, pre-cleaned using the procedure described above. To avoid cross-contamination between sample stations, the corer will be thoroughly brushed down with on-site water at the next sample location prior to collection of the subsequent sample.

Water

Surface Water

Water samples collected for DDT and ancillary parameter analysis from tributaries and agricultural drainages will be depth and width integrated, to the extent possible. A depth-integrated sampler (i.e., ACOE D-77 Teflon cap with DH-81 adapter) will be used that allows sample water to contact only Teflon or glass. Samples will be collected by slowly lowering the sampler to the bottom and immediately raising it back to the surface in a smooth motion. Sub-samples will be collected at each site from three positions across the transect (quarter-point). If the water source is too shallow for using the depth integrated sampler, then the sample will be hand collected. For hand collection of samples, field personnel will use the glass sample jars from the depth integrated sampler.

Jars used for collection of organic contaminant samples will be pre-cleaned thoroughly with tap water and Liquinox detergent, followed by sequential rinses of hot tap water, de-ionized water, pesticide-grade acetone, and finally, pesticide-grade hexane. Sampling personnel will wear non-talc nitrile gloves while collecting samples. Sample water will be composited at each site by hand splitting into individual sample bottles. Sample containers will be filled one-third from each of the quarter-point sub-samples. DDT samples will be collected in one-gallon glass bottles. Grab samples for TSS and turbidity will be collected in 1000 and 500 mL poly bottles, respectively.

At sample sites that are wadable, flow will be measured using a Marsh-McBirney 201 velocity meter and standard top-setting wading rod. Operating procedures for determining discharge will follow those described in WAS (1993). For streams where a flow measurement by wading is not an option, flow will be estimated as a percentage of the Stehekin River discharge, based on the ratio of the drainage area for the Stehekin River compared to the drainage area for the sample site. Sample site locations will be determined by hand-held GPS and recorded in field log books.

Samples will be placed in coolers on ice, immediately following collection, until delivered to the MEL under chain-of-custody the following day. Requirements for containers, preservation, and holding times are listed in Table 6.

SPMDs

SPMDs will be deployed and retrieved following guidance in Huckins et al., (2000).

The SPMD membranes, and stainless steel canisters to house the membranes, will be purchased from Environmental Sampling Technologies (EST). SPMD membranes are preloaded onto spindles by EST in a clean room environment and shipped in solvent-rinsed metal cans filled with argon gas. Each SPMD canister deployed will have five membranes. The SPMD membranes will be kept frozen until deployed.

At the sample site, cans containing SPMD membranes will be carefully pried open. Five of the SPMD membrane spindles will be slid into each canister, and closed by screwing on the lid. Loading the SPMDs into the canisters will be done as quickly as possible as they are known to be potent air samplers. The SPMDs will be anchored to the bottom at approximately 200 feet and suspended in the water column to 20 feet above the sediment surface by float. SPMDs will be located and secured in such a way as to not draw attention and avoid vandalism. SPMDs will remain submerged until retrieved. Field personnel will wear nitrile gloves and avoid touching the membranes.

SPMDs will be deployed for approximately 28 days. Retrieval will follow reverse order of deployment. Care must be taken with the cans holding the membranes. Can seals must not be damaged as membranes will need to be resealed in original cans following deployment to prevent contamination. SPMDs must be maintained at or near freezing until they arrive at EST or other approved laboratory for extraction.

Companion temperature and TOC data are needed for determination of dissolved and total DDT and PCB concentrations from the SPMDs. A Tidbit temperature logger will be attached to the SPMD canister to log water temperature on the half hour. At deployment and at retrieval, a TOC and turbidity sample will be collected at each SPMD location. A hand-held or boat-mounted GPS will establish latitude and longitude for each SPMD deployment, which will be noted in the field logs.

SPMD membranes will be shipped under chain-of-custody to EST or other approved laboratory by overnight Federal Express, in coolers packed in blue ice. Other water samples will be returned to Ecology Headquarters under chain-of-custody to be transported to MEL the following day. Requirements for sample containers, preservation, and holding times are listed in Table 6.

Table 6. Containers, Preservatives, and Holding Times for TMDL Samples (PSEP, 1996).

Analyte	Container[1]	Preservation	Holding Time
TOC in Sediment	Glass or Polyethylene	Freeze, -18° C Cool to 4° C	6 Months 14 Days
TOC in Water	60 mL n/m Poly	HCl to pH<2, 4° C	7 Days
Grain Size	Glass or Polyethylene	Cool to 4° C	6 Months
TSS in Water	1-liter w/m Poly	Cool to 4° C	28 Days
Turbidity	500 mL Poly	Cool to 4° C	48 Hours
DDT, PCBs in Sediment	Certified 4-oz Glass, Teflon Lid Liner	Cool to 4° C	7 Days Extraction 40 Days Analysis (1 Year if frozen)
DDT in Water	Certified 1-gallon Glass, Teflon Lid Liner	Cool to 4° C	7 Days Extraction 40 Days Analysis
DDT/PCB SPMDs	1-gallon metal can[1]	Freeze, -18° C	1 Year frozen
Sediment ^{210}Pb	Polystyrene	Freeze, -18° C Cool to 4° C	na
Sediment ^{137}Cs	Polystyrene	Freeze, -18° C Cool to 4° C	na
Sediment Total Pb	4-oz Glass	Freeze, -18° C Cool to 4° C	2 Years 6 Months
DDT, PCBs in fish	Certified 4-oz Glass, Teflon Lid Liner	Cool to 4° C	7 Days Extraction 40 Days Analysis (1 Year if frozen)
Lipids in Fish	Certified 4-oz Glass, Teflon Lid Liner		na
Dioxins in Fish	Certified 8-oz Amber Glass Teflon Lid Liner[1]	Freeze, -18° C Cool to 4° C	7 Days Extraction 40 Days Analysis

[1] = Containers will be obtained from MEL, except for the SPMD and dioxin sample containers, which will be supplied by the contract laboratory.
na = Not applicable

Laboratory Procedures

A list of target analytes, number of samples, expected range of results, and analytical methods is shown in Table 7. The MEL will conduct sample analysis or an accredited laboratory will be selected and contracted by MEL, in consultation with the project manager.

The EST laboratory, or another selected by MEL, will conduct dialysis of the SPMDs and perform GPC clean-up on the extract. Extracts will be shipped to MEL for final analysis. The EST dialysis is a patented procedure. The dialysis and GPC methods are documented in SOPs E14, E15, E19, E21, E33, E44, and E48. These SOPs are on file at the EAP.

The PCB congener analysis of fish tissue will also be contracted through MEL. Lower limits of detection are possible with PCB congener analysis than Aroclor analysis, and allow quantification of individual PCB compounds that have different levels of toxicity. This can be important to the human health assessment by WDOH. Method 1668A allows determination of more than 150 PCB congeners by isotope dilution high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). The contractor will report total PCBs as well as individual congeners.

Table 7. Target Analytes, Sample Numbers, Expected Range of Results, and Analytical Methods.

Analyte	Sample Matrix	Number of Samples[1]	Expected Result Range	Sample Prep Method	Method Reference
DDT analogs[2]	fish tissue	46	1-2,000 *u*g/Kg	SW3540/3620/3665[3]	SW8081
PCB Aroclors	fish tissue	40	5-500 *u*g/Kg	SW3540	SW8082
PCB Congeners	fish tissue	4	5-500 *u*g/Kg	EPA 1668A	EPA 1668A
Percent Lipid	fish tissue	46	0.1-10%	extraction	EPA 608.5
Dioxins	fish tissue	8	0.10 – 10.0 ng./Kg	Silica-gel clean-up	EPA 8290
DDT analogs[2]	sediment/cores	50	1-2,000 *u*g/Kg	EPA 8081	EPA 8081
PCB Aroclors	sediment/cores	50	5-500 *u*g/Kg	EPA 8081	EPA 8081
TOC	sediment/cores	50	1.0-20.0 %	combustion/NDIR	PSEP, 1986
Grain size	sediment	20	NA	sieve and pipet	PSEP, 1986
Total Pb	cores	10	2-500 mg/Kg dry	NA	EPA 200.8
^{210}Pb	cores	10	1.0-15.0 pCi/g	NA	Gamma Detection
^{137}Cs	cores	10	0.50-15.0 pCi/g	NA	Gamma Detection
DDT analogs[2]	whole water	77	<0.1-10 ng/L	SW3510/3620/3665	SW8081
TOC	whole water	89[4]	1-10 mg/L	NA	EPA 415.1
TSS	whole water	77	1-500 mg/L	NA	EPA 160.2
Turbidity	whole water	89[4]	1-100 NTU	NA	EPA 180.1
DDT analogs[2]	SPMD extract	6	1-500 ng	dialysis/GPC[5]	SW 8081
PCB Aroclors	SPMD extract	6	50-500 ng	dialysis/GPC[5]	SW 8082
PCB Congeners	SPMD extract	3	5-500 *u*g/Kg	EPA 1668A	EPA 1668A

[1] = Does not include blanks, duplicates, or spikes.
[2] = 4,4'-DDT, 4,4'-DDE, 4,4'-DDD.
[3] = and corresponding MEL SOPs and modifications (Appendix F).
[4] = Includes whole water samples at SPMD sites.
[5] = EST SOPs E14, E15, E19, E21, E33, E44, E48.

Project Responsibilities

The following individuals and organizations will be involved in the project:

David Schneider (Ecology): Client and Staff Contact for the Central Regional Office. Responsible for reviewing the QA Project Plan, draft study report, and coordinating basin planning activities (509-454-7894).

Randy Coots (Ecology): Toxics Studies Unit. Develops the project objectives, scope, and study design. Responsible for preparation of the QA Project Plan, field sampling, and write-up of study findings (360-407-6690).

Dale Norton (Ecology): Toxics Studies Unit Supervisor. Responsible for review of the QA Project Plan and draft study report (360-407-6765).

Will Kendra (Ecology): Section Manager, Watershed Ecology Section. Responsible for review of the QA Project Plan and draft study report (360-407-6698).

Cliff Kirchmer (Ecology): Quality Assurance Officer. Responsible for review of the QA Project Plan and available for technical assistance on QA during implementation and assessment (360-407-6455).

Stuart Magoon and Manchester Environmental Laboratory Personnel (Ecology): Responsible for review of the QA Project Plan pertaining to laboratory analyses and the analysis/reporting of project data to principal investigator (360-871-8801).

Dave Serdar (Ecology): Toxics Studies Unit. Technical resource and field support for fish collection and tissue processing (360-407-6772).

Brandee Era-Miller and *Morgan Roose* (Ecology): Toxics Studies Unit. Sampling and field support (360-407-6771 and 360-407-6458).

Carolyn Lee (Ecology): Toxics Studies Unit. Responsible for entering project data into the EIM database system (360-407-6430).

Schedule and Budget

Field Work

SPMD Deployment	April, July, and October 2003
Storm Event Sampling	February through May 2003
Sediment Transect and Cores	June through September 2003
Fish Tissue	April through October 2003

Reports

Fish Tissue Data to WDOH	January 2004
Draft TMDL Report	June 2004
Final TMDL Report	December 2004
EIM Data Entry Due Date	December 2004

Below is a summary of laboratory costs for the proposed analyses for the Lake Chelan DDT/PCB TMDL. Table G1 in Appendix G gives a detailed cost estimate.

Summary of Laboratory Cost*

	FY03	FY04	Total
SPMD (dialysis/extraction)	$1,688	$3,937	$5,625
SPMD (analysis)	$1,767	$3,851	$5,618
Fish Tissue Samples	$12,375	$31,778	$44,153
Sediment Samples	$28,000		$28,000
Water Samples	$17,329		$17,329
ESTIMATED TOTAL LABORATORY COST	$61,159	$39,566	$100,725

* Includes field QA samples and is based on 50% discount rate for analysis at MEL.

Quality Control

Field Quality Control

Table 8 shows a list of the field quality assurance samples and types to be analyzed for the project. The intent of quality assurance field samples is to provide an estimate of the total variability of each analysis, field plus lab. Field quality assurance samples will include replicates, duplicates (splits), and blanks. Sampling will be conducted to avoid cross-contamination. Samplers will wear non-talc nitrile gloves during sample collection. Water and sediment samples will be collected in sequence from sites expected to have the lowest to highest contamination. Immediately following collection, samples will be stored in plastic bags, in iced coolers, until delivered to MEL.

Table 8. Field Quality Control Samples.

Matrix	Replicates	Duplicates	Field Blanks
Fish Tissue			
4,4'-DDT, -DDE, -DDD	--	4/study	--
PCB Aroclors	--	4/study	--
PCB Congeners	--	--	--
Percent Lipids	--	4/study	--
Dioxins	--	--	--
Sediment			
4,4'-DDT, -DDE, -DDD	--	3/study	--
PCB Aroclors	--	3/study	--
Grain size	--	2/study	--
TOC	--	3/study	--
^{210}Pb	--	--	--
^{137}Cs	--	--	--
Total Pb	--	--	--
Water			
4,4'-DDT, -DDE, -DDD	--	3/study	1/study (transport)
TOC	--	3/study	--
TSS	--	3/study	--
Turbidity	--	3/study	--
SPMDs	3/study	--	1/deployment

Replicates = Independent sample collected at the same location.
Duplicate = Single sample homogenized and split.

Because SPMD uptake rates for some analytes may be influenced by flow, permeability reference compounds (PRCs) will be used to provide a correction factor. PRCs are analytically non-interfering compounds with fairly high fugacity (escape potential). PRCs are added to the SPMD lipid prior to deployment. The PRC loss rate during SPMD deployment is used to adjust for the effects of temperature, water velocity, and biofouling on SPMD sampling rates that have been determined in the laboratory.

2,2'-Dichlorobiphenyl and 2,4,5-trichlorobiphenyl will be used as PRCs for the SPMD sampling. These congeners are not generally found at significant levels in commercial Aroclors. Studies have shown that the uptake rate of compounds with a wide range of K_{ow}'s[4], like the target analytes in Lake Chelan, can be predicted by loss rates of PRCs with a narrow K_{ow} range (Huckins et al., 2002). The MEL will provide the PRC spiking solution at a level of 0.2 *u*g of each congener per SPMD.

To help minimize field variability from sample collection, field samplers will be familiar with and follow methods described in WAS (1993), PSEP (1996), and Huckins et al., (2000). All sampling equipment will be cleaned prior to going into the field according to protocols (see Field Procedures). Pre-cleaned, sampling equipment will be wrapped in aluminum foil until used.

Laboratory Quality Control

The MEL routinely runs laboratory control samples for TOC, TSS, turbidity, conductivity, and percent lipids, which will be satisfactory for the purposes of this project. The MEL will follow standard operating procedures as described in the *Quality Assurance Manual for the Washington State Department of Ecology Manchester Environmental Laboratory* (MEL, 2001). Laboratory quality control samples to be analyzed for this project are presented in Table 9.

In addition to the above, SPMDs will require other control samples as well. EST, or another contract laboratory able to perform dialysis of SPMDs, will prepare the following blanks for the first deployment: 1) A dialysis blank-SPMD, to represent background during dialysis and cleanup; 2) A day-zero blank SPMD, developed just prior to dialysis, for use as a control; and 3) A reagent blank to evaluate contamination independent of the SPMDs. These blanks will be analyzed along with the first batch of SPMDs deployed. A review of the results from the laboratory blanks from the first deployment will determine which of the blanks would need to be analyzed with subsequent SPMD deployments. To establish an estimate of accuracy for the entire analytical process, EST, or another contract laboratory, will add surrogate compounds to each SPMD prior to dialysis. The surrogates will be dibromooctafluorobiphenyl, decachlorobiphenyl, and dibutylchlorendate. The MEL will supply the surrogate spiking solutions to EST, or another contract laboratory, at a level of 40 ng per SPMD. Some level of background contamination for DDT is expected. The MEL reports contamination around 11.5 ng/5 SPMDs for 4,4'-DDE and 10.4 ng/5 SPMDs for 4,4'-DDT.

[4] octonol-water partition coefficient – a measure of a chemical's bioaccumulation potential.

Table 9. Laboratory Quality Control Samples.

Matrix	Analysis	Method Blank	Check Standards	OPR[1] Standards	Surrogate Spikes	Labeled Compounds	Matrix Spike	Std Ref. Material	Duplicate Analyses
Fish Tissue									
	DDT analogs	1/batch	--	--	all samples	--	2/batch	1/batch	2/batch
	PCB Aroclors	1/batch	--	--	all samples	--	2/batch	--	2/batch
	PCB congeners	1/batch	--	each/batch	--	all samples	2/batch	--	1/batch
	Dioxins	1/batch	--	--	--	--	--	--	1/batch
	Lipids	1/batch	--	--	--	--	--	--	2/batch
Sediment									
	DDT analogs	1/batch	--	--	1/batch	--	2/batch	1/batch	--
	PCB Aroclors	1/batch	--	--	1/batch	--	2/batch	--	--
	Grain size	--	--	--	--	--	--	--	1/batch
	TOC	1/batch	--	--	--	--	--	--	1/batch
	Total Pb	1/batch	--	--	--	--	--	--	1/batch
	^{210}Pb	1/batch	--	--	--	--	--	--	1/batch
	^{137}Cs	1/batch	--	--	--	--	--	--	1/batch
Water									
	DDT analogs	1/batch	1/batch	--	--	--	1/batch	--	1/batch
	TOC	1/batch	--	--	--	--	--	--	1/batch
	TSS	--	--	--	--	--	--	--	1/batch
	Turbidity	--	--	--	--	--	--	--	1/batch
SPMD extracts									
	DDT analogs	1/batch[2]	--	--	all samples[3]	--	2/batch[3]	--	--
	PCB Aroclors	1/batch[2]	--	--	all samples[3]	--	2/batch[3]	--	--

[1] = On-going precision and recovery.
[2] = Analysis by MEL; other blanks are processed by EST or other contractor doing dialysis of SPMDs.
[3] = Will be spiked by EST or other contract laboratory.

A standard reference material (SRM) will be analyzed for determining accuracy of the DDT data for fish tissue and sediments. The MEL will analyze National Institute of Standards & Technology (NIST) SRM 2978 – Mussel Tissue: Organic Contaminants—Raritan Bay, New Jersey and SRM 1941b Organics in Marine Sediments. The NIST certified values for DDT analogs are shown in Table 10.

Table 10. Certified DDT Concentrations in SRM 2978: Mussel Tissue, Organic Contaminants, and SRM 1941b: Organics in Marine Sediments (*u*g/Kg, dry wt).

Pesticide	Certified Concentration Mussel Tissue	Certified Concentration Sediment
4,4'-DDT	3.84 +/- 0.28	1.12 +/- 0.42
4,4'-DDE	37.5 +/- 1.5	3.22 +/- 0.28
4,4'-DDD	38.8 +/- 2.3	4.66 +/- 0.46
2,4'-DDT	9.2 +/- 1.6	--
2,4'-DDE	4.41 +/- 0.56	0.38 +/- 0.12
2,4'-DDD	10.5 +/- 1.0	--

Data Review, Verification, and Validation

The MEL's standard operating procedures for data reduction, review, and reporting will meet the needs of the project. Data packages including QC results for pesticide/PCB analysis conducted by MEL and others will be assessed by laboratory staff using the EPA Functional Guidelines for Organic Data Review. The MEL will provide a written report of their data review, which will include discussion verifying if MQOs were met; analytical methods and protocols were followed; calibrations and controls were within limits; and that data werew consistent, correct, and complete, without errors or omissions. All data generated from the project will be entered into the EIM database.

The project lead will be responsible for data validation and acceptance of project data. For data analyzed by outside laboratories, the MEL will be responsible for data validation. The complete data package, along with MEL's written report, will be assessed for completeness and reasonableness. Based on these assessments, the data will either be accepted, accepted with qualifications, or rejected and re-analysis considered.

Data Quality Assessment

After the project data has been reviewed, verified, and validated, the project lead will determine if the data is of sufficient quality to make decisions for which the study was designed. The data from the laboratory's quality control procedures, replicate field samples, and SRMs will provide information to determine if DQOs have been met. Laboratory and quality assurance staff familiar with assessment of data quality may be consulted. The projects final report will discuss data quality and whether the projects objectives can be met. If limitations in the data are identified they will be noted.

Reporting

A report will be completed in December 2004 presenting the significant findings of the study by the EA Program. The report will be distributed in draft form for review by the Central Regional Office staff and the Lake Chelan Water Quality Committee. The report will include:

- A map of the study area showing sampling sites and significant features.
- Coordinates of each sample site.
- Descriptions of field and laboratory methods.
- Discussion of data quality and the significance of any problems encountered.
- Results of the DDT and PCBs related to recommended standards.
- Summary tables of the chemical and physical data.
- An evaluation of the significant findings and comparisons of historical data to current conditions.
- Complete set of chemical and physical data and the MEL QA review as an Appendix.
- All required elements of a TMDL.

In addition to the above mentioned report, a fish tissue data report will be prepared for the WDOH to conduct a human health assessment. Tentatively, this report will be ready January 2004. The report will include all chemical and ancillary data (including biological data on fish), QC data, case narratives, and MEL's data reviews. The WDOH will be responsible for determination and issuing fish advisories if warranted in consultation with the local health department.

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Appendices

Appendix A

Lake Chelan Basin
1996 and 1998 Section 303(d) Listings

Final 1998 Section 303(d) List - WRIA 47

Water Name	CHELAN LAKE				
Parameter	Total Phosphorus			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	No	**Action Needed**	None
New Segment ID #	292NWR	**Old Segment ID #**	WA-47-9020		
Stream Route #		**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**			
Range	22E	**Grid Latitude**			
Section	13	**Grid Longitude**			
Basis for Consideration of Listing	Patmont, et al. 1991.;Pelletier, 1991.;R.W. Beck and Associates, 1991.				
Remarks	TMDL for antidegradation lake to remain at ultra-oligiotrophic conditions based on the Water Quality Management Plan submitted 3/9/92. EPA approved the TMDL on 1/26/93.				

Water Name	CHELAN LAKE				
Parameter	4,4'-DDE			**Mediu**	Tissue
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	292NWR	**Old Segment ID #**	WA-47-9020		
Stream Route #		**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**	47120I1H6		
Range	22E	**Grid Latitude**	47.875		
Section	13	**Grid Longitude**	120.165		
Basis for Consideration of Listing	Davis and Johnson, 1994. , excursions beyond the criterion of edible fish tissue samples.;				
Remarks					

Water Name	CHELAN LAKE				
Parameter	PCB-1254			**Mediu**	Tissue
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	292NWR	**Old Segment ID #**	WA-47-9020		
Stream Route #		**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**	47120I1H6		
Range	22E	**Grid Latitude**	47.875		
Section	13	**Grid Longitude**	120.165		
Basis for Consideration of Listing	Davis and Johnson, 1994. , excursions beyond the criterion of edible fish tissue samples.				
Remarks					

Water Name	CHELAN LAKE				
Parameter	pH			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	Yes	**Action Needed**	None
New Segment ID #	292NWR	**Old Segment ID #**	WA-47-9020		
Stream Route #		**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**	47120I0D1		
Range	22E	**Grid Latitude**	47.835		
Section	13	**Grid Longitude**	120.015		
Basis for Consideration of Listing	1 excursion beyond the criterion out of 12 samples (<1%) at Ecology ambient monitoring station 47A070 (RM 4.8) between 9/91 and 9/96.				
Remarks	A single excursion does not meet the Water Quality Program policy for listing				

Water Name	CHELAN LAKE				
Parameter	PCB-1260			**Mediu**	Tissue
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	292NWR	**Old Segment ID #**	WA-47-9020		
Stream Route #		**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**	47120I1H6		
Range	22E	**Grid Latitude**	47.875		
Section	13	**Grid Longitude**	120.165		
Basis for Consideration of Listing	Davis and Serdar, 1996 , excursions beyond the criterion in edible fish tissue of Kokanee and Rainbow Trout during 1994.				
Remarks					

Water Name	CHELAN LAKE				
Parameter	4,4'-DDE			**Mediu**	Tissue
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	292NWR	**Old Segment ID #**	WA-47-9020		
Stream Route #		**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**	47120I1H6		
Range	22E	**Grid Latitude**	47.875		
Section	13	**Grid Longitude**	120.165		
Basis for Consideration of Listing	Davis and Serdar, 1996 , excursions beyond the criterion in edible fish tissue of Kokanee, Rainbow Trout, and Smallmouth Bass during 1994.				
Remarks					

Water Name	CHELAN LAKE				
Parameter	PCB-1254			**Mediu**	Tissue
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	292NWR	**Old Segment ID #**	WA-47-9020		
Stream Route #		**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**	47120I1H6		
Range	22E	**Grid Latitude**	47.875		
Section	13	**Grid Longitude**	120.165		
Basis for Consideration of Listing	Davis and Serdar, 1996 , excursions beyond the criterion in edible fish tissue of Kokanee, Rainbow Trout, and Smallmouth Bass during 1994.				
Remarks					

Water Name	CHELAN RIVER				
Parameter	Temperature			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	No	**Action Needed**	None
New Segment ID #	JI23XG	**Old Segment ID #**	WA-47-1010		
Stream Route #	5.98	**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**			
Range	22E	**Grid Latitude**			
Section	13	**Grid Longitude**			
Basis for Consideration of Listing	3 excursions beyond the criterion out of 12 samples (25%) at Ecology ambient monitoring station 47A070 (RM 4.8) between 9/91 and 9/96.				
Remarks	The Ecology ambient monitoring station 47A070 is located at the mouth of Lake Chelan and represents lake conditions. Therefore, state lake criteria should be applied. Solar heating of the surface layer of the stratified lake will cause outflow water temperature to be high. This judgement was recommended by Gordon Congdon of Chelan County PUD and agreed upon by Brad Hopkins (Dept. of Ecology) on 1/96.				

Water Name	CHELAN RIVER				
Parameter	Fecal Coliform			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	Yes	**Action Needed**	None
New Segment ID #	JI23XG	**Old Segment ID #**	WA-47-1010		
Stream Route #	5.98	**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**			
Range	22E	**Grid Latitude**			
Section	13	**Grid Longitude**			
Basis for Consideration of Listing	0 excursions beyond the criterion out of 12 samples (0%) at Ecology ambient monitoring station 47A070 between 9/91 and 9/96. Listed in 1996 based on 3 excursions beyond the criterion at Ecology ambient monitoringstation 47A070 in 12/85, 9/86 and 10/89.				
Remarks	The segment now meets water quality standards for fecal coliform.				

Water Name	CHELAN RIVER				
Parameter	pH			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	No	**Action Needed**	None
New Segment ID #	JI23XG	**Old Segment ID #**	WA-47-1010		
Stream Route #	5.98	**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**			
Range	22E	**Grid Latitude**			
Section	13	**Grid Longitude**			
Basis for Consideration of Listing	1 excursions beyond the criterion out of 12 samples (8%) at Ecology ambient monitoring station 47A070 (RM 4.8) between 9/91 and 9/96.				
Remarks	A single excursion does not meet the Water Quality Program policy for listing. The Ecology ambient monitoring station 47A070 is located at the mouth of Lake Chelan and represents lake conditions. Therefore, state lake criteria should be applied. Epilimnetic productivity is the likely cause of these excursions beyond the pH criterion. This judgement was recommended by Gordon Congdon of Chelan County PUD and agreed upon by Brad Hopkins (Dept. of Ecology) on 1/96.				

Water Name	COLUMBIA RIVER				
Parameter	Total Dissolved Gas			**Mediu**	Water
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	NN57SG	**Old Segment ID #**	WA-CR-1040		
Stream Route #	817.194	**Water Resource Inventory Area**	47		
Township	28N	**Waterbody Grid #**			
Range	24E	**Grid Latitude**			
Section	07	**Grid Longitude**			
Basis for Consideration of Listing	U.S. Army Corp of Engineers, 1991. , numerous excursions beyond the criterion at station 2407(below Wells Dam)				
Remarks					

Water Name	COLUMBIA RIVER				
Parameter	Temperature			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	Yes	**Action Needed**	None
New Segment ID #	NN57SG	**Old Segment ID #**	WA-CR-1040		
Stream Route #	798.896	**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**			
Range	23E	**Grid Latitude**			
Section	29	**Grid Longitude**			
Basis for Consideration of Listing	1 excursion beyond the criterion out of 12 samples (8%) at Ecology ambient monitoring station 47B070 (RM 504.1) between 9/91 and 9/96.				
Remarks	A single excursion beyond criterion does not meet the Water Quality Program policy for listing.				

Water Name	COLUMBIA RIVER				
Parameter	pH			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	Yes	**Action Needed**	None
New Segment ID #	NN57SG	**Old Segment ID #**	WA-CR-1040		
Stream Route #	798.896	**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**			
Range	23E	**Grid Latitude**			
Section	29	**Grid Longitude**			
Basis for Consideration of Listing	0 excursions beyond the criterion out of 12 samples (0%) at Ecology ambient monitoring station 47B070 between 9/91 and 9/96. Listed in 1996 based on 2 excursions beyond the criterion at Ecology ambient monitoringstation 47B070 on 1/15/91 and 4/9/91.				
Remarks	The segment now meets water quality standards for pH.				

Water Name	COLUMBIA RIVER				
Parameter	Total Dissolved Gas			**Mediu**	Water
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	NN57SG	**Old Segment ID #**	WA-CR-1040		
Stream Route #	817.194	**Water Resource Inventory Area**	47		
Township	28N	**Waterbody Grid #**			
Range	24E	**Grid Latitude**			
Section	07	**Grid Longitude**			
Basis for Consideration of Listing	20 excursions beyond the criterion at the Douglas County PUD station WEL in 1993.; 7 excursions beyond the criterion at the Douglas County PUD station WEL in 1994.;				
Remarks					

Water Name	COLUMBIA RIVER				
Parameter	Temperature			**Mediu**	Water
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	NN57SG	**Old Segment ID #**	WA-CR-1050		
Stream Route #	819.059	**Water Resource Inventory Area**	47		
Township	28N	**Waterbody Grid #**			
Range	24E	**Grid Latitude**			
Section	06	**Grid Longitude**			
Basis for Consideration of Listing	Washington Dept. of Fish and Wildlife data show numerous excursions beyond the criterion at the inflow to the Wells Hatchery.				
Remarks	The likely cause of these excursions beyond the criterion are due to stratification behind impoundments. Remedies to the problem may not be available.				

Water Name	FIRST CREEK				
Parameter	Dissolved Oxygen			**Mediu**	Water
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	CH30BE	**Old Segment ID #**	WA-47-1012		
Stream Route #	0.719	**Water Resource Inventory Area**	47		
Township	27N	**Waterbody Grid #**			
Range	21E	**Grid Latitude**			
Section	04	**Grid Longitude**			
Basis for Consideration of Listing	Patmont, et al. 1989. , 2 excursions beyond the criterion, at the mouth, between 12/86 and 11/87.				
Remarks					

Water Name	MITCHELL CREEK				
Parameter	pH			**Mediu**	Water
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	QF17YZ			**Old Segment ID #**	WA-47-1014
Stream Route #	0			**Water Resource Inventory Area**	47
Township	29N			**Waterbody Grid #**	
Range	21E			**Grid Latitude**	
Section	34			**Grid Longitude**	
Basis for Consideration of Listing	Patmont, et al. 1989. , 2 excursions beyond the criterion out of 13 samples (15%) , at the mouth, on 7/28/87 and 6/16/87.				
Remarks					

Water Name	RAILROAD CREEK				
Parameter	Arsenic			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	Yes	**Action Needed**	None
New Segment ID #	DD44JV			**Old Segment ID #**	WA-47-1020
Stream Route #	0			**Water Resource Inventory Area**	47
Township	31N			**Waterbody Grid #**	
Range	10E			**Grid Latitude**	
Section	10			**Grid Longitude**	
Basis for Consideration of Listing	Patmont, et al. 1989. , 4 excursions beyond the criterion at the mouth between 3/87 and 9/87. Johnson, et al. 1997., exceedance of the acute water quality occur upstream of the holden Mine site and decrease in concentrations going downstream to the mouth.				
Remarks	The analysis by Johnson, et al. 1997, show that natural background concentrations exceed the standard, and therefore is not a violation of the water quality standards and the segment should not be listed. The new analysis shows that concentrations of Arsenic actually decrease as the water flows past the Holden Mine site. The high arsenic levels are most likely due to the geology of the area.; There is significant uncertainty regarding the accuracy of the current arsenic criteria for human health. Even EPA is reluctant to impose the criteria (62 FR 42179, August 5, 1997) that they promulgated on Washington State through the national toxic rule. Ecology is currently considering revising the arsenic standard.				

Water Name	ROSES (ALKALI) LAKE				
Parameter	4,4'-DDE			**Mediu**	Tissue
Place on 1998 List?	Yes	**Listed in 1996**	Yes	**Action Needed**	TMDL
New Segment ID #	370XQC	**Old Segment ID #**	WA-47-9037		
Stream Route #		**Water Resource Inventory Area**	47		
Township	28N	**Waterbody Grid #**			
Range	21E	**Grid Latitude**			
Section	26	**Grid Longitude**			
Basis for Consideration of Listing	Serdar, et al. 1994. , excursions beyond the criterion in edible fish tissue.				
Remarks					

Water Name	STEHEKIN RIVER				
Parameter	Arsenic			**Mediu**	Water
Place on 1998 List?	No	**Listed in 1996**	Yes	**Action Needed**	None
New Segment ID #	HW13SG	**Old Segment ID #**	WA-47-1030		
Stream Route #	0	**Water Resource Inventory Area**	47		
Township	33N	**Waterbody Grid #**			
Range	17E	**Grid Latitude**			
Section	36	**Grid Longitude**			
Basis for Consideration of Listing	Patmont, et al. 1989. , 5 excursions beyond the criterion, at the mouth, between12/86 and 11/87.				
Remarks	The analysis by Johnson, et al. 1997, show that natural background concentrations exceed the standard, and therefore is not a violation of the water quality standards and the segment should not be listed. The new analysis shows that concentrations of Arsenic actually decrease as the water flows past the Holden Mine site on Railroad Creek. The high arsenic levels are most likely due to the geology of the area.; There is significant uncertainty regarding the accuracy of the current arsenic criteria for human health. Even EPA is reluctant to impose the criteria (62 FR 42179, August 5, 1997) that they promulgated on Washington State through the national toxic rule. Ecology is currently considering revising the arsenic standard.				

Appendix B

Figures

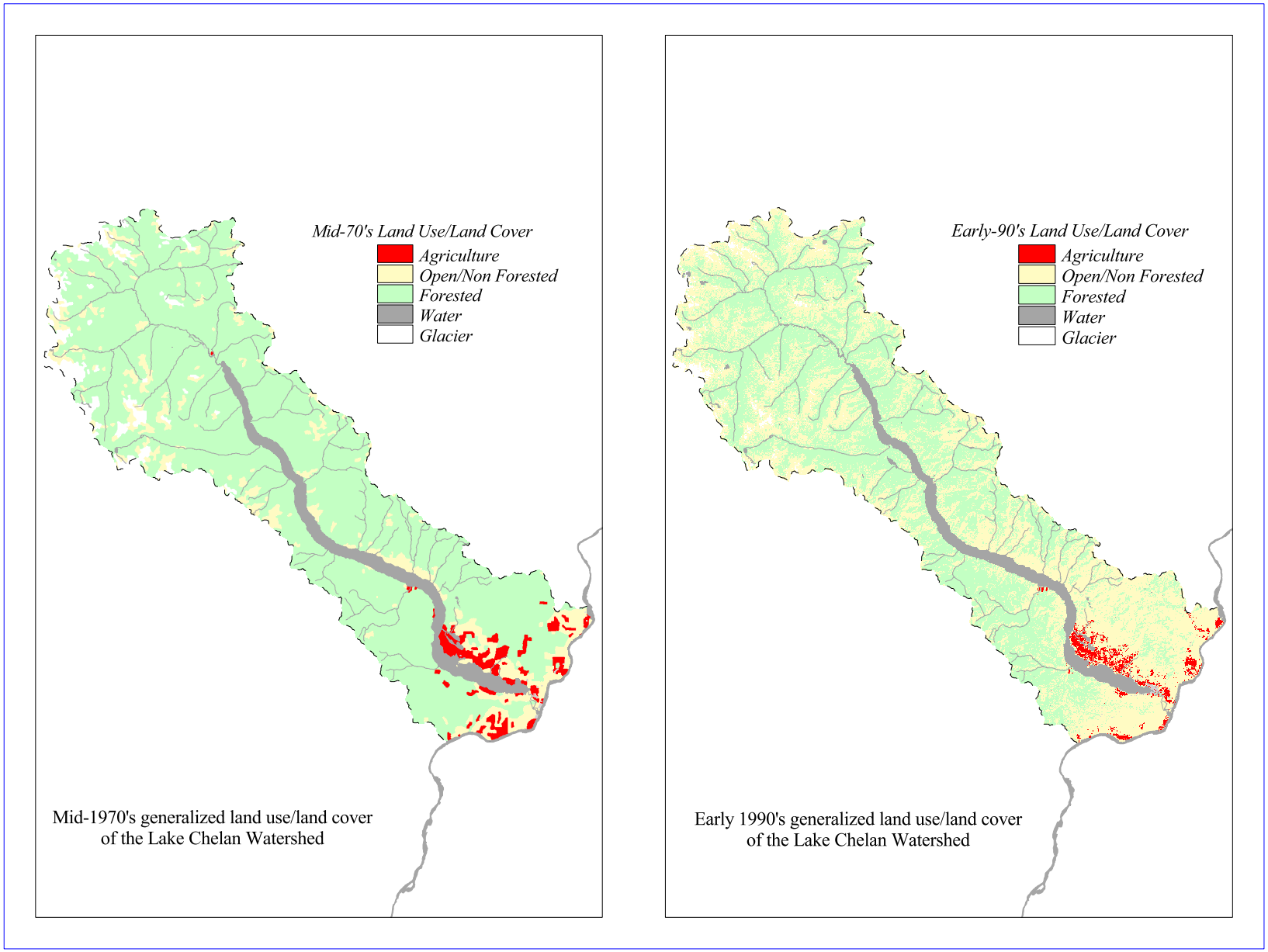

Figure B1. Land Use/Land Cover for the Lake Chelan Watershed

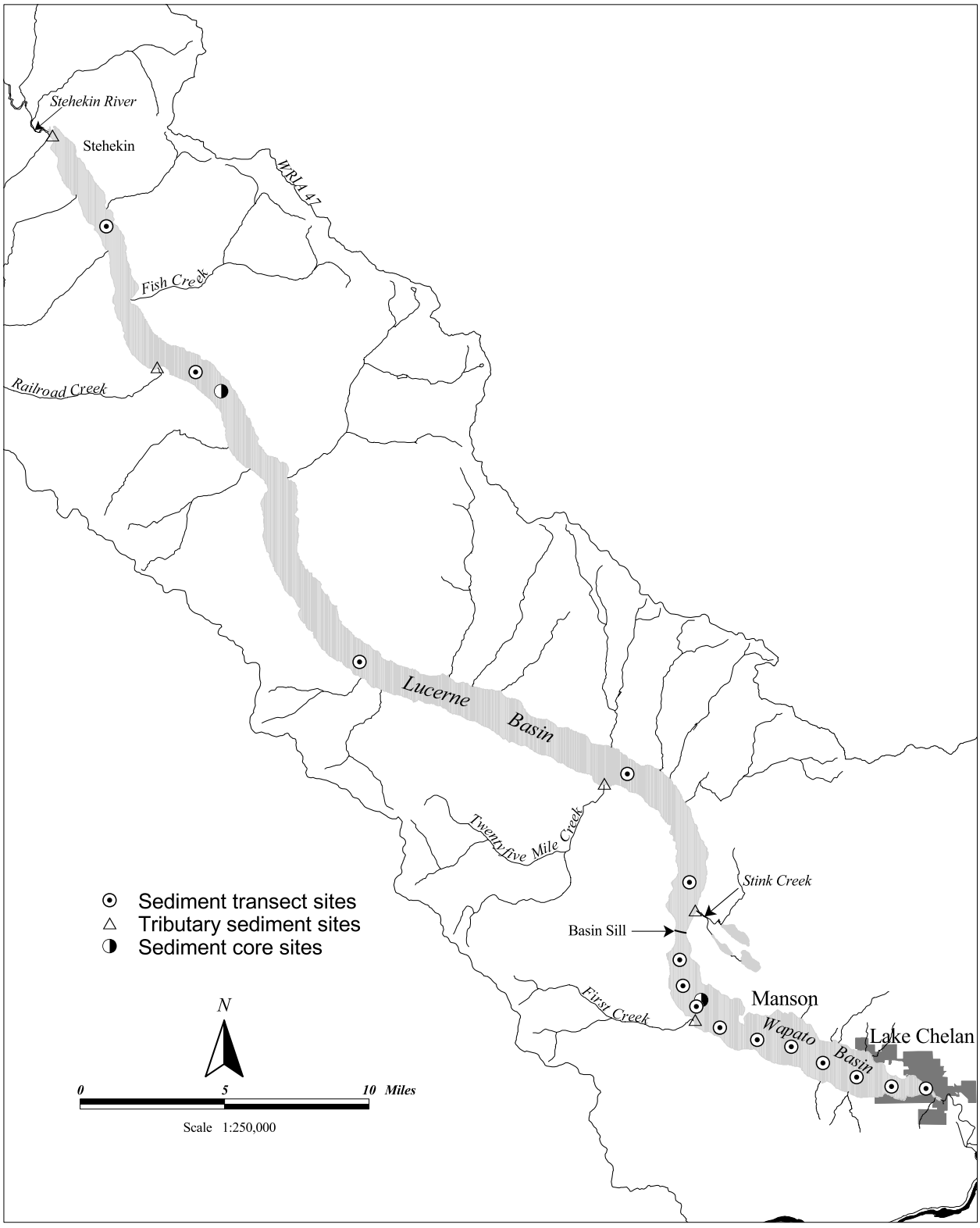

Figure B2. Proposed Surface Sediments and Core Sample Sites in Lake Chelan

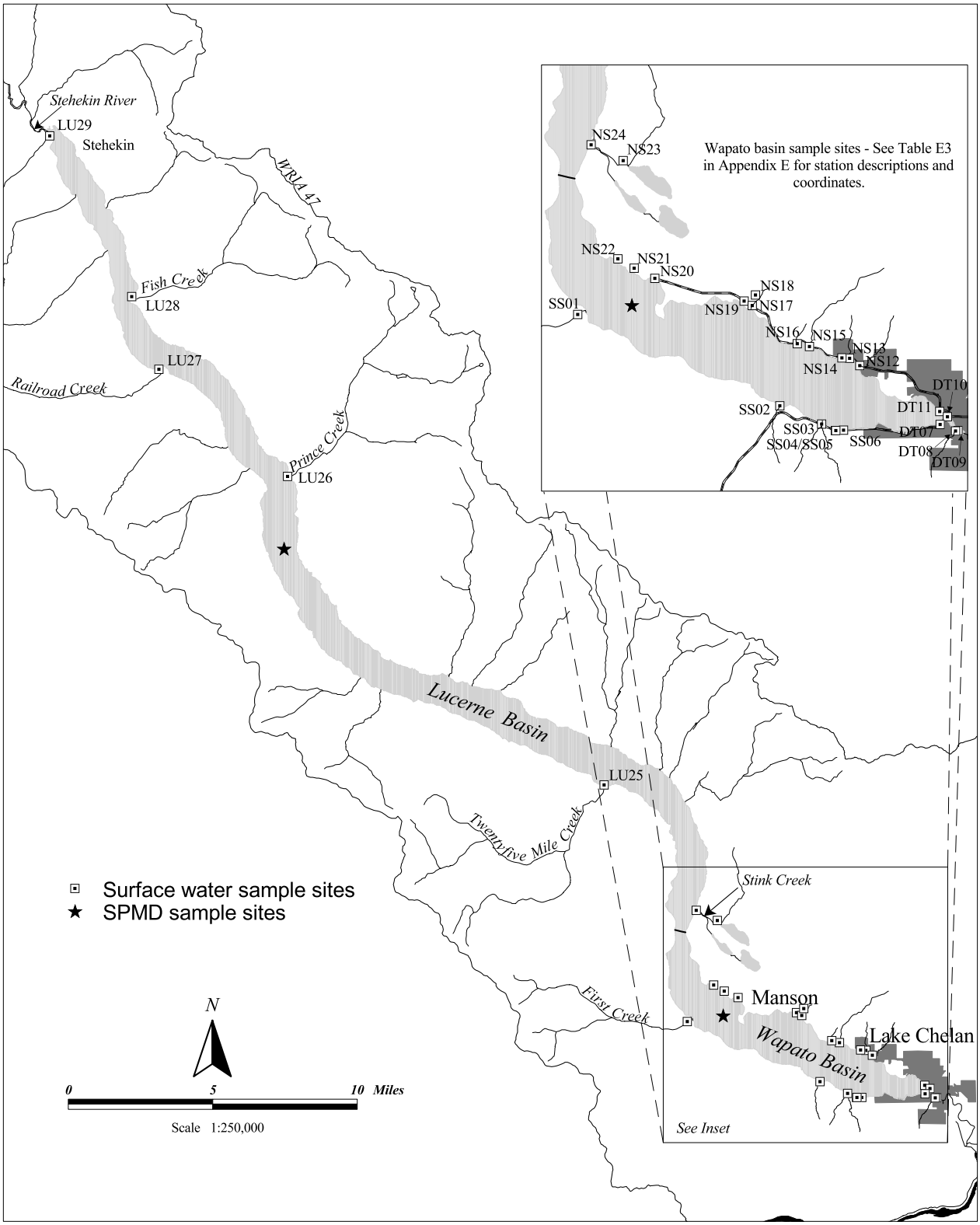

Figure B3. Proposed Surface Water and SPMD Sample Sites in Lake Chelan

Appendix C

Lake Chelan Basin Historical Water Quality Data for DDT and PCBs

Table C1. Summary of DDT and PCB Data on Fish Tissue from Lake Chelan and Manson Lakes (ug/Kg, wet weight basis, part per billion)

Waterbody	Basin	Sample Date	Fish Species	Tissue Type	4,4'-DDT	4,4'-DDE	4,4'-DDD	tDDT[1]	PCB-1254	PCB-1260	tPCB[2]	Reference
Lake Chelan	Wapato	Sep-82	Bridgelip sucker	Whole body	418	3,200	850	4,468				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-82	Northern pike minnow	Whole body	48	1,380	104	1,532				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-83	Bridgelip sucker	Fillet	**113**	**473**	**193**	779				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-83	Bridgelip sucker	Whole body	140	1,189	510	1,839				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-83	Northern pike minnow	Fillet	21	**1,709**	**97**	1,827				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-83	Northern pike minnow	Whole body	*nd*	1,339	77	1,416				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-84	Bridgelip sucker	Fillet	**44**	**990**	**110**	1,144				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-84	Northern pike minnow	Fillet	**75**	**1,000**	31	1,106				Hopkins and Clark, 1985
Lake Chelan	Wapato	Sep-87	Sucker	Whole body	13	290	39	342				Patmont et al., 1989
Lake Chelan	Wapato	Sep-87	Northern pike minnow	Whole body	3	3,200	160	3,363				Patmont et al., 1989
Lake Chelan	Wapato	Sep-87	Kokanee (sockeye)	Whole body	50	630	93	773				Patmont et al., 1989
Lake Chelan	Wapato	Sep-87	Burbot (cod)	Fillet	20	**440**	18	478				Patmont et al., 1989
Lake Chelan	Wapato	Sep-87	Northern pike minnow	Whole body	*nd*	3,600	150	3,750				Patmont et al., 1989
Lake Chelan	Wapato	Sep-87	Sucker	Whole body	110	820	77	1,007				Patmont et al., 1989
Lake Chelan	Wapato	Sep-87	Sucker	Whole body	95	650	89	834				Patmont et al., 1989
Lake Chelan	Lucerne	Sep-87	Kokanee (Sockeye)	Whole body	25	260	36	321				Patmont et al., 1989
Lake Chelan	Lucerne	Sep-87	Chinook	Fillet	**110**	**2,800**	**190**	3,100				Patmont et al., 1989
Lake Chelan	Lucerne	Sep-87	Rainbow trout	Fillet	5	**780**	30	815				Patmont et al., 1989
Lake Chelan	Lucerne	Sep-87	Burbot (cod)	Fillet	*nd*	**59**	2	61				Patmont et al., 1989
Lake Chelan	Lucerne	Sep-87	Sucker	Whole body	24	370	81	475				Patmont et al., 1989
Lake Chelan	Lucerne	Sep-87	Northern pike minnow	Whole body	*nd*	1,400	80	1,480				Patmont et al., 1989
Lake Chelan	Lucerne	Sep-87	Northern pike minnow	Whole body	*nd*	1,100	61	1,161				Patmont et al., 1989
Roses Lake		Aug-92	Brown bullhead	Whole body	6	388	86	480				Serdar et al., 1994
Roses Lake		Aug-92	Rainbow trout	Fillet	2	**75**	26	103				Serdar et al., 1994
Roses Lake		Aug-92	Brown bullhead	Fillet	2	**165**	19	186				Serdar et al., 1994
Lake Chelan	Wapato	Sep-92	Largescale sucker	Whole body	5	133	29	167	17		17	Davis and Johnson, 1994
Lake Chelan	Wapato	Sep-92	Rainbow trout	Fillet	2	**53**	2	57	**15**		**15**	Davis and Johnson, 1994
Lake Chelan	Wapato	Sep-92	Kokanee (Sockeye)	Fillet	19	**398**	17	417	**12**		**12**	Davis and Johnson, 1994
Lake Chelan	Wapato	Sep-92	Kokanee (Sockeye)	Eggs	82	1370	59	1,452	14	16	30	Davis and Johnson, 1994
Lake Chelan	Wapato	Sep-94	Kokanee (Sockeye)	Fillet	12	**140**	12	164	**84**	**15**	**99**	Davis and Serdar, 1996
Lake Chelan	Wapato	Sep-94	Rainbow trout	Fillet		**56**		56	**65**	**15**	**80**	Davis and Serdar, 1996
Lake Chelan	Wapato	Sep-94	Smallmouth bass	Fillet	28	**330**	34	392	**16**		**16**	Davis and Serdar, 1996
Lake Chelan	Wapato	Sep-94	Largescale Sucker	Whole body	53	800	93	946	34	35	69	Davis and Serdar, 1996
Wapato Lake		Sep-96	Rainbow trout (age yr 1)	Fillet	4	15	2	21				Johnson, A., 1997
Wapato Lake		Sep-96	Rainbow trout (age yr 2)	Fillet	4	28	3	35				Johnson, A., 1997
Wapato Lake		Sep-96	Rainbow trout	Whole body	11	50	6	67				Johnson, A., 1997
Lake Chelan	Lucerne	Sep-2000	Lake trout	Fillet	**46**	**1,394**	41	1,481				EPA National Fish Tissue Study - unpublished
Lake Chelan	Lucerne	Aug-2000	Largescale sucker	Whole body	24	728	2	754				EPA National Fish Tissue Study - unpublished
National Toxics Rule (NTR) Human Health Criteria[3]					32	32	45		1.4	1.4	5.3	

[1] = tDDT is the sum of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD

[2] = tPCB is the sum of all aroclors detected

Bolded values exceed NTR human health criteria

nd = not detected

☐ Boxed values are the basis for the1998 303(d) listings

[3] = Based on EPA bioconcentration factors and National Toxics Rule water column criteria

Table C2. Summary of DDT Data on Sediments from Lake Chelan and Manson Lakes (*u*g/Kg, dry weight basis, part per billion).

Waterbody	Sample Date	Station Identification	Water Depth (m)	Sediment Depth (cm)	4,4'-DDT	4,4'-DDE	4,4'-DDD	tDDT	Reference
Lake Chelan	Sep-84	Outlet	5-10	0-15	10	32	53	95	Hopkins and Clark, 1985
Lake Chelan	Nov-86	Urban drain 2	5	0-5	5	5	5	15	Patmont et al., 1989
Lake Chelan	Nov-86	Station 1	7	0-5	73	47	50	170	Patmont et al., 1989
Lake Chelan	Nov-86	Manson Urban Drain	7	0-5	69	40	64	173	Patmont et al., 1989
Lake Chelan	Nov-86	Orchard drain 8	7	0-5	58	55	287	400	Patmont et al., 1989
Lake Chelan	Nov-86	Orchard drain 6	6	0-5	*nd*	1	*nd*	1	Patmont et al., 1989
Lake Chelan	Nov-86	Orchard drain 8	77	0-5	16	16	19	51	Patmont et al., 1989
Lake Chelan	Nov-86	Orchard drain 6	80	0-5	108	203	389	700	Patmont et al., 1989
Lake Chelan	Nov-86	Station 4	124	0-5	44	120	108	272	Patmont et al., 1989
Lake Chelan	Nov-86	Safety Harbor	2	0-5	*nd*	*nd*	*nd*	*nd*	Patmont et al., 1989
Lake Chelan	Nov-86	Station 6A	451	0-5	*nd*	8	3	11	Patmont et al., 1989
Lake Chelan	Nov-86	Urban drain 1	7	0-5	8	13	15	36	Patmont et al., 1989
Lake Chelan	1987	North of Fish Creek						*nd*	Patmont et al., 1989
Lake Chelan	1987	In Stehekin aluv. fan						*nd*	Patmont et al., 1989
Lake Chelan	1987	1 mile up Stehekin R						2	Patmont et al., 1989
Roses Lake	Jun-92	East End	7	0-2	48	670	770	1488	Serdar et al., 1994
Roses Lake	Jun-92	Outlet	9	0-2	77	890	790	1757	Serdar et al., 1994
Lake Chelan	Sep-94	Wapato Point		0-2	*nd*	8	12	20	Davis and Serdar, 1996
Wapato Lake	Aug-96	Lower Lake	17	0-2	27	470	650	1147	Johnson, 1997
Wapato Lake	Aug-96	Upper Lake	17	0-2	*nd*	160	230	390	Johnson, 1997
Wapato Lake	Jun-2002	East end			*nd*	*nd*	*nd*	*nd*	LCRD/Ecology sampling - not published
Wapato Lake	Jun-2002	Center			*nd*	35	36	71	LCRD/Ecology sampling - not published
Wapato Lake	Jun-2002	West end			*nd*	15	8	23	LCRD/Ecology sampling - not published
Roses Lake	Jun-2002	East end			39	29	14	82	LCRD/Ecology sampling - not published
Roses Lake	Jun-2002	Center			*nd*	48	22	70	LCRD/Ecology sampling - not published
Roses Lake	Jun-2002	West end			*nd*	12	19	31	LCRD/Ecology sampling - not published
Dry Lake	Jun-2002	East end			*nd*	49	55	104	LCRD/Ecology sampling - not published
Dry Lake	Jun-2002	Center			*nd*	68	44	112	LCRD/Ecology sampling - not published
Dry Lake	Jun-2002	West end			4	43	21	68	LCRD/Ecology sampling - not published

nd = not detected
tDDT = 4,4' -DDT + 4,4' -DDE + 4,4' -DDD

Table C3. Summary of DDT Data on Water from Lake Chelan and Tributaries (ng/L, part per trillion).

Sample Date	Waterbody	4,4'-DDT	4,4'-DDE	4,4'-DDD	tDDT	Reference
May-96	Knapp Coulee Creek (site G4)		**110**		**110**	CCCD report "Lake Chelan WQ Project 2000"
Jun-96	Unnamed drainway (site 3)		**110**		**110**	CCCD report "Lake Chelan WQ Project 2000"
Jul-97	Unnamed drainway (site 3)			**150**	**150**	CCCD report "Lake Chelan WQ Project 2000"
Jun-2002	Prince Ck - Sawtooth Wilderness	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Unnamed culvert discharge	**0.95**	**3.5**	0.21	**4.66**	Ecology preliminary sampling - not published
Jun-2002	Lake Chelan	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Purtteman Creek culvert	**4.8**	**8.6**	**1.9**	**15.3**	Ecology preliminary sampling - not published
Jun-2002	First Creek	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Stink Creek	0.24U	**1.2**	0.25	**1.45**	Ecology preliminary sampling - not published
Jun-2002	Wapato Lk + Joe Ck outflow	0.25U	0.35	0.17	0.52	Ecology preliminary sampling - not published
Jun-2002	Twentyfive Mile Creek	0.17U	0.17U	0.17U	0.17U	Ecology preliminary sampling - not published
Jun-2002	Railroad Creek	0.17U	0.17U	0.17U	0.17U	Ecology preliminary sampling - not published
Jun-2002	Fish Creek - At Moore Point	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
Jun-2002	Stehekin River	0.16U	0.16U	0.16U	0.16U	Ecology preliminary sampling - not published
WAC 173-201A - Acute					1100	
WAC 173-201A - Chronic 24 hour average					1.0	
National Toxics Rule (NTR) criteria		0.59	0.59	0.84		

U = not detected at the value shown
tDDT = 4,4' -DDT + 4,4' -DDE + 4,4' -DDD
Bolded values exceed one or more of the applicable criteria

Appendix D

Overview of Proposed Sampling

Table D1. Sampling Strategy Overview.

Sample Media	Sample Locations	Number of Sites	Sample Period	Number of Sample Events
Fish				
Lake Chelan:				
Lake trout	Wapato-Lucerne basins	-	May 2003	1
Kokanee	Wapato-Lucerne basins	-	Apr - Oct 2003	1
Rainbow trout	Wapato-Lucerne basins	-	Apr - Oct 2003	1
Burbot	Wapato-Lucerne basins	-	Apr - Oct 2003	1
Roses Lake:				
Rainbow trout	Whole lake	-	Apr - Oct 2003	1
Brown trout	Whole lake	-	Apr - Oct 2003	1
Black crappie	Whole lake	-	Apr - Oct 2003	1
Sediment				
Lake Chelan sediments:				
Tributaries	At major tributaries[1]	5	Apr - June 2003	1
Transect	Wapato basin[1]	10	Apr - June 2003	1
	Lucerne basin[1]	5	Apr - June 2003	1
Cores	Wapato basin[1]	1	Apr - June 2003	1
	Lucerne basin[1]	1	Apr - June 2003	1
Water				
Lake Chelan surface water:				
Tributary and drains	Wapato basin[2]	23	Rain events - 2003	3
	Lucerne basin[2]	5	Rain event - 2003	1
Lake Chelan	At the outlet[2]	1	Rain events - 2003	3
SPMDs:				
Lake Chelan	Wapato basin[2]	1	Apr-Jul-Oct 2003	3
	Lucerne basin[2]	1	Apr-Jul-Oct 2003	3

[1] = See Figure B2 in Appendix B for sediment sample locations
[2] = See Figure B3 in Appendix B for water sample locations

Appendix E

Proposed Sample Locations

Table E1. Surface Sediment Transect Station Target Coordinates for the Lake Chelan DDT/PCB TMDL.

Station	Latitude	Longitude
W-0.69	47.840443	-120.022238
W-1.89	47.841593	-120.048057
W-3.15	47.846405	-120.074159
W-4.41	47.853616	-120.099158
W-5.64	47.861656	-120.122601
W-6.86	47.865413	-120.147948
W-8.22	47.871646	-120.175585
W-9.31	47.882031	-120.193206
W-10.17	47.892558	-120.203148
W-11.08	47.905608	-120.205271
L-13.79	47.944482	-120.198011
L-18.53	47.998738	-120.244016
L-28.61	48.055403	-120.443631
L-40.62	48.200185	-120.566757
L-47.00	48.273448	-120.633751

See Figure B2 in Appendix B for station locations.

Table E2. Sediment Core Station Target Coordinates for the Lake Chelan DDT/PCB TMDL.

Station	Site ID	Latitude	Longitude
Wapato basin	WB01	47.885425	-120.192352
Lucerne basin	LB02	48.190782	-120.547175

See Figure B2 in Appendix B for station locations.

Table E3. Water Sample Station Target Coordinates for the Lake Chelan DDT/PCB TMDL.

Station Description	Site ID	Latitude	Longitude
First Creek at the campground	SS01	47.874246	-120.199473
Knapp Coulee on Highway 971	SS02	47.843909	-120.101018
South Shore Orchard Drain on Alt 97	SS03	47.837800	-120.080465
Stamps property, CCCD site 3	SS04	47.835712	-120.073691
Stamps property, CCCD site 2	SS05	47.835717	-120.073837
Culvert on Alt 97, CCCD site 1	SS06	47.835850	-120.069911
At Forest Service Office	DT07	47.837521	-120.022687
At Chelan River boat ramp	DT08	47.835282	-120.015195
In Chelan River near the outlet	DT09	47.835456	-120.013956
At Campbell's Resort Bridge	DT10	47.840019	-120.019079
At City Park boat ramp	DT11	47.841690	-120.022971
Just West of Chelan Shores	NS12	47.856962	-120.061862
Culvert east of Crystal View (at pink house)	NS13	47.859403	-120.066621
Across from the Crystal View development	NS14	47.859509	-120.070551
Purtteman Creek on Highway 150	NS15	47.863432	-120.086401
At Veroske's on Highway 150	NS16	47.864302	-120.092155
At Groh's house, station 8 in LCRD report	NS17	47.876947	-120.114204
The Cooper drainage	NS18	47.880429	-120.112628
Bennett Road manhole	NS19	47.878404	-120.118159
Below Manson Fire Station	NS20	47.886025	-120.161644
Keupkin Street manhole	NS21	47.889331	-120.171870
Buck Orchards	NS22	47.892453	-120.179734
Wapato Lake plus Joe Creek	NS23	47.924685	-120.176905
Stink Creek at discharge	NS24	47.930003	-120.192653
Twentyfive Mile Creek at the campground	LU25	47.992922	-120.261006
Prince Creek at discharge	LU26	48.147492	-120.497094
Railroad Creek at the bridge	LU27	48.201287	-120.593440
Fish Creek at discharge	LU28	48.237487	-120.613903
Stehekin River at discharge	LU29	48.317922	-120.675571

See Figure B3 in Appendix B for station locations.

Table E4. SPMD Sample Station Target Coordinates for the Lake Chelan DDT/PCB TMDL.

Station Description	Site ID	Latitude	Longitude
Wapato basin	SPMD01W	47.877292	-120.172987
Lucerne basin	SPMD02L	47.111553	-120.500159

See Figure B3 in Appendix B for station locations.

Appendix F

Manchester Environmental Laboratory SOPs for EPA Methods

Manchester Environmental Laboratory SOPs for EPA Methods

Manchester SOP Number	EPA Method SW-846 Number
Pest/PCB Water extraction 730084	3510 (modified*)
Pest/PCB sediment extraction by Soxhlet extraction 730012	3540
Pest/PCB tissue extraction 730072	3540 (modified)
Pest/PCB sediment extraction by accelerated solvent extraction (ASE) 730081	3545
Macro Florisil Clean-up procedure (waters and sediments) 730018	3620
Macro Florisil Clean-up procedure and acetonitrile back extraction for tissue 730073	3620 (modified)
Micro Florisil Clean-up procedure for PCBs and some Pesticides in process	3620
Concentrated Sulfuric acid clean-up part of 730002	3665
Mercury clean-up Part of 730002	3660 (modified)
Pesticide analysis by GC-ECD / PCB analysis by GC-ECD 730002	8081/8082
Determination of Percent Lipids 730009	(Reference EPA 608.5 method)

* "modified" indicates the SOP incorporates substantial changes to the EPA method

Appendix G

Detailed Cost Estimate for Laboratory Services

Table G1. Estimated Laboratory Cost for the Lake Chelan DDT/PCB TMDL.

		Number of Samples	Number of QA Samples	Sample Total	Cost Per Sample	Total Sample Cost	Contracting Fee (25%)	FY03 $	FY04 $
DDT analogs	fish tissue	46	4	50	287	14350			14350
PCB Aroclors	fish tissue	40	4	44	287	12628			12628
PCB Congeners	fish tissue	4	-	4	650	2600	650		3250
Percent Lipid	fish tissue	46	4	50	31	1550			1550
Dioxins	fish tissue	8	1	9	1100	9900	2475	12375	
DDT analogs	sediment/cores	50	3	53	203	10759		10759	
PCB Aroclors	sediment/cores	50	3	53	203	10759		10759	
TOC	sediment/cores	50	3	53	39	2067		2067	
Grain size	sediment	20	2	22	90	1980	495	2475	
^{210}Pb	cores	10	-	10	60	600	150	750	
^{137}Cs	cores	10	-	10	60	600	150	750	
Total Lead	cores	10	-	10	44	440		440	
DDT analogs	whole water	77	4	81	159	12879		12879	
TOC	whole water	89	3	92	31	2852		2852	
TSS	whole water	74	3	77	10	770		770	
Turbidity	whole water	89	3	92	9	828		828	
DDT analogs	SPMD extract	6	4	10	450	4500	1125	1688	3937
PCB Aroclors	SPMD extract	6	4	10					
DDT analogs	SPMD analysis	6	4	10	159	1590		477	1113
PCB Aroclors	SPMD analysis	6	4	10	159	1590		477	1113
PCB Congeners	SPMD analysis	3	-	3	650	1950	488	813	1625
						Total Cost FY03		61,159	
						Total Cost FY04			39,566
						Total Projected Cost of Laboratory Services		100,725	