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A Total Maximum Daily Load Evaluation for Chlorinated Pesticides and PCBs in the Walla Walla River

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A Total Maximum Daily Load Evaluation for Chlorinated Pesticides and PCBs in the Walla Walla River

by
Art Johnson, Brandee Era-Miller, Randy Coots, and Steve Golding

Environmental Assessment Program
Olympia, Washington 98504-7710

October 2004

1998 303(d) listings addressed in this report:

Walla Walla River, Waterbody No. WA-32-1010
4,4'-DDE, 4,4'-DDD, dieldrin, heptachlor epoxide,
hexachlorobenzene, chlordane, and PCB-1260

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Acronyms and Abbreviations

BAF	bioaccumulation factor
BCF	bioconcentration factor
CFS	cubic feet per second
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DDD	dichlorodiphenyl dichloroethane
DDE	dichlorodiphenyl dichloroethylene
DDT	dichlorodiphenyl trichloroethylene
DOC	dissolved organic carbon
EST	Environmental Sampling Technologies
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GC-ECD	gas chromatography – electron capture detection
GC-MS	gas chromatography – mass spectrometry
GPC	gel permeation chromatography
GPS	global positioning system
MGD	million gallons per day
NPDES	National Pollution Discharge Elimination System
NTR	National Toxics Rule
NTU	nephelometric turbidity units
PCB	polychlorinated biphenyl
PRC	performance reference compound
QA/QC	quality assurance/quality control
RPD	relative percent difference
SPMD	semipermeable membrane device
TOC	total organic carbon
TMDL	total maximum daily load
TSS	total suspended solids
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOH	Washington State Department of Health
WWTP	wastewater treatment plant
USGS	U.S. Geological Survey
mg/L	milligrams per liter (parts per million)
ug/L	micrograms per liter (parts per billion)
ng/L	nanograms per liter (parts per trillion)
ug/Kg	micrograms per kilogram (parts per billion)

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Abstract

The state of Washington placed the Walla Walla River on the 1996 303(d) list as being water quality limited for 4,4'-DDE, 4,4'-DDD, dieldrin, chlordane, hexachlorobenzene, heptachlor epoxide, and PCB-1260 in edible fish tissue. The U.S. Environmental Protection Agency requires the states to set priorities for cleaning up 303(d) listed waters and to establish a Total Maximum Daily Load (TMDL) for each. A TMDL entails an analysis of how much of a pollutant load a waterbody can assimilate without violating water quality standards.

This report presents results of a field study that forms the basis for a TMDL evaluation of these chlorinated pesticides/breakdown products and PCBs in the Walla Walla River drainage. The following TMDL elements are addressed: scope, applicable water quality standards, numerical targets, loading capacity, wasteload and load allocations, margin of safety, seasonal variation, and monitoring plan.

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Summary

Background

In 1996 the Walla Walla River was 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, 4,4'-DDD, dieldrin, chlordane, hexachlorobenzene, heptachlor epoxide, and PCB-1260 in edible fish tissue. These chlorinated pesticides/breakdown products and polychlorinated biphenyls (PCBs) are no longer used in the United States, having been banned in the 1970s and 1980s.

EPA requires the states to set priorities for cleaning up 303(d) listed waters and to establish a Total Maximum Daily Load (TMDL) for each. A TMDL entails an analysis of how much of a pollutant load a waterbody can assimilate without violating water quality standards.
This report presents results of a TMDL evaluation for the above mentioned chemicals in the Walla Walla River drainage. The evaluation is based on a field study where water, fish tissue, and wastewater treatment plant effluents were monitored by the Washington State Department of Ecology from May 2002 through September 2003.

The Walla Walla River is located in the southeast corner of Washington and extends 61 miles from its headwaters in Oregon to its confluence with the Columbia River. Approximately two-thirds of the drainage basin and the last 40 miles of the mainstem lie within Washington. The major cities are Walla Walla and College Place, with a combined population of less than 40,000. Dryland and irrigated agriculture are the predominant land uses. Cultivation has been a major cause of soil erosion in the basin, and erosion of agricultural soils is the main route by which chlorinated pesticides reach surface waters.

Results of Field Study

Results from water sampling showed the highest average total DDT[1], chlordane, and dieldrin concentrations were in Yellowhawk Creek, 3.7, 2.7, and 3.8 ng/L, respectively (parts per trillion, dissolved). Dry Creek had the highest concentrations of hexachlorobenzene and heptachlor epoxide, averaging 1.5 and 0.6 ng/L. Relatively large amounts of toxaphene were detected in Pine Creek, where concentrations up to approximately 40 ng/L were found. Creeks in the urbanized Mill Creek watershed had higher PCB concentrations than those that drained farming areas. The maximum total PCB concentrations, 0.77 – 9.2 ng/L, were measured in Garrison Creek. Lower Mill Creek and Yellowhawk Creek had the second highest PCB levels, 0.54 – 1.1 ng/L. Upper Mill Creek, the upper Walla Walla River at the state line, and the Touchet River consistently had the lowest concentrations of both pesticides and PCBs.

Water sampling was done primarily on a quarterly basis: May-June, August-September, and November-December of 2002 and February-March of 2003. In the mainstem Walla Walla

[1] DDT + breakdown products DDE and DDD

River, the highest pesticide concentrations always occurred during May-June; the lowest concentrations almost always occurred in November-December. February-March generally saw the second highest levels. The highest PCB concentrations were similarly recorded in May-June and February-March. Runoff in the basin is greatest during January through June, which is the likely reason for higher concentrations during this period.

Pesticides and PCBs increased substantially in the Walla Walla mainstem between the Oregon border and middle river (at Detour Road), generally by factors of 2-to-4. Except for toxaphene, concentrations generally decreased in the lower Walla Walla River (below Cummins Bridge). The reduced lower river concentrations are largely attributable to dilution by the Touchet River.

The Washington State human health water quality criteria that apply to chlorinated pesticides and PCBs in the Walla Walla River are for a one in one million (10^{-6}) increased lifetime cancer risk from fish consumption. The criteria for total DDT and dieldrin were chronically exceeded in the Walla Walla drainage. The exceedances primarily occurred in and downstream of Yellowhawk Creek. Toxaphene commonly exceeded the criteria in Pine Creek and downstream in the lower Walla Walla River. Total chlordane exceedances were scattered throughout the drainage. There were relatively few exceedances for heptachlor epoxide and fewer yet for hexachlorobenzene, these being mostly restricted to lower parts of the drainage. PCB detection limits in some samples were not low enough to compare to the human health criterion. However, in every instance where PCB concentrations could be unambiguously quantified, the criterion was exceeded.

Exceedances of the less restrictive aquatic life criteria were primarily limited to total DDT and were for chronic rather than acute exposure. Except for Yellowhawk Creek, the exceedances were almost entirely restricted to the May-June period.

Fish sampling was limited to resident mainstem species, with upper river fish being analyzed separately from lower river fish. Over 120 smallmouth bass, channel catfish, carp, bridgelip suckers, and northern pike minnow were collected for the study. Fillets and a few whole fish samples were analyzed. The Washington State Department of Health is analyzing the data to determine if a fish advisory is warranted.

In the fillet samples, DDT compounds were present in the highest concentrations, followed by PCBs/toxaphene, total chlordane, dieldrin, hexachlorobenzene, and heptachlor epoxide, in that order. The relative amounts of these compounds generally mirrored what was found in the mainstem water column. Average concentrations of total DDT in fillets ranged from 30 – 657 ug/Kg (parts per billion, wet weight) depending on the species. Total PCB and toxaphene concentrations averaged 8.9 – 238 ug/Kg and 16 – 56 ug/Kg, respectively. Average total chlordane concentrations were 2.7 – 19 ug/Kg. Dieldrin, hexachlorobenzene, and heptachlor epoxide concentrations were 2.1 ug/Kg or less.

The highest pesticide and PCB concentrations were in carp, while the lowest were in smallmouth bass. Upper river fish tended to have higher concentrations of total DDT, total PCBs, total chlordane, and dieldrin, but lower concentrations of toxaphene and hexachlorobenzene, which is consistent with the location of major sources. Whole fish samples had higher concentrations than fillets.

Water Quality Targets

Historical application of chlorinated pesticides to soils and crops is the primary source of river and stream contamination in agricultural areas like the Walla Walla basin. Because chlorinated pesticides bind strongly to soil particles, the key to meeting pesticide standards in the Walla Walla River and its tributaries is to reduce the amount of soil entering these waterbodies.

Total suspended solids (TSS) and turbidity are proposed as water quality indicators and surrogate numerical targets for chlorinated pesticides in the Walla Walla River. Setting water quality targets based on TSS and turbidity has the advantage of translating more directly into land use practices and being easier and less expensive to monitor than trace chemical concentrations. Additionally, TSS and turbidity levels in rivers and streams have a direct and quantifiable effect on the health of fish and other aquatic organisms as well as aesthetic values.

Based on an analysis of data from the field study and other information, the following numerical water quality targets are recommended for the Walla Walla River drainage, except for the East Little Walla Walla River and Yellowhawk Creek:

TSS Target	Turbidity Target	Effect of Meeting the Target
50 mg/L	24 NTU	• achieves compliance with human health water quality criteria for chlorinated pesticides • protects average fish consumers among the general public • provides a moderate level of habitat protection
30 mg/L	15 NTU	• achieves compliance with the Class A turbidity standard
5 mg/L	3 NTU	• protects average tribal fish consumers • provides a high level of habitat protection
2 mg/L	1 NTU	• protects high fish consumers among the general public
1 mg/L	<1 NTU	• protects high fish consumers among tribal members

The following targets are recommended specifically for the East Little Walla Walla River and Yellowhawk Creek:

TSS Target	Turbidity Target	Effect of Meeting the Target
30 mg/L	15 NTU	• achieves compliance with the Class A turbidity standard (for mainstem Walla Walla) • provides a moderate level of habitat protection
15 mg/L (Yellowhawk Creek)	8 NTU (Yellowhawk Creek)	• achieves compliance with the Class A turbidity standard (for Mill Creek drainage)
5 mg/L	3 NTU	• achieves compliance with human health water quality criteria for chlorinated pesticides • protects average fish consumers among the general public • provides a high level of habitat protection
Targets to protect high fish consumers among the general public and tribal consumers to be developed at a later date.		

Because of the difficulty inherent in measuring low levels of PCBs in surface waters, TSS and turbidity targets could not be derived specifically for PCBs in the Walla Walla River. PCBs also have a strong affinity for soil particles and atmospheric deposition is the likely major source to agricultural land. Therefore, meeting the TSS/turbidity targets in the Walla Walla drainage will reduce PCB concentrations in the river and its tributaries. Improving agricultural practices may not be sufficient to achieve water quality standards for PCBs in the urbanized Mill Creek watershed, and additional steps will likely be required.

It is recommended that the water quality targets be applied to the Walla Walla River at the state line and at the mouths of all mainstem tributaries in Washington. A phased approach should be adopted for meeting the targets, starting with the 30 mg/L:15 NTU target in the East Little Walla Walla River and Yellowhawk Creek, and the 50 mg/L:24 NTU target in other parts of the drainage. The targets should be applied directly to all irrigation returns at the point they enter the mainstem or tributaries. The 2 mg/L:1 NTU and 1 mg/L:<1 NTU targets imply exceptional water quality and will be difficult to achieve in an agricultural basin. Because there is substantial uncertainty in the accuracy of these values they should be re-assessed once the more easily achieved targets are met. The goal of any future reassessment of these targets should be to return the river to conditions consistent with treaty rights of the Consolidated Tribes of the Umatilla Indian Reservation.

The report includes a brief summary showing the progress that has been achieved in meeting similar water quality targets in the lower Yakima River TMDL.

Critical Season and Loading Capacity

The critical season for TSS loading in the Walla Walla drainage was identified by examining the historical lower river data. The record shows the 50 mg/L TSS target is routinely exceeded from January through June but rarely exceeded during July – December. Therefore January – June is considered to be the critical period. This is the same time frame when the highest pesticide and PCB levels occur in the surface waters.

Estimated TSS loads during critical season flows were compared to loads at the TSS targets, i.e., the loading capacity. The 90^{th} percentile flow was used to assess loading capacity. At the 90^{th} percentile, TSS concentrations would be expected to exceed loading capacity no more than 10% of the time. Estimates were provided of the reductions in TSS loading needed to meet water quality targets in the mainstem Walla Walla River and tributaries. The load reductions that appear to be needed in the mainstem lower river can be summarized as follows:

Estimates of Loading Reductions Needed in the Mainstem Lower Walla Walla River To Meet Water Quality Targets for TSS			
Time Period	@ 50mg/L TSS Target	@ 30 mg/L TSS Target	@ 5 mg/L TSS Target
January - June	74%	84%	97%
July - December	0%	20%	86%

The calculations indicate that no load reductions would be needed in Oregon in order for the Walla Walla River to meet either the 50 mg/L or 30 mg/L targets at the state line. TSS reductions on the Oregon side do appear to be called for to meet the 5 mg/L target. Under this scenario, very large TSS reductions would be needed basin-wide in both Washington and Oregon.

The report notes results of a recent study of soil erosion in the Walla Walla basin conducted by Economic and Engineering Services Inc. They conclude that “total sediment loading can be reduced by 85% by using no-till practices instead of historical cropping practices involving significant tillage operations.” Thus, the present estimates of TSS load reductions needed to meet the 50 mg/L and 30 mg/L TSS targets appear to be achievable using established agricultural practices.

The Walla Walla and College Place wastewater treatment plants (WWTP) were evaluated as sources of chlorinated pesticides, PCBs, and TSS to Mill and Garrison creeks, respectively, where they discharge. The only compounds consistently detected in the final effluents were DDE, chlordane, and PCBs. Without further dilution, total PCB concentrations exceeded the human health criterion at both facilities. However, a comparison of loading estimates suggests that the WWTPs represent less than 10% of the PCB load in the receiving waters and thus are insignificant relative to nonpoint sources and background in these watersheds. TSS concentrations in the effluents are limited through their NPDES permits. Discharge monitoring reports on file with Ecology show these facilities are not significant TSS sources.

Load Allocation

A TMDL must identify the total allowed pollutant amount and its components: appropriate wasteload allocations for point sources and load allocations for nonpoint sources and natural background. In this TMDL evaluation, TSS is proposed as a surrogate measure for chlorinated pesticides. Equivalent targets are provided for turbidity. Achieving the TSS/turbidity targets also addresses the PCB listings in the drainage. Because of the existence of both point and nonpoint sources of PCBs in the Mill Creek watershed, specific PCB allocations were proposed for Mill and Garrison creeks.

The proposed load allocations for TSS in the upper and lower mainstem Walla Walla River are shown below. These allocations are for the critical January through June period.

Location	TSS Load Allocation (pounds per day)		
	@ 50 mg/L TSS	@ 30 mg/L TSS	@ 5 mg/L TSS
Upper Walla Walla River @ Peppers Bridge	120,000	69,000	12,000
Lower Walla Walla River @ Cummins Bridge	450,000	270,000	45,000

As previously discussed, the relationship between pesticides and TSS levels in the river can be expected to change as erosion of agricultural soils is brought under control. For this reason, and because of acknowledged uncertainties in the analysis, TSS load allocations are not proposed for the 2 mg/L and 1 mg/L targets at this time.

This TMDL evaluation did not attempt to differentiate between TSS loading from point sources, nonpoint sources, and background in Oregon. No significant TSS point sources to the Walla Walla River are present or anticipated in Oregon. Therefore wasteload allocations are zero. The entire TSS loading capacity of the Walla Walla River at the state line is allocated to nonpoint sources and background in Oregon. The river's loading allocation at the state line for the initial 50 mg/L TSS target is 120,000 pounds per day.

No significant point sources of TSS are present or anticipated in the Washington portion of the Walla Walla watershed. Wasteload allocations are therefore zero, with the exception of the Walla Walla and College Place WWTPs. Adjustments to the NPDES permits for these WWTPs are not necessary at this time, and TSS allocations should be consistent with permit load limits.

This evaluation did not attempt to differentiate between TSS loading from nonpoint sources and background in Washington. Therefore, 100% of the TSS loading capacity is allocated to nonpoint sources and background. The loading allocation of the lower Walla Walla River for the initial 50 mg/L target is 450,000 pounds per day. Nonpoint and background sources in Oregon contribute an unknown part of the TSS load to the East Little Walla Walla River, West Little Walla Walla River, Pine Creek, and Mud Creek via their upper watersheds.

Wasteload and load allocations were assigned for PCBs in Garrison Creek and Mill Creek in light of the levels detected in the College Place and Walla Walla WWTP effluents. The WWTP wasteload was calculated as the product of the human health water quality criterion and the NPDES permit limit for the average monthly effluent flow. The remaining loading capacity of these streams was allocated to nonpoint sources. (There is no natural background for PCBs).

Wasteload and Load Allocations for PCBs (gm/day)	Garrison Creek	Mill Creek
Wasteload Allocation for WWTP	0.0011	0.0062
Load Allocation for Nonpoint	0.0017	0.023
Loading Capacity	0.0028	0.029

Compliance Schedule

In the TMDL process, a flexible schedule is allowed for compliance with water quality targets since nonpoint source implementation is not an exact science. Interim targets are compared to monitoring data at regular intervals after best management practices, education programs, and other parts of the implementation strategy have been initiated. As the targets and data are compared, the progress toward improved water quality conditions is assessed, and adjustments or changes in the TMDL strategy are publicly discussed. The goal is to find practical and effective solutions to eliminate the water pollution problems addressed in the TMDL. A separate TMDL submittal report to EPA will have dates for meeting interim water quality targets, using input from a TMDL advisory group.

Safety Margin / Monitoring Plan / Follow-up Work

The report concludes with a discussion of safety margins and uncertainties in the TMDL evaluation. A plan is also outlined for TMDL effectiveness monitoring. Finally, follow-up work is suggested in three areas: 1) sediment sampling in the Columbia River backwater in the lower Walla Walla River to assess their potential as a source of pesticides/PCBs to fish, to evaluate ecological risk, and to estimate time to recovery as upstream water quality targets are achieved; 2) source identification for PCBs in the Mill Creek watershed; and 3) sampling to identify toxaphene sources in Pine Creek.

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Introduction

In 1996 the Walla Walla River was listed by the state of Washington under Section 303(d) of the Clean Water Act for non-attainment of the U.S. Environmental Protection Agency (EPA) human health criteria for 4,4'-DDE, 4,4'-DDD, dieldrin, chlordane, hexachlorobenzene, heptachlor epoxide, and PCB-1260 in edible fish tissue.[2] The listings are based on sampling done by the Washington State Department of Ecology (Ecology) in 1993 (Davis et al., 1995). The 1996 303(d) listings were maintained on the 1998 and draft 2002/2004 lists (Table 1). Garrison Creek, a Walla Walla tributary, was also proposed for listing in 2002/2004 due to human health exceedances for DDT compounds and hexachlorobenzene in water samples (White et al., 1998.)

These chlorinated pesticides/breakdown products and polychlorinated biphenyls (PCBs) are no longer used in the United States, having been banned in the 1970s and 1980s for ecological concerns. They are now classed as probable human carcinogens by EPA. Detailed profiles including use, regulations, environmental occurrence, and health effects have been prepared by the Agency for Toxic Substances and Disease Registry and are available at http://www.atsdr.cdc.gov/toxpro2.html.

EPA requires the states to set priorities for cleaning up 303(d) listed waters and to establish a Total Maximum Daily Load (TMDL) for each. A TMDL entails an analysis of how much of a pollutant load a waterbody can assimilate without violating water quality standards.

This report presents results of a field study that monitored levels of the above-mentioned pesticides and PCBs in the Walla Walla drainage during May 2002 through September 2003. The study, conducted by Ecology, forms the basis for a TMDL evaluation in which water quality targets are proposed for meeting human health criteria and addressing other water quality concerns in the Walla Walla River. The report includes the following TMDL elements required by EPA Region 10:

- scope of the TMDL
- applicable water quality standards
- numerical targets
- loading capacity
- wasteload and load allocations
- margin of safety
- seasonal variation
- monitoring plan

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[2] The 1996 and 1998 303(d) listings for fish tissue in the Walla Walla River mistakenly include a heptachlor listing in place of heptachlor epoxide, and 4,4'-DDT was mistakenly entered in place of 4,4'-DDD. The proposed 2002/2004 list for the Walla Walla River has been corrected to include 4,4'-DDD in fish tissue.

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Table 1. Walla Walla Subbasin (WRIA 32) Toxics Listings (proposed 2002/2004 list information downloaded 5/13/04).

Waterbody	Parameter	Medium	Township Range Section	Water Course #/ Grid #	Lower Route #	1996 List	1998 List	2002/ 2004 List	Listing Basis
Walla Walla River (Old ID# WA-32-1010)	4,4'-DDE	Tissue	07N 31E 25	QE90PI	4.081	Yes	Yes	Yes	Davis et al., 1995, excursions beyond the criterion in edible carp tissue near the mouth in 1993.
Walla Walla River (Old ID# WA-32-1010)	Chlordane	Tissue	07N 31E 25	QE90PI	4.081	Yes	Yes	Yes	Davis et al., 1995, excursions beyond the criterion in edible carp tissue near the mouth in 1993.
Walla Walla River (Old ID# WA-32-1010)	Dieldrin	Tissue	07N 31E 25	QE90PI	4.081	Yes	Yes	Yes	Davis et al., 1995, excursions beyond the criterion in edible carp tissue near the mouth in 1993.
Walla Walla River (Old ID# WA-32-1010)	Heptachlor epoxide	Tissue	07N 31E 25	QE90PI	4.081	Yes	Yes	Yes	Davis et al., 1995, excursions beyond the criterion in edible carp tissue near the mouth in 1993.
Walla Walla River (Old ID# WA-32-1010)	Hexachloro-benzene	Tissue	07N 31E 25	QE90PI	4.081	Yes	Yes	Yes	Davis et al., 1995, excursions beyond the criterion in edible carp tissue near the mouth in 1993.
Walla Walla River (Old ID# WA-32-1010)	Total PCBs	Tissue	07N 31E 25	QE90PI	4.081	Yes	Yes	Yes	Davis et al., 1995, excursions beyond the criterion in edible carp tissue near the mouth in 1993.
Walla Walla River	4,4'-DDE	Tissue	07N 32E 35	QE90PI	21.03	No	No	Yes	Hopkins et al., 1985, excursions beyond the criterion in a multiple fish composite of edible tissue collected in 1984.
Garrison Creek	Total DDT	Water	06N 35E 3	DH35GB	0.66	No	No	Yes	White et al., 1998, excursions beyond the criterion at stations GU2 and GD2 collected in 1996.
Garrison Creek	Hexachloro-benzene	Water	06N 35E 3	DH35GB	0.66	No	No	Yes	White et al., 1998, excursions beyond the criterion at stations GU2 and GD2 collected in 1996.

Scope of the TMDL

Geographic

This TMDL evaluation covers that portion of the Walla Walla River from the Washington-Oregon border at river mile (r.m.) 40.0 to the river's confluence with the Columbia River, including its Washington tributaries (Water Resource Inventory Area 32).

303(d) Listings

This TMDL specifically addresses each of the 303(d) listings in Table 1. Although not one of the contaminants on the 303(d) list, toxaphene is also addressed in this evaluation based on findings from the field study which indicate it to be a significant source of impairment.

A turbidity listing has been proposed for the Touchet River in 2002/2004. Although turbidity is factored into the numerical targets proposed in the present report, this study does not constitute a TMDL for turbidity in the Touchet River.

Pollutant Parameters

This TMDL is for the following chemicals in the water column and fish tissue:

- 4,4'-DDT
- 4,4'-DDE (DDT breakdown product)
- 4,4'-DDD (DDT breakdown product)
- dieldrin
- heptachlor epoxide (heptachlor breakdown product)
- hexachlorobenzene
- *cis* and *trans* chlordane
- *cis* and *trans* nonachlor (chlordane constituents)
- oxychlordane (chlordane breakdown product)
- toxaphene
- PCBs

Basin Description

The Walla Walla River is located in the southeast corner of Washington State (Figure 1). The river extends 61 miles from its headwaters in Oregon to its confluence with the Columbia River. The drainage basin covers approximately 1,760 square-miles. Approximately three-quarters (73%) of the drainage and the last 40 miles of the mainstem lie within Washington. In downstream order, the major Washington tributaries are Yellowhawk Creek, Garrison Creek, Mill Creek, Dry Creek, Pine Creek, and the Touchet River. Minor tributaries, also in downstream order, include the East Little Walla Walla River, West Little Walla Walla River, Stone Creek, Mud Creek, and Gardena Creek.

Mill Creek flows from Class AA municipal watershed conditions in the Blue Mountains. Most of the city of Walla Walla's drinking water comes from a 36 square-mile protected portion of upper Mill Creek. Below the waterworks, part of its flow is diverted to Yellowhawk and Garrison creeks from May through October for irrigation purposes.

The two major permitted discharges in the basin are the Walla Walla Wastewater Treatment Plant (WWTP) which discharges to Mill Creek at r.m. 5.4 and the College Place WWTP which discharges to Garrison Creek at r.m. 1.0. Yellowhawk, Garrison, and Mill creeks enter the Walla Walla River between r.m. 37.9 and 33.6. The drainage area of the greater Mill Creek watershed is 96 square-miles.

Dry Creek flows into the Walla Walla approximately five miles below Mill Creek. It has a 246 square-mile basin with elevations ranging from 4,600 feet in the Blue Mountains to 450 feet at its Walla Walla confluence near Lowden (r.m. 27.2). Dry Creek's watershed is mainly used for dryland wheat, with only sparse forests in the headwaters.

The Pine Creek confluence is approximately 4 miles below Dry Creek (r.m. 23.4). Its watershed is 170 square-miles, the upper portion of which is in Oregon.

The Touchet River is the largest Walla Walla tributary. It originates in four forks deep in forested areas of the Blue Mountains at an elevation of 6,000 feet. The Touchet flows through the small towns of Dayton, Waitsburg, and Prescott, reaching the Walla Walla at r.m. 21.6 near the town of Touchet, elevation 469 feet. The basin area is 747 square-miles. Land use from Dayton to the Walla Walla confluence is mostly agricultural.

The Walla Walla basin has few urban areas. The major cities are Walla Walla and College Place, with a combined population of less than 40,000. Starting as early as the 1920s the principal form of land use was production of small grains, such as wheat and alfalfa, and row crops (Mapes, 1969). By the 1970s nearly 90% of the Washington portion of the basin had been cultivated. Currently, wheat, alfalfa seed and hay, and peas are the largest percentage of the irrigated crops. Other crops include onions, grapes, apples, asparagus, and barley. Figure 2 shows land use patterns as of the late 1980s/early 1990s.

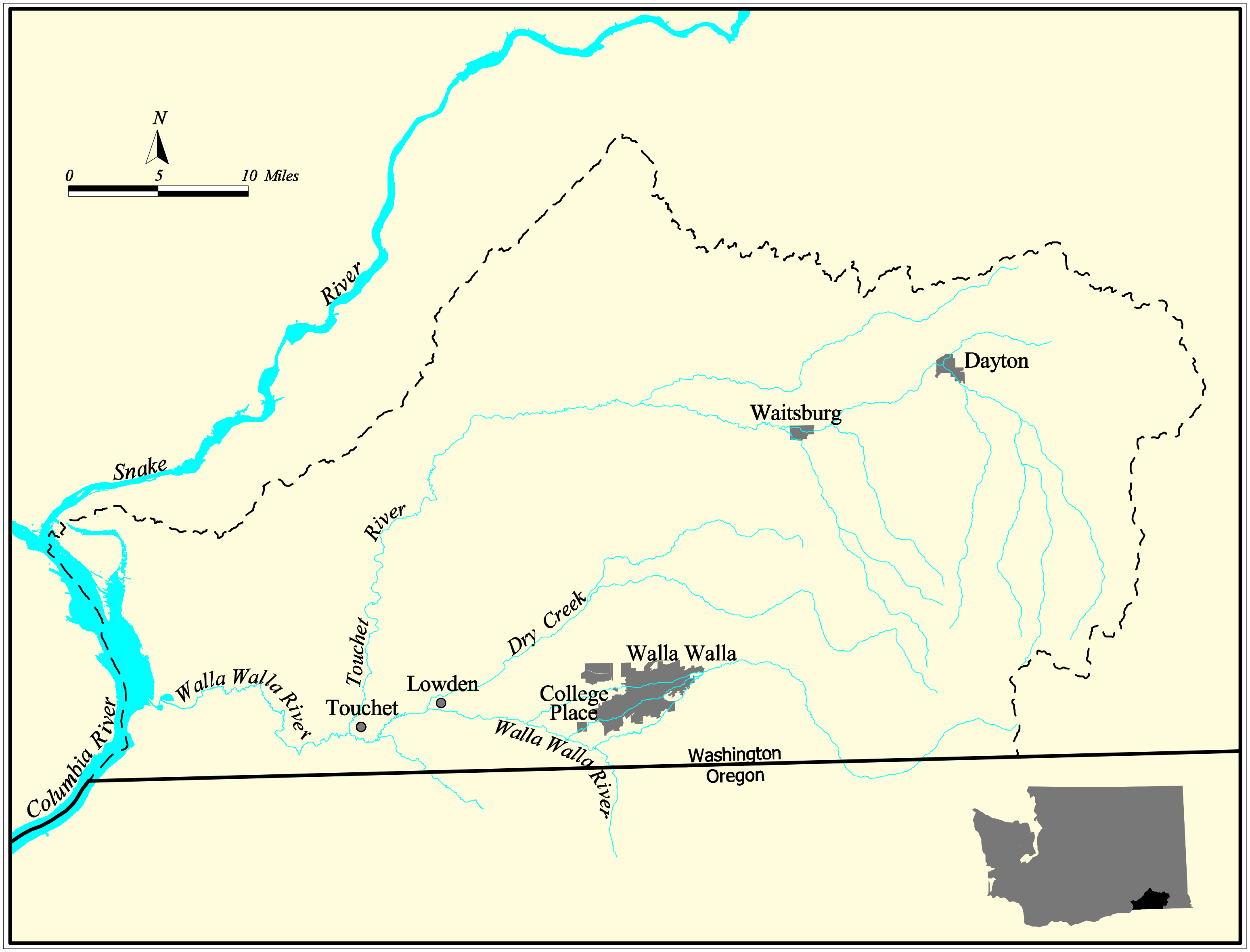

Figure 1. Walla Walla River Basin.

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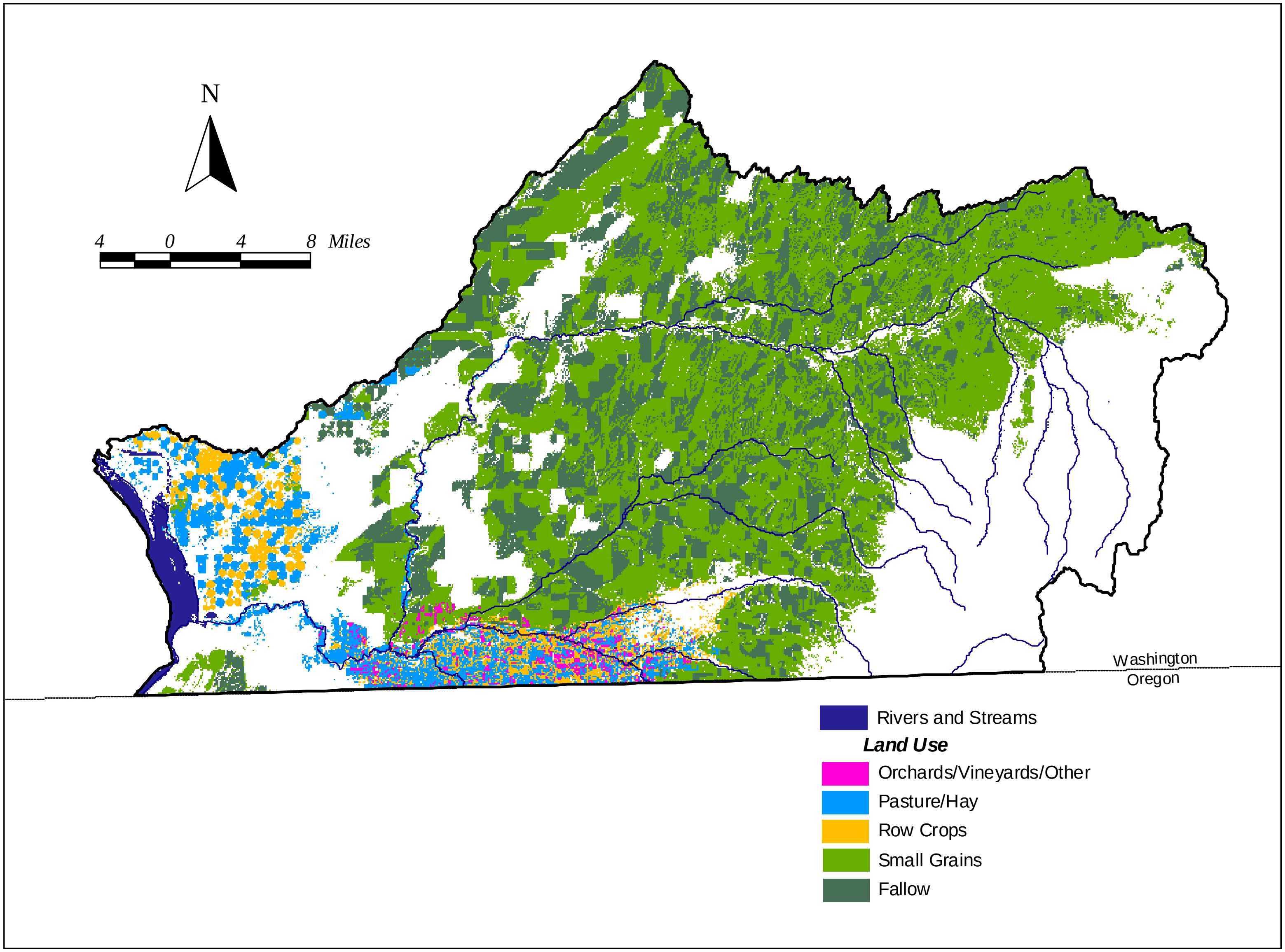

Figure 2. Land Use in the Walla Walla Basin, 1986-1996 data

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Cultivation has been a major cause of soil erosion in the Walla Walla basin, and erosion of agricultural soils is the primary route by which chlorinated pesticides reach surface waters. Studies conducted in the 1960s showed yields of suspended sediment were greatest in the highly cultivated Touchet River and Dry Creek drainage basins, which were contributing up to 80% of the total sediment load to the Walla Walla River (Mapes, 1969). Soils in these two drainages consist of well-drained silty loams and very fine sandy loams that are highly susceptible to erosion from runoff.

Silt predominates in the suspended sediment transported by basin streams. Within the TMDL study area, bedload is only about 2 – 8% of the suspended load (Mapes, 1969). Sediment deposition in the mainstem occurs primarily in the lower ten miles of the river, due to backwater effects from McNary Dam on the Columbia River. Otherwise, the river bed is mostly gravel and cobble.

A recent report by Economic and Engineering Services Inc. has concluded that erosion of fine sediment is a serious problem in the lower Walla Walla basin (EES, 2003). Stream segments with poor salmonid habitat ratings due to sediment or with sediment concentrations listed as a key water quality concern include the Walla Walla River (state line to the mouth), Yellowhawk Creek, Dry Creek, and the Touchet River (Kuttel et al., 2001; Saul et al., 2001).

EES identified a number of sources of sediment including road-building and logging activities in the upper reaches of tributaries, recreational vehicle use, and urban runoff. They concluded, however, that "given the predominance of agricultural land use in the watershed, agricultural practices have been identified as the principal source of fine sediment".

The irrigation season in the Walla Walla basin generally extends from mid-April to mid-October. The majority of runoff and erosion occurs from precipitation in winter through early spring, sustained through June by snow melt. Precipitation varies dramatically with elevation. Near the mouth of the river, there is less than 10 inches of rainfall annually. Precipitation increases with elevation to a maximum of over 40 inches annually in the headwaters, most falling as snow.

The typical flow pattern in the Walla Walla and its tributaries is illustrated in Figure 3. Groundwater springs supply baseflow to surface waters year-round. Infrequent storm events during the winter months sometimes cause severe flooding from heavy rainfall and rapid snowmelt that contribute the highest concentrations of suspended sediments (Mapes, 1969).

Rivers and streams in the basin experience greatly reduced flows in the summer from a combination of reduced supply and diversion for irrigation. The Walla Walla River has gone dry at the Oregon border, and lower Mill and Pine creeks have little or no flow during the late summer. Dewatering has also been a problem in the lower Touchet. Conditions have improved recently as a result of farmers diverting less water in response to bull trout endangered species listings.

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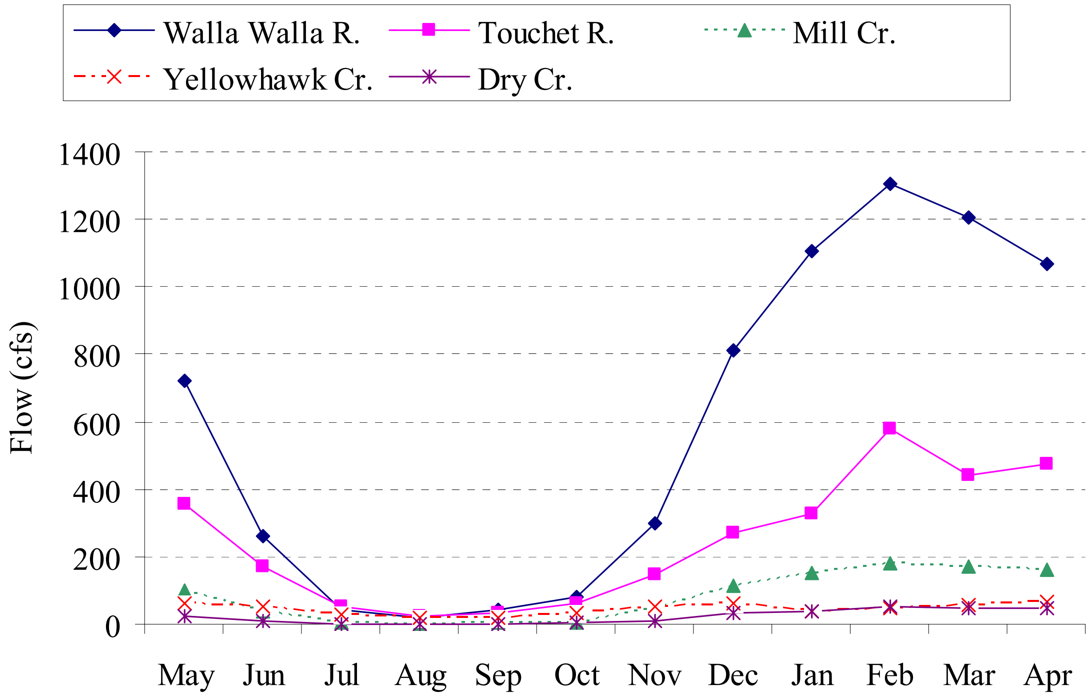

Figure 3. Typical Flow Patterns in the Walla Walla Drainage (USGS data, 1951-2002).

Some local farmers have already made substantial efforts to improve water quality by migrating to no-till or low-till farming. Much of the dryland acreage in Columbia County (Touchet River watershed) has been converted to no-till, and the soil savings have been excellent (Victoria Leuba, Ecology Eastern Regional Office, personal communication). There has also been a recent push to provide buffers on streams through riparian plantings. The Walla Walla Conservation District enrolled the greatest acreage in the state in 2003 – 2,200 acres all within 180 feet of streams or the equivalent of about 118 stream miles buffered. Additionally, there is ongoing restoration of Garrison Creek riparian areas in Fort Walla Walla funded by the Terry Husseman account and implemented by the City of Walla Walla and the Walla Walla stream team. This is an effort to improve water quality and riparian habitat in the city.

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) maintains treaty protected rights to fish and gather in the Walla Walla basin. CTUIR, in partnership with the Army Corps of Engineers, is in the process of developing the Walla Walla River Basin Feasibility Study. The tribe is committed to restoring salmon populations and the flow necessary to support those populations in the Walla Walla basin. The goal of the Walla Walla River Basin Project, which CTUIR is sponsoring, is to restore streamflows. Low streamflows are a critical limiting factor to salmonid restoration. The Tribe also saw the first returns from adult spring chinook outplantings this year, another aspect of the Tribe's multi-faceted salmon restoration plan.

Historical Pesticide/PCB Data

Elevated levels of chlorinated pesticides and PCBs in Walla Walla River fish were first reported by Ecology in Hopkins et al. (1985). The more recent 1992-93 Ecology fish tissue data that resulted in the 1996 303(d) listings for the Walla Walla are summarized in Table 2 and compared to the listing criteria. Each of these samples was a composite formed by pooling tissues from five individual fish. In order for a waterbody to be placed on the 303(d) list, Ecology required at least two single-fish samples or one composite of at least five fish that exceeded human health listing criteria.

The 303(d) human health criteria shown in Table 1 are based on EPA bioconcentration factors (BCF[3]) and water column criteria established under the EPA National Toxics Rule (40 CFR Part 131). For example, the 32 ug/Kg fish tissue criterion for 4,4'-DDE is calculated by converting the water quality criterion of 0.59 ng/L to ug/L (0.00059 ug/L) and multiplying by a BCF of 53,600 L/Kg. Units of ug/Kg and ug/L are equivalent to parts per billion, and ng/L is parts per trillion.

Ecology's 1992-93 fish samples were collected in the lower 15 miles of the Walla Walla River. The analysis included 43 chlorinated pesticides or breakdown products and seven PCB mixtures; only detected compounds are shown in Table 2.

Fillets were analyzed from three species – common carp (*Cyprinus carpio*), steelhead trout (*Oncorhynchus mykiss*), and white crappie (*Pomoxis annularis*). The highest pesticide and PCB residues were found in carp, where 303(d) listing criteria were exceeded by a factor of approximately 10 or more for DDE, dieldrin, heptachlor epoxide, hexachlorobenzene, and PCBs. Carp also exceeded the total chlordane criterion. There were modest exceedances of the total DDT (DDT+DDE+DDD), dieldrin, and heptachlor epoxide criteria in steelhead. However, these were returning adults, so it is unknown how much contamination can be attributed to the Walla Walla River. The only criterion exceeded in crappie was for heptachlor epoxide, approximately by a factor of 3. All of these chemicals were also detected in whole-body and egg samples from largescale suckers (*Catostomus macrocheilus*) collected in the same area.

[3] BCF= C_t/C_w, where C_t is the contaminant concentration in tissue (wet weight) and C_w is the concentration in water.

Table 2. Summary of Historical Data on Chlorinated Pesticides and PCBs Detected in Walla Walla River Fish (ug/Kg wet weight; parts per billion).

Species:	Largescale Sucker			White Crappie	Common Carp	Steelhead	303(d)
Tissue:	Whole Body	Eggs	Whole Body	Fillet	Fillet	Fillet	Listing
Date:	Sep-92	Sep-92	Sep-93	Sep-92	Sep-93	Sep-93	Criteria
4,4'-DDT	26	3.6	15	nd	nd	4.0	32
4,4'-DDE	425	57	338	17	**600**	15	32
4,4'-DDD	51	7.2	49	1.7	**97**	15	45
Total DDT	502	68	402	19	**697**	**34**	32
Dieldrin	5.0	nd	4.5	nd	**10**	**4.0**	0.65
Heptachlor Epoxide	8.3	2.1	3.5	**3.7**	**8.2**	**4.0**	1.2
Hexachlorobenzene	6.9	2.7	8.8	2.1	**20**	4.8	6.7
Cis-Chlordane	4.6	0.8	3.0	0.7	8.0	2.0	
Trans-Chlordane	4.9	0.7	2.7	0.7	8.5	1.0	
Cis-Nonachlor	1.9	nd	2.3	nd	5.0	1.0	
Trans-Nonachlor	10	nd	6.4	nd	13	3.0	
Oxychlordane	2.0	nd	0.8	nd	1.0	1.0	
Total Chlordane	23	1.5	15	1.4	**36**	8.0	8.3
PCB - 1254	48	10	nd	nd	nd	nd	5.3
PCB - 1260	90	22	122	nd	300	nd	5.3
Total PCBs	138	32	122	nd	**300**	nd	5.3
DCPA (Dacthal)	nd	nd	nd	nd	nd	5.0	
Ethion	nd	nd	3.0	nd	2.0	nd	
DDMU	16	1.9	8.0	nd	15	nd	
Alpha-BHC	0.5	nd	nd	nd	nd	nd	1.7
Gamma-BHC (Lindane)	7.9	2.3	1.0	1.3	1.0	1.0	8.2

From Davis and Johnson (1994), Davis et al. (1995)
Note: Values in bold exceed 303(d) criteria for edible tissue
nd = not detected

Ecology has also analyzed chlorinated pesticides in water and sediment samples from the Walla Walla mainstem and tributaries (Tables 3 and 4). PCBs have only been analyzed in fish.

Table 3. Summary of Historical Data on Chlorinated Pesticides Detected in Water Samples from the Walla Walla Drainage (ng/L; parts per trillion).

Date	Pesticides Detected	Yellowhawk Creek	Garrison Creek	Mill Creek	Lower Mud Creek	Dry Creek	Pine Creek	Touchet River	Walla Walla River	Ref.
May-92	none	na	na	na	na	na	na	na	<50	1
Apr-93	none	na	na	na	na	na	na	na	<50	2
Jun-93	"	na	na	na	na	na	na	na	<50	2
Aug-93	"	<50	na	<50	<50	<50	<50	<50	<50	2
Oct-93	"	na	na	na	na	na	na	na	<50	2
Apr-96	none	<50	na	<50	<50	<50	<50	<50	<50	3
Jun-96	4,4'-DDT	<50	na	<50	<50	6	<50	<50	<50	3
"	Aldrin	110	na	<50	<50	<50	<50	<50	<50	3
Sep-96	t-DDT	na	4-8	na	na	na	na	na	na	4
"	HCB	na	7-8	na	na	na	na	na	na	4
Apr-97	none	<12	na	na	<12	<12	<12	na	na	5
May-97	"	<12	na	na	<12	<12	<12	na	na	5

References: 1 = Davis (1994) 2 = Davis and Johnson (1994) 3 = Johnson (1997a) 4 = White et al. (1998)
5 = Johnson (1997b)
na = not analyzed

Table 4. Summary of Historical Data on Chlorinated Pesticides Detected in Sediment Samples from the Walla Walla Drainage (ug/Kg dry weight; parts per billion).

Location:	Yellowhawk Creek	Garrison Creek	Mill Creek	Lower Mud Creek	Dry Creek	Pine Creek	Touchet River	Walla Walla River
Date:	Jun-96	Aug-96	Jun-96	Jun-96	Jun-96	Jun-96	Jun-96	Jun-96
4,4'-DDT	3.0	1.2	1.8	1.2	<1.1	1.9	0.69	1.2
4,4'-DDE	2.7	30	3.3	6.6	5.0	4.2	3.1	7.6
4,4'-DDD	0.61	12	0.76	2.5	0.99	0.77	0.83	1.8
Total DDT	6.3	43	5.9	10	6.0	6.9	4.6	10.6
Dieldrin	<3.7	nd	<4.5	<5.3	<4.3	<3.9	<4.2	<4.6
Heptachlor epoxide	<1.2	nd	<1.5	<1.8	<1.4	<1.3	<1.4	<1.5
Hexachlorobenzene	0.49	2.7	0.45	0.89	3.7	1.2	1.4	2.0
Chlordane	1.7	46	3.5	<18	3.0	1.5	<14	3.0
Gamma BHC	0.74	nd	0.91	0.89	3.7	0.90	0.56	0.80
TOC (%)	0.30	na	1.5	1.4	0.8	0.60	0.80	9.2

From Johnson (1997a), White et al. (1998)
nd = not detected
na = not analyzed

For the most part, the detection limits achieved in past water samples have only been appropriate for observing gross contamination, and few pesticides have been found. DDT compounds and hexachlorobenzene were detected in two Garrison Creek samples at 4 – 8 ng/L. DDT was detected at 6 ng/L in a Dry Creek sample. A high concentration of aldrin, 110 ng/L, was detected once in Yellowhawk Creek. Aldrin rapidly breaks down to dieldrin. These concentrations exceed both human health and aquatic life criteria.

More sensitive methods have been used to analyze sediment samples (Johnson, 1997a; White, 1998). Results showed that DDT compounds, hexachlorobenzene, and chlordane were detectable at most sites, with concentrations ranging from 0.45 – 46 ug/Kg. Dieldrin and heptachlor epoxide were not detected in sediments.

Applicable Water Quality Standards

Washington

Water quality standards for surface waters of the state of Washington are codified in Chapter 173-201 of the Washington Administrative Code (WAC).

Characteristic Uses

The Walla Walla is a Class A river. Characteristic uses for Class A waters include, but are not limited to the following (WAC 173-201A-030):

(i) Water supply (domestic, industrial, agricultural).
(ii) Stock watering.
(iii) Fish and shellfish:
Salmonid migration, rearing, spawning, and harvesting.
Other fish migration, rearing, spawning, and harvesting.
Clam, oyster, and mussel rearing, spawning, and harvesting.
Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.
(iv) Wildlife habitat.
(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).
(vi) Commerce and navigation.

Toxic Substances

WAC 173-201A-030 states the following with regard to toxic substances:

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

Toxics substances are further addressed in WAC 173-201A-040 as follows (selected sections):

(1) Toxic substances shall not be introduced above natural background levels in waters of the state which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic toxicity to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department.

(2) The department shall employ or require chemical testing, acute and chronic toxicity testing, and biological assessments, as appropriate, to evaluate compliance with subsection (1) of this section and to ensure that aquatic communities and the existing and characteristic beneficial uses of waters are being fully protected.

and

(5) Concentrations of toxic and other substances with toxic propensities not listed in subsection (3) of this section shall be determined in consideration of USEPA Quality Criteria for Water, 1986, as revised, and other relevant information as appropriate. Human health-based water quality criteria used by the state are contained in 40 CFR 131.36 (known as the National Toxics Rule).

(6) Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than or equal to one in one million.

Water Quality Criteria

Washington State water quality criteria that apply to 303(d) listed pesticides and PCBs in the Walla Walla drainage are shown in Table 5 (from sections (3) and (5) of WAC 173-201A-040). The human health criteria are for a one in one million (10^{-6}) increased lifetime cancer risk from consumption of water and fish or fish only. A fish consumption rate of 6.5 grams per day and a water consumption rate of 2 liters per day are assumed. These criteria were promulgated on Washington in the EPA National Toxics Rule.

Table 5. Applicable Washington State Water Quality Criteria* for Chlorinated Pesticides and PCBs (ng/L; parts per trillion).

Chemical	Criteria for Protection of Aquatic Life		Criteria for Protection of Human Health	
	Freshwater Acute	Freshwater Chronic	Water and Fish Consumption	Fish Consumption
4,4'-DDT			0.59	0.59
4,4'-DDE			0.59	0.59
4,4'-DDD			0.83	0.84
DDT (and metabolites)	1,100	1.0		
Dieldrin	2,500	1.9	0.14	0.14
Heptachlor	520	3.8	0.21	0.21
Heptachlor epoxide			0.10	0.11
Hexachlorobenzene			0.75	0.77
Chlordane	2,400	4.3	0.57	0.59
Toxaphene	730	0.2	0.73	0.75
PCBs	2,000	14	0.17	0.17

*WAC 173-201A-040

Oregon

Beneficial uses and water quality standards for the surface waters of the state of Oregon are codified in the Oregon Administrative Rules (OAR) Chapter 340, Division 41.

Beneficial Uses

Beneficial uses for the Walla Walla River basin are given in OAR 340-041-0682 and shown below:

Beneficial Uses	Walla Walla River Mainstem from Confluence of North and South Forks to State Line	All Other Basin Streams
[1]Public Domestic Water Supply	X	X
[1]Private Domestic Water Supply	X	X
Industrial Water Supply	X	
Irrigation	X	X
Livestock Watering	X	X
Anadromous Fish Passage	X	X
Salmonid Fish Rearing	X	X
Salmonid Fish Spawning	X	X
Resident Fish & Aquatic Life	X	X
Wildlife & Hunting	X	X
Fishing	X	X
Boating	X	X
Water Contact Recreation	X	X
Aesthetic Quality	X	X
Hydro Power		X

[1] With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.

Toxic Substances

OAR 340-041-0685 (part p) states the following with regard to toxic substances:

(A) Toxic substances shall not be introduced above natural background levels in the waters of the state in amounts, concentrations, or combinations which may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare; aquatic life; wildlife; or other designated beneficial uses;

(B) Levels of toxic substances shall not exceed the criteria in Table 22 which were based on criteria established by EPA and published in Quality Criteria for Water (1986), unless otherwise noted.

Water Quality Criteria

Oregon state water quality criteria that apply to 303(d) listed pesticides and PCBs in the Walla Walla River basin are shown in Table 6.

Table 6. Applicable Oregon State Water Quality Criteria* for Chlorinated Pesticides and PCBs (ng/L; parts per trillion).

	Criteria for Protection of Aquatic Life		Guidance Values for the Protection of Human Health	
Chemical	Freshwater Acute	Freshwater Chronic	Water and Fish Consumption	Fish Consumption
4,4'-DDT	1,100	1.0	0.024	0.024
4,4'-DDE	1,050,000**			
4,4'-DDD	60**			
Dieldrin	2,500	1.9	0.071	0.071
Heptachlor	520	3.8	0.28	0.29
Heptachlor epoxide				
Hexachlorobenzene			0.72	0.74
Chlordane	2,400	4.3	0.46	0.48
Toxaphene	730	0.2	0.71	0.73
PCBs	2,000	14	0.079	0.079

*OAR 340-041-0685 (part p)
**guidance value only

Project Description

The primary goals of the field study for the Walla Walla River chlorinated pesticide/PCB TMDL were to: 1) quantify water column concentrations and loadings of 303(d) listed pesticides and PCBs in the Walla Walla mainstem, major tributaries, and significant point sources; 2) recommend numerical water quality targets that will result in fish meeting human health standards; and 3) propose load allocations to meet the targets. In pursuit of these goals, sufficient data were obtained to allow an assessment of human health risk from fish consumption, and benchmarks were established to gauge future improvements in water quality. The health risk assessment is being conducted by the Washington State Department of Health (WDOH) Office of Environmental Health Assessments and will be reported separately.

Specific objectives of the TMDL field study were as follows:

1. Obtain representative data on water column concentrations of 303(d) listed pesticides, PCBs, ancillary parameters, and flow in the mainstem and major tributaries.
2. Investigate wastewater treatment plant (WWTP) discharges as potential pesticide/PCB sources to the river.
3. Obtain a reliable estimate of mean pesticide and PCB concentrations in the edible tissues of resident mainstem fish species most frequently consumed.
4. Use the water, effluent, and fish tissue data in conjunction with other information to select appropriate numerical water quality targets for the river.
5. Evaluate the correlation between chlorinated pesticides, total suspended solids (TSS), and turbidity as a possible means of selecting water quality targets.
6. Determine the river's loading capacity for these constituents and propose wasteload and load allocations for point sources, nonpoint sources, and background.
7. Incorporate the data and analysis into a report that addresses the TMDL elements required by EPA Region 10.

The study area included the mainstem Walla Walla River and its tributaries from the Oregon border to the Columbia River. Tributary sampling was confined to sites at or near their mouths, except for upper Mill Creek and the WWTPs. Fish sampling was limited to resident species. Field work began in May 2002 and was completed in September 2003. The study was conducted by the Ecology Environmental Assessment Program following a Quality Assurance Project Plan prepared by Johnson and Era-Miller (2002).

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Design of Field Study

Surface Waters

The purpose of the water sampling was to: 1) identify and rank sources of contamination; 2) assess compliance with human health and aquatic life criteria; 3) test for relationships between chlorinated pesticides, TSS, and turbidity; and 4) calculate loadings to and within the river.

Semipermeable Membrane Devices

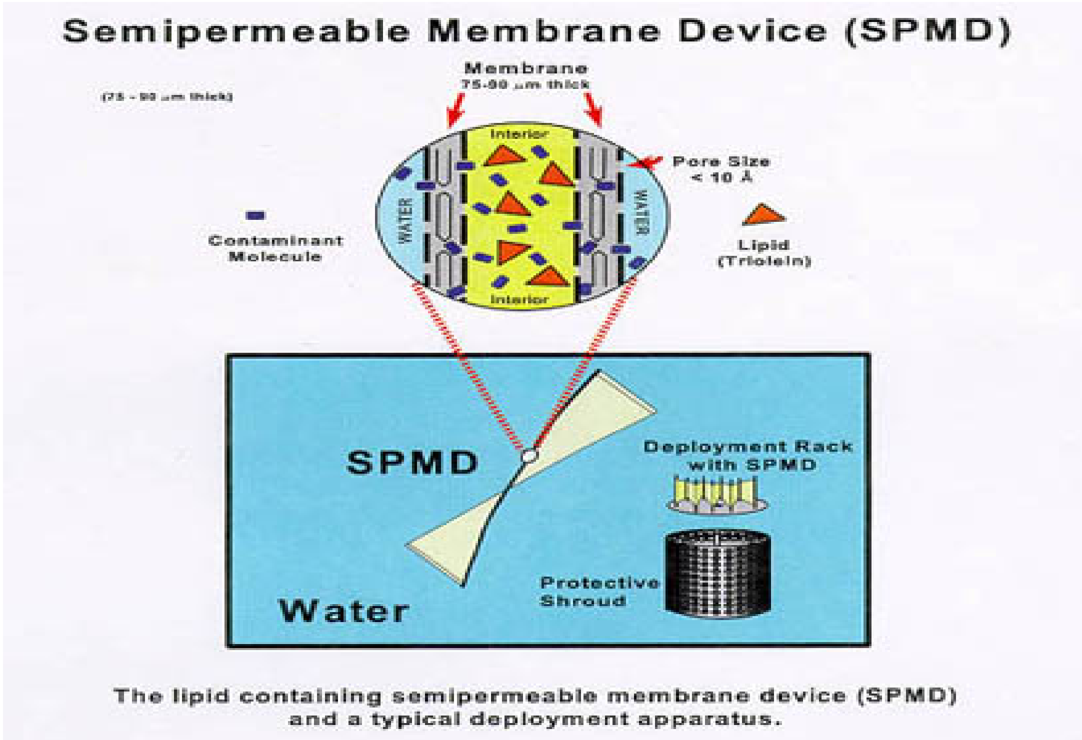
Water column concentrations of 303(d) listed pesticides and PCBs in the Walla Walla drainage were poorly known, but expected to be low, especially for those chemicals found at trace levels in fish samples. Reconnaissance sampling conducted in January 2002 confirmed low concentrations of 0.043 – 0.15 ng/L for 4,4'-DDE, dieldrin, and hexachlorobenzene in the lower Walla Walla River and Mill Creek (Johnson and Era-Miller, 2002).

In light of the low concentrations, a semipermeable membrane device (SPMD) was used as the primary means of reliably detecting and quantifying all the chemicals of interest. SPMDs are passive samplers that mimic the biological uptake of low solubility organic compounds and can achieve detection limits in the sub-parts per trillion. The device used in the present study was developed by the U.S. Geological Survey (USGS), Columbia Environmental Research Center and is now of standardized design, patented, and commercially available through Environmental Sampling Technologies (EST), St. Joseph, MO (http://www.spmds.com). Details of SPMD theory, construction, and application can be found at http://wwwaux.cerc.cr.usgs.gov/spmd.

Each SPMD is composed of a thin-walled, layflat polyethylene tube (91 x 2.5 cm) filled with triolein, the major neutral lipid in fish (Figure 4). When placed in water, dissolved lipophilic organic compounds diffuse through the membrane and are concentrated over time. Deployment times vary but are typically 20 – 30 days. The SPMDs are then extracted and analyzed for the chemicals of interest.

A combination of laboratory calibration data and Permeability/Performance Reference Compounds (PRCs) spiked in deployed SPMDs are used in conjunction with field temperature to obtain an estimate of average concentrations. A SPMD will effectively sample 0.5 – 10 liters of water per day, depending on the compound in question.

SPMDs provide a time-weighted average concentration for the chemicals of interest and only measure the dissolved and, therefore, readily bioavailable fraction. Studies have shown the results are comparable to other low-level sampling methods such as liquid-liquid extraction and solid-phase extraction (Ellis et al., 1995; Rantalainen et al., 1998). Recent use of SPMDs in Washington State includes studies of chlorinated pesticides and PCBs in the Columbia River and Spokane River (McCarthy and Gale, 1999; EILS, 1995; Hart Crowser, 1995; Anchor Environmental, 2000).



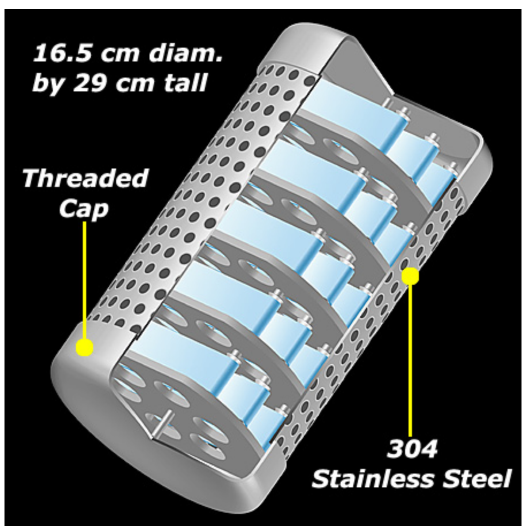


Figure 4. SPMD Device and Deployment Canister.
http://wwwaux.cerc.cr.usgs.gov/spmd/spmd_overview.htm

For the Walla Walla TMDL, SPMDs were deployed at the ten sites listed in Table 7. The locations are shown in Figure 5. Detailed descriptions of the sampling sites are provided in Appendix A.

Table 7. Water Quality Monitoring Sites Where SPMDs Were Deployed in the Walla Walla Drainage During 2002-2003.

Sampling Site	Mainstem River Mile	Drainage Area (sq. miles)
Upper Walla Walla River @ Peppers Bridge	39.6	~193
Yellowhawk Creek @ Old Milton Highway	37.9	70
Garrison Creek @ Mission Rd.	36.1	?
Upper Mill Creek @ Seven Mile Rd.	- -	?
Lower Mill Creek @ Mission Rd.	33.6	96
Middle Walla Walla River @ Detour Rd.	32.9	~328
Dry Creek @ Highway 12 Bridge	27.2	246
Pine Creek @ Sand Pit Rd.	23.4	170
Touchet River @ Highway 12 Bridge	21.6	747
Lower Walla Walla River bw. Cummins Bridge	14.3	1,690

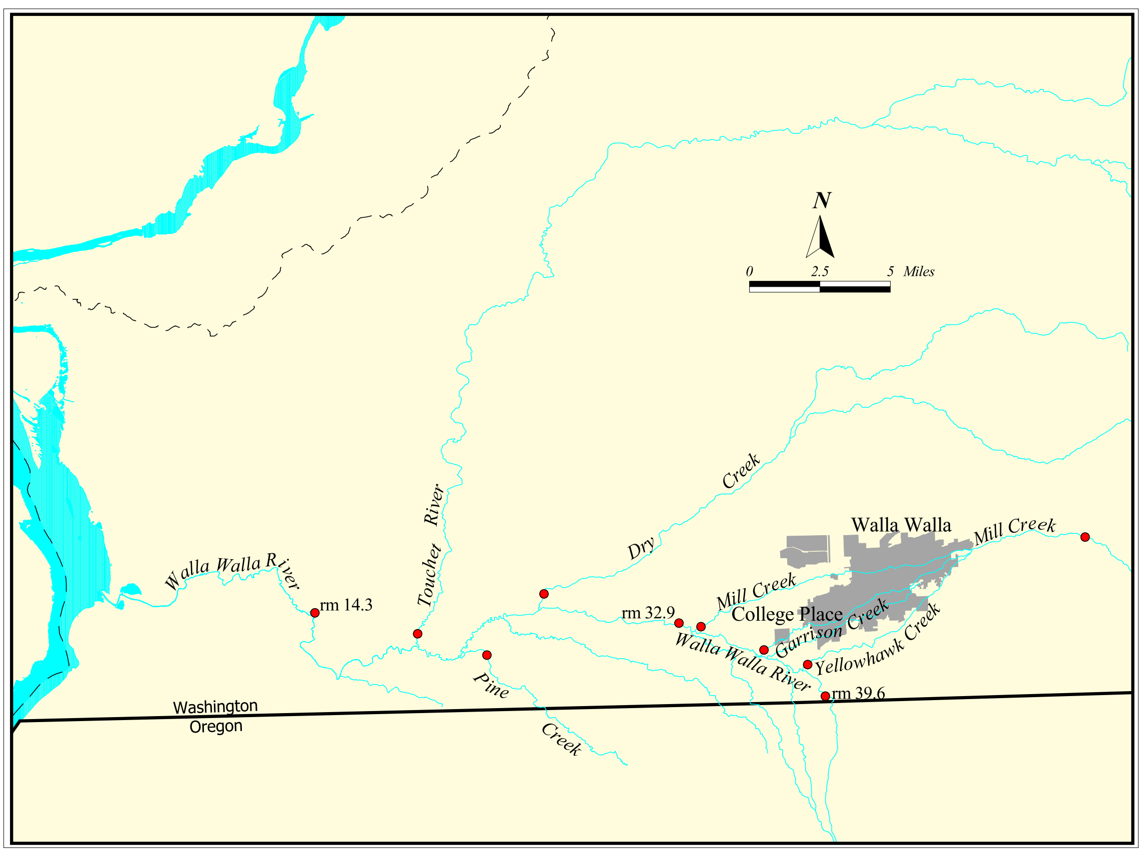


Figure 5. Water Quality Monitoring Sites Where SPMDs Were Deployed.

Six tributaries were monitored: Yellowhawk Creek, Garrison Creek, Mill Creek, Dry Creek, Pine Creek, and the Touchet River. These represent over 85% of the river's drainage area in Washington. They include the major TSS sources (Touchet River and Dry Creek) and the two major urban streams (Mill and Garrison creeks). A sampling site was also located on upper Mill Creek to measure contaminant levels in drainage from forested vs. agricultural land and to establish background water quality for Mill, Yellowhawk, and Garrison creeks. The mainstem was monitored at the Oregon border (@ Peppers Bridge), approximately midway downstream below Mill Creek (@ Detour Road), and in the lower river about one mile below Cummins Bridge.

SPMDs were deployed quarterly for approximately one month each, as indicated in Figure 6. The deployments were timed to provide representative data over the range of runoff conditions that normally occur in the drainage. There were two deployments during the 2002 irrigation season, one in the spring and one during summer low flow; one deployment during the rising flows of early winter 2002; and one deployment during the late winter peak flows of 2003.

The lower Walla Walla River and Touchet River SPMDs from May-June 2002 became buried in silt and were unusable. The May-June SPMD data in this report are from samplers deployed at the same time the following year.

Temperature was monitored continuously during each SPMD deployment. At the beginning, middle, and end of each deployment period, ancillary data were obtained on flow, TSS, turbidity, total organic carbon (TOC), dissolved organic carbon (DOC), and conductivity. Flow data were obtained through Ecology's Environmental Assessment Program Stream Hydrology Unit, USGS, and other sources or gauged in the field.

The SPMD extracts were analyzed for the 303(d) listed pesticides and PCBs. The analysis was expanded to include toxaphene, based on examination of the chromatograms from the initial deployment in May.

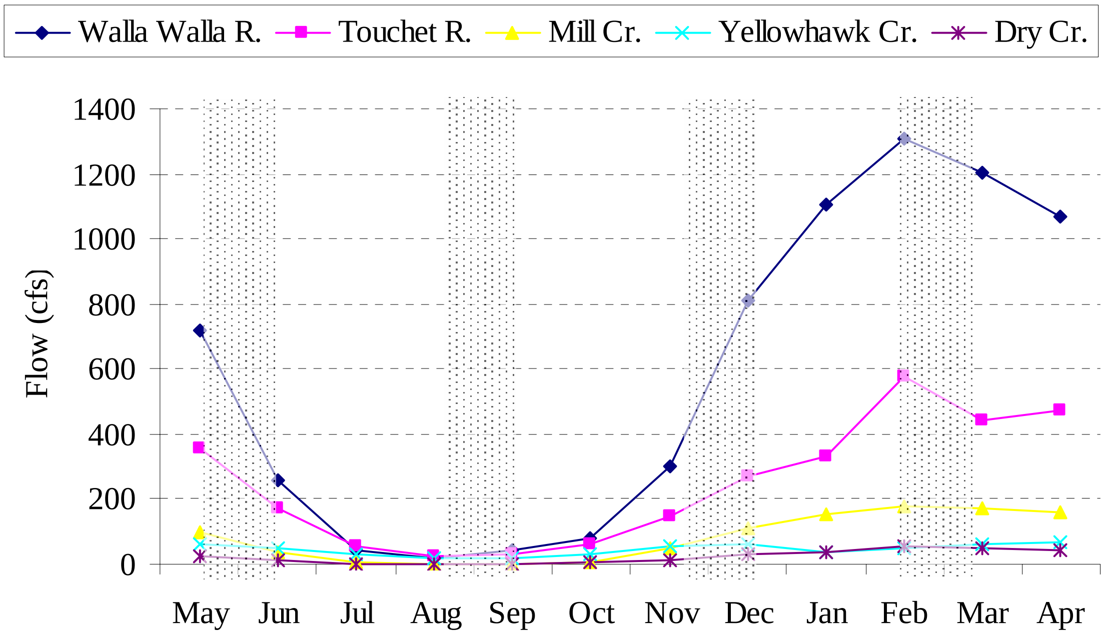


Figure 6. Historical Flow Patterns in the Walla Walla Drainage, with Shaded Areas Indicating Periods When SPMD Samplers were Deployed in 2002-2003 (USGS data).

TSS/Turbidity Correlation

The National Research Council (2001) has suggested using statistical regression of a water quality indicator on one or more predictor variables as a simple and useful model for developing TMDLs. This approach has been used successfully in a TMDL for the lower Yakima River (Joy and Patterson, 1997). That study was able to correlate total DDT with TSS and set instream targets for TSS reduction to meet DDT criteria for aquatic life. TSS was, in turn, linked to the state turbidity standard and to fish habitat requirements.

Data were obtained to test this relationship in the Walla Walla drainage. Grab samples were periodically collected from the SPMD deployment sites and analyzed for the target pesticides in conjunction with TSS, turbidity, and other ancillary parameters. Low detection limits were achieved by using a new large-volume injection technique (see Methods). No attempt was made to quantify PCB concentrations in the grab samples, since the cost of doing so on surface waters is prohibitive.

Follow-up Sampling

Several smaller tributaries were not included in the routine water quality monitoring. In order to determine if pesticide concentrations were comparable to the larger tributaries that had been the focus of the study, grab samples were collected from the East Little Walla Walla River, West Little Walla River, Stone Creek, Lower Mud Creek, and Gardena Creek in February 2003 (Figure 7). Because results showed elevated concentrations in some of these streams, periodic grab sampling was continued through September 2003.

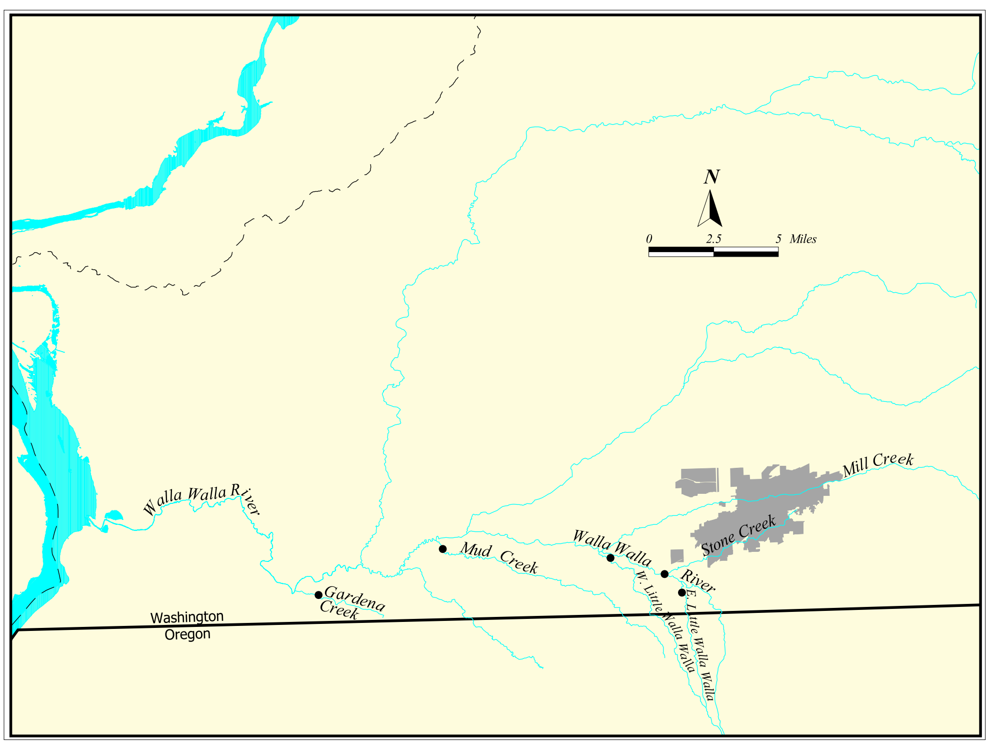


Figure 7. Minor Tributaries Where Follow-up Water Sampling was Done.

NPDES Discharges

There are 20 NPDES (National Pollution Discharge Elimination System) permits within the basin (Table 8). Four of these are for WWTPs located in the cities of Walla Walla, College Place, Waitsburg, and Dayton. The remaining 16 permits are for industries, municipalities, and land owners who either discharge directly to one of the treatment plants or whose discharge is land application.

Table 8. NPDES Permits in the Walla Walla Basin.

Facility Name	Type	Size	City	County	Permit No.
Columbia Mosquito Control Dist.	aquatic pesticide	general permits	Burbank	Walla Walla	WAG992002A
Broetje Orchards	fruit packers	general permits	Prescott	Walla Walla	WAG437006C
College Place WWTP	municipal	minor	Walla Walla	Walla Walla	WA0020656B
Dayton acclimation pond	fish	general permits	Dayton	Columbia	WAG137004C
Dayton WWTP	municipal	minor	Dayton	Columbia	WA0020729B
Koncrete Industries Inc.	industrial	general permits	Walla Walla	Walla Walla	WAG507028B
Koncrete Industries Inc.	industrial	general permits	Walla Walla	Walla Walla	WAG500026A
Konen Rock Crushing Inc.	industrial	general permits	Dayton	Columbia	WAG507051B
Konen Rock Crushing Inc.	industrial	general permits	Dayton	Columbia	WAG500006A
Rock Hill Concrete Co.	industrial	general permits	Dayton	Columbia	WAG507041B
Simplot Feeders	industrial	minor	Wallula	Walla Walla	WA0045420B
Transtate Asphalt Co.	industrial	general permits	Walla walla	Walla Walla	WAG507032B
WA DOT sc region ps-0-68	industrial	general permits	Burbank	Walla Walla	WAG507062B
WA DOT sc region qs-co-16	industrial	general permits	Dayton	Columbia	WAG507094B
Wa DOT sc region qs-o-66	industrial	general permits	Waitsburg	Walla Walla	WAG507073B
Waitsburg WWTP	municipal	minor	Waitsburg	Walla Walla	WA0045551A
Walla Walla WWTP	municipal	major	Walla Walla	Walla Walla	WA0024627C
Weidert Farms Inc. - quarry	industrial	general permits	Touchet	Walla Walla	WAG507111B
Boise Cascade	industrial	major	Walla Walla	Walla Walla	WA0003697B
Camas Gravel Co.	industrial	general permits	Dayton	Columbia	WAG500054A

The Walla Walla and College Place WWTPs were evaluated as possible sources of chlorinated pesticides and PCBs. The Walla Walla plant (9.6 million gallons per day) discharges to Mill Creek and the College Place plant (1.6 mgd) discharges to Garrison Creek (Figure 8).

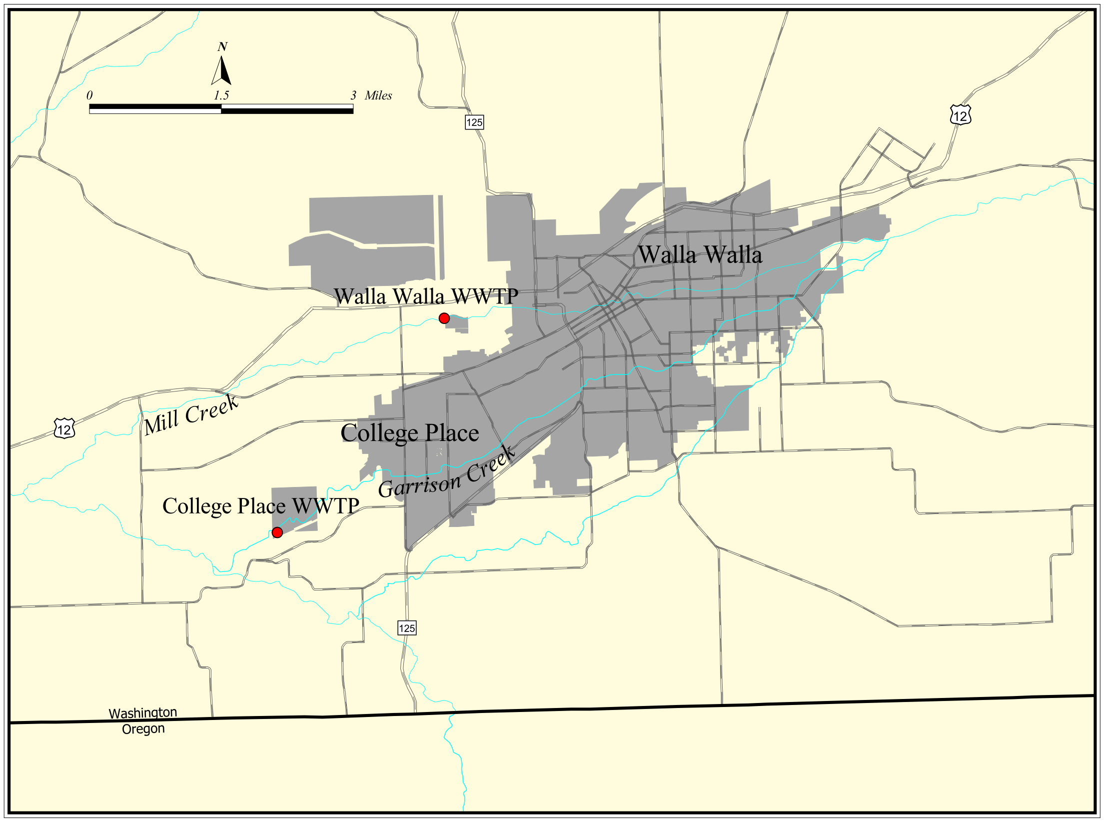


Figure 8. Location of Walla Walla and College Place WWTPs.

The city of Walla Walla is authorized to discharge treated and disinfected effluent to Mill Creek from December 1 through April 30 of each year, subject to the effluent limits and conditions of its NPDES permit. The city is required by a 1927 court order to deliver up to 7.9 mgd of treated and disinfected wastewater to the Gose and Blallock Irrigation Districts from May 1 through November 30. The NPDES permit allows diversion of the effluent to the irrigation districts from April 15 through December 15. The districts can choose to use the effluent or divert it back into Mill Creek.

College Place effluent is discharged during May through October into wetlands that feed into Garrison Creek. November through April the effluent is discharged directly to the creek.

The other two WWTPs in the basin – Dayton and Waitsburg – are small discharges (< 1 mgd) located over 40 miles up the Touchet River and were considered unlikely to be significant pesticide/PCB contributors to the Walla Walla River. In the opinion of the Ecology Eastern Regional Office, industries and other NPDES facilities in the Walla Walla basin are not significant sources (Pat Hallinan and Jerry Anderson, Ecology Eastern Regional Office, personal communication, 2002).

For the TMDL study, composite effluent samples were collected over a two-day period on a quarterly basis from the Walla Walla and College Place WWTPs. The locations of the effluent sampling sites are in Appendix A. Sampling was done near the midpoint of the SPMD deployment period. Each sample was analyzed for chlorinated pesticides, PCBs, TSS, and conductivity. Low detection limits were achieved by using large-volume injection for pesticides and high-resolution GC/MS for individual PCB congeners[4].

Fish Tissue

The purpose of the fish tissue samples was to: 1) determine the extent to which the pesticides and PCBs detected in 1992-93 continue to exceed 303(d) listing criteria; 2) assess appropriateness of applying EPA human health criteria to the Walla Walla River; and 3) provide data to the WDOH for a human health assessment.

Washington Department of Fish & Wildlife (WDFW) biologists in the Walla Walla area were contacted for information on sport and subsistence fishing on the river. Results of these discussions are summarized in Table 9.

The resident species most frequently consumed from the Walla Walla River are smallmouth bass (*Micropterus dolomieu*), channel catfish (*Ictalurus punctatus*), and carp (*Cyprinus carpio*). The fish tissue collection for the TMDL focused on these species. Some segments of the local population consume almost any fish they catch (Glen Mendel, WDFW, personal communication). Therefore, two other commonly encountered species, bridgelip suckers (*Catostomus columbianus*) and northern pike minnow (*Ptychocheilus oregonensis*; formerly known as northern squawfish) were also collected. WDFW indicated that some crayfish are taken, but studies have shown that crayfish muscle has a low potential to accumulate chlorinated pesticides or PCBs (Serdar et al., 1999; EILS, 1995).

[4] PCBs can be analyzed as equivalent concentrations of the commercial mixtures (Aroclors in the U.S., e.g., Aroclor-1260) or through a more sensitive and expensive method for individual compounds, referred to as congeners, of which there are 209 possible. Because of the cost associated with a congener analysis, this study primarily analyzed Aroclor-equivalents.

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Table 9. Fisheries Information for Resident Walla Walla Species (notes from discussion with G. Mendel and M. Birely, WDFW).

Species	Range	Season and locations fished	Spawn season	Size and bag limits
Smallmouth bass	Several miles downstream of Mill Creek to the Columbia and in Touchet upstream to Dayton	Fished in the late spring/early summer from the mouth of the Touchet to the Columbia.	Spring	No minimum size/ 5 per day
Common carp	In the Walla Walla from the mouth of Mill Creek to the Columbia River and a short distance up the Touchet	Fished from April through June in the shallow delta at the mouth of the Walla Walla River (fish caught in the delta are probably resident to the lower part of the Walla Walla River delta). Local fishing places: between Burbank and Wallula (Casey pond).	Spring	No minimum size or limit
Channel catfish	From the mouth of the Touchet out to the Columbia	Fished in late spring/early summer (particularly night fishing in the summer) from the mouth of the Touchet out to the Columbia. Local fishing places: at old abandoned highway bridge, below Little Goose Dam and Lion's Ferry State Park, highway 12 off of Wallula Game Department Road .	Spring/early summer	12" minimum size/ 5 per day
Largescale/ Bridgelip suckers	From the state line to the Columbia River and up the Touchet to Dayton	From the state line to the Columbia River and up the Touchet to Dayton; not really fished.	Spring/early summer	No minimum size or limit
Brown/ Black bullheads	From the mouth of the Touchet out to the Columbia, but since they are a reservoir-type fish, adult fish are probably found more often near the mouth of the Walla Walla River	Fished in spring/early summer (and fall?) from the mouth of the Touchet out to the Columbia River. Fished in many of the same local places as channel catfish.	Spring/early summer	No minimum size or limit
White crappie	From the mouth of the Touchet out to the Columbia (mainly near the mouth of the Walla Walla)	Found in low abundance, so aren't fished for much. A few are caught locally near the old abandoned highway bridge.	Spring/early summer	No minimum size or limit
Crayfish	In Mill Creek near city of Walla Walla and in streams throughout the basin with a rocky bottom	Some immigrants have been found fishing for them in Mill Creek. Are found on rocky stream bottoms, probably not too many near the mouth of the Walla Walla (Legal fishery open from May through summer).	unknown	2 pots per day

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) was contacted to determine if the Walla Walla River is an important source of fish for Tribal members. According to CTUIR, there is evidence that the Tribe has eaten the above-mentioned species in the past. There is suspected current use by Tribal members, although there is no written documentation. Use will likely increase once flows are restored and other traditional anadromous species are returned to the river. This is expected to bring Tribal members back to the area more regularly, in which case these other species would be harvested more frequently as well. (Terry Shepard, CTUIR, personal communication).

Salmonids that inhabit the Walla Walla drainage include steelhead, spring chinook, and bull trout. These species were not sampled for the TMDL because they are migratory, threatened, and/or endangered. Rainbow trout and whitefish occur in the study area, but legal size rainbow are rare and whitefish density very low (Mendel et al., 2001).

Within the mainstem, bass and catfish are primarily found between the mouth of the Walla Walla and the Touchet River. Carp, bridgelip suckers, and pike minnow occur throughout the river.

As previously mentioned, the Touchet and nearby Dry Creek transport most of the sediment load discharged from the basin. Inputs of sediments and associated contaminants from these two tributaries, as well as Pine Creek, have the potential to result in substantially different water quality conditions in the lower river. Therefore, separate specimens for chemical analysis were obtained from the upper and lower river, using the Touchet River-Dry Creek reach as an approximate dividing line (Figure 9). Samples close to the confluence with the Columbia River were avoided in an effort to obtain data representative of the Walla Walla River. The reaches where fish sampling was done are described in Appendix A. The fish samples were collected in July and September, 2002. Fillets were analyzed for 303(d) listed pesticides, PCBs (Aroclor-equivalents), and percent lipids.

Composite samples were used to obtain a cost efficient estimate of mean chemical concentrations. For a given number of fish to be analyzed as composites, greater statistical power is achieved by increasing the number of replicate composites as opposed to increasing the number of fish per composite (EPA, 2000b). The target sample size was 20 fish of each species from each location, to be analyzed in composites of five fish each. A composite size of five was selected to balance the need for confidence in estimating mean concentrations against the cost of chemical analysis.

The CTUIR requested that Ecology include whole fish samples in the TMDL study, as many Tribal members use the entire fish (CTUIR April 2, 2002 board meeting). Therefore, several whole fish composites were included in the analysis.

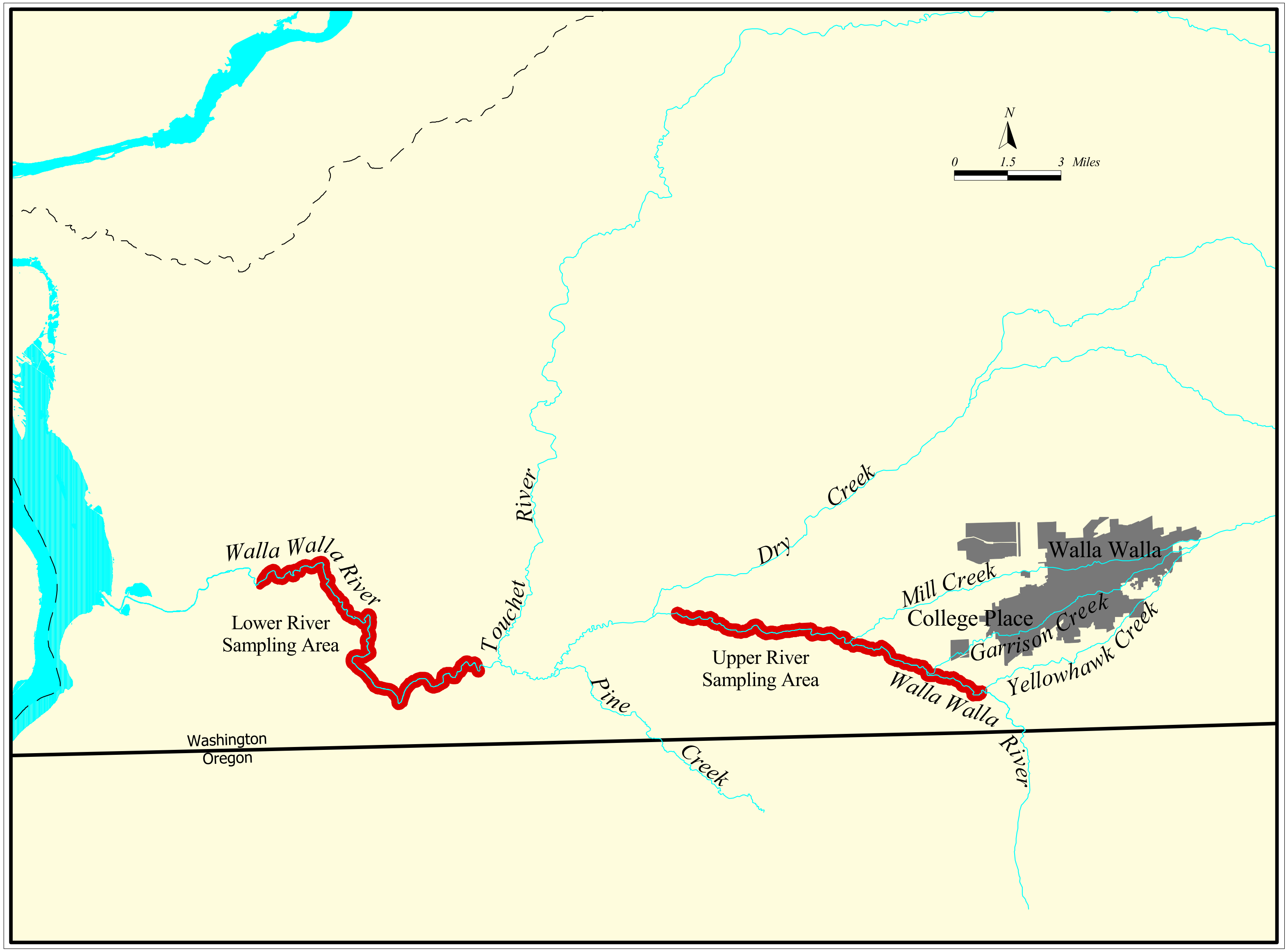

Figure 9. Location of Fish Samples

Summary of Field Work

The number and timing of field samples collected for this project are summarized in Table 10.

Table 10. Summary of Field Work for the Walla Walla Chlorinated Pesticide/PCB TMDL Study.

Sample Type	No. of Sites	Duration Frequency No. Samples	2002								2003								
			M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
SPMDs	10	26-28 days quarterly 41	■	■		■	■		■	■		■	■		■	■			
Whole water	4-12	grabs periodic 88*	•			•	•		•	•	•	•	•		•	•			•
WWTP effluent	2	2-day composites quarterly 8	•				•			•		•							
Fish tissue	2	2-4 days/reach - - 29 composites			•		•												

* 88 pesticide samples; additional conventional water quality samples were also collected

Methods

Field Procedures

SPMD Samples

Deployment and retrieval procedures for semipermeable membrane devices (SPMDs) followed the guidance in Huckins et al. (2000). Standard SPMDs (91 x 2.5 cm membrane containing 1 mL triolein) and the stainless steel canisters (16.5 x 29 cm) and carriers that hold the membranes during deployment were obtained from Environmental Sampling Technologies (EST). The SPMDs were preloaded onto the carriers by EST in a clean-room and shipped in solvent-rinsed metal cans under argon atmosphere. Five SPMDs were used in each canister, with one canister per sampling site. The SPMDs were kept frozen until deployed.

On arriving at the sampling site, the cans were pried open, carriers slid into the canisters, and the device anchored and tethered in the stream. The SPMDs were located out of strong currents, situated in such a way as to minimize the potential for vandalism, and placed deep enough to allow for anticipated fluctuations in water level. Because SPMDs are potent air samples, the procedure was done as quickly as possible, typically a minute or less. Field personnel wore nitrile gloves and did not touch the membranes.

The SPMDs were deployed for 28 days each, on average. The retrieval procedure was essentially the opposite of deployment. Cans holding the SPMDs were carefully sealed and shipped to EST for extraction. The SPMDs were kept at or near freezing and arrived at EST within 24 hours of retrieval. Chain-of-custody was maintained.

An Onset StowAway Tidbit was attached to each canister to monitor temperature. The latitude and longitude of the sampling sites were recorded from a Magellan 320 GPS receiver. Where required, streamflow was measured using a Swoffer Model 2100 meter and top-setting rod.

Surface Water Grab Samples

At the beginning, middle, and end of each deployment period, grab samples for TOC, DOC, TSS, turbidity, and conductivity were collected at each SPMD site. Pesticide samples were also collected periodically, both from the SPMD sites and other minor tributaries.

Multiple grabs with a hand-held glass jar were composited into 1-gallon glass jars with Teflon lid liners, both cleaned to EPA (1990a) QA/QC specifications. Sub-samples from the composite were split into appropriate containers (Table 11). DOC samples were filtered in the field (0.45 micron). The water samples were placed on ice for return to Ecology headquarters, where they were held in a secure cooler for later transport with chain-of-custody record to the Ecology Manchester Environmental Laboratory.

Table 11. Sample Containers, Preservation, and Holding Times for Water Samples.

Parameter	Container*	Preservation	Holding Time
Chlorinated pesticides	1 gal. glass; Teflon lid	Cool to 4°C	7 days
PCBs (congeners)	1 L amber glass; Teflon lid	Cool to 4°C	7 days
TSS	1 L poly bottle	Cool to 4°C	7 days
Turbidity	500 mL poly bottle	Cool to 4°C	48 hours
Conductivity	500 mL poly bottle	Cool to 4°C	28 days
TOC	125 mL poly bottle	HCl to pH<2, 4°C	28 days
DOC	125 mL poly bottle	Filter, HCl to pH<2, 4°C	28 days

*Obtained from Manchester Laboratory or Axys Laboratory (PCB congeners)

Effluent Samples

Final effluent samples from the Walla Walla and College Place WWTPs were composites collected by hand. Each composite consisted of two separate grabs per day (morning and afternoon) for two days.

The composites were split into appropriate containers for chlorinated pesticides, PCB congeners, TSS, and conductivity. Sample containers, preservation, and holding times were as shown in Table 11. Flow data were obtained from WWTP records. The latitude and longitude of the sampling sites were recorded from a Magellan 320 GPS. The effluent samples were placed on ice for return to Ecology headquarters, where they were held in a secure cooler for later transport with chain-of-custody record to Manchester Laboratory. Manchester shipped the congener samples to Axys Laboratory for analysis.

Fish Samples

Upper river fish were collected during an electrofishing survey of salmonid abundance being conducted by WDFW. Lower river fish were collected with the assistance of CTUIR biologists, using electrofishing and beach seines. Most species have no size limits (see Table 9). Those taken for analysis were judged large enough to be retained for consumption. The latitude and longitude of the sampling sites were recorded from a Magellan 320 GPS.

Fish selected for analysis were killed by a blow to the head. Each fish was given a unique identifying number and its length and weight recorded. The fish were individually wrapped in aluminum foil, put in plastic bags, and placed on ice for transport to Ecology headquarters, where the samples were frozen pending preparation of tissue samples.

Laboratory Procedures

Fish Tissue

Fish tissue samples were prepared following the guidance in EPA (2000b). Techniques to minimize potential for sample contamination were used. Persons preparing the samples wore non-talc nitrile gloves and worked on heavy duty aluminum foil or a polyethylene cutting board. The gloves and foil were changed between samples and the cutting board cleaned between samples, as described below.

The fish were thawed enough to remove the foil wrapper and rinsed with tap water, then deionized water to remove any adhering debris. The entire fillet from one or both sides of each fish (depending on its size) was removed with stainless steel knives and homogenized in a Kitchen-Aid or Hobart commercial blender. The fillets were skin-off for catfish, and scaled with skin-on for other species, as recommended by EPA (2000b). Whole fish samples were homogenized in the Hobart blender without scaling. The sex of each fish was recorded and hard structures (scales, otoliths, opercles, dorsal, and/or pectoral spines as appropriate for each species) saved for age determination.

Five individual fish were used for each composite sample. To the extent possible, the length of the smallest fish in each composite was no less than 75% of the length of the largest fish. The composites were prepared using equal weight aliquots from each fish. The pooled tissues were homogenized to uniform color and consistency, using a minimum of three passes through the blender. The homogenates were placed in 8 oz. glass jars with Teflon lid liners, cleaned to EPA (1990a) QA/QC specifications.

Cleaning of resecting instruments, cutting boards, and blender parts was done by washing in tap water with Liquinox detergent, followed by sequential rinses with tap water, de-ionized water, and pesticide-grade acetone. The items were then air dried on aluminum foil in a fume hood before use.

The tissue samples were refrozen for shipment with chain-of-custody record to Manchester Laboratory. The samples were stored frozen at Manchester until analyzed.

Appendix B contains detailed information on the age, length, and weight of each fish in the composite samples. Fish ages were determined by John Sneva and Lucinda Morrow of WDFW.

Chemical Analyses

The methods used to analyze samples collected for this study are listed in Table 12. All of the analyses were conducted by Manchester Laboratory, except PCB congeners were analyzed by Axys Analytical Services Ltd. in Sidney, B.C. Some additional details on analyzing the SPMDs are provided below.

Table 12. Laboratory Procedures.

Analysis	Matrix	Sample Prep Method	Analytical Method
Chlor. pesticides	SPMD	dialysis/GPC*, EPA SW-3620/3665	EPA SW-8081/8082
PCBs (Aroclor equiv.)	SPMD	dialysis/GPC*, EPA SW-3620	EPA SW-8082
Chlor. pesticides	whole water	EPA SW-3510	EPA SW-8081
TSS	whole water	n/a	EPA 160.2
Turbidity	whole water	n/a	SM 2130
TOC, DOC	whole water	n/a	EPA 415.1
Conductivity	whole water	n/a	EPA 120.1
Chlor. pesticides	WWTP effluent	EPA SW-3510	EPA SW-8081
PCBs (congeners)	WWTP effluent	EPA 1668A	EPA 1668A
TSS	WWTP effluent	n/a	EPA 160.2
Conductivity	WWTP effluent	n/a	EPA 120.1
Chlor. pesticides	fish tissue	EPA SW-3540/3620/3665	EPA SW-8081
PCBs (Aroclor equiv.)	fish tissue	EPA SW-3540	EPA SW-8082
Percent lipid	fish tissue	extraction	EPA 608.5
Percent solids	fish tissue	dry @ 105^{o}C	SM 2540

*EST SOPs E14, E15, E19, E21, E33, E44, E48
n/a = not applicable

The SPMDs were spiked with pesticide/PCB surrogates, extracted (referred to as dialysis), and cleaned up by gel permeation chromatography at EST. The cleaned-up extracts were then analyzed by Manchester Laboratory.

The SPMD samples arrived at Manchester as hexane extracts of 4-5 mL volume in heat-sealed ampoules. The extracts were quantitatively transferred to centrifuge tubes, then concentrated under a nitrogen gas stream to approximately 1 mL. Each extract was eluted through a macro Florisil® column: first with 100% hexane which was collected as the 0% Florisil® fraction, followed by a 50% hexane/preserved diethyl ether solution which was collected as the 50% Florisil® fraction. The extracts were then solvent exchanged into iso-octane and concentrated to approximately 1 mL. The 50% fraction was split into two portions. One portion of the 50% fraction and the 0% fraction were treated with concentrated sulfuric acid to remove interferences prior to analysis by dual column GC-ECD (gas chromatography – electron capture detection). The untreated portion of the 50% fraction was analyzed without further treatment. Excess extract was stored at 0^{o}C.

Calculation Procedures for SPMDs

The sampling rates of standard SPMD membranes have been determined in the laboratory for a variety of organic compounds. Sampling rate varies with temperature, water velocity, and biofouling. Flow generally has a greater impact than either temperature or biofouling. Reliable estimates of average dissolved concentrations for the chemicals of interest require field data on temperature and an adjustment of laboratory-derived sampling rates for the water velocity and biofouling conditions that existed during deployment.

For the Walla Walla study, temperature was monitored continuously for each SPMD deployment. The effects of water velocity and biofouling were accounted for by spiking each membrane with Permeability/Performance Reference Compounds (PRCs). PRCs are analytically non-interfering compounds with moderate to relatively high fugacity (escape tendency). The use of PRCs can be viewed as an *in situ* calibration/recalibration approach, where the rate of PRC loss during exposure is related to target compound uptake. This is accomplished by measuring PRC loss rates during laboratory calibration studies and field exposures. Using these values, an exposure adjustment factor (EAF) is derived.

A fundamental assumption of the PRC approach is that PRCs can be used to predict the EAFs of chemicals over a range of octanol-water partition coefficients (K_{ow}[5]). Based on recent studies by Huckins et al. (2002), this assumption appears valid, and the difference between measured concentrations of an analyte and the PRC-derived estimates should be within a factor of 2.

PCB-4 (2,2'-dichlorobiphenyl) and PCB-29 (2,4,5-trichlorobiphenyl) were used as PRCs for the Walla Walla study. These congeners are not present to any significant extent in commercial PCB mixtures or in environmental samples. The SPMD membranes were spiked with 0.2 ng of each congener prior to being deployed in the field. The spiking was done by EST using a spiking solution provided by Manchester Laboratory.

The data on exposure time, temperature, initial and final PRC concentration, and chemical residues in the SPMDs were entered into an Excel spreadsheet calculator developed by David Alvarez, USGS Columbia Environmental Research Center (Appendix C). PCB-29 was used as the PRC for these calculations since its K_{ow} is closer to those of the target compounds. The equations behind this spreadsheet can be found at http://wwwaux.cerc.cr.usgs.gov/spmd/SPMD-Tech_Tutorial.htm.

No laboratory calibration data were available for toxaphene. Concentrations were estimated by assuming equilibrium and using an average log K_{ow} of 4.36. The toxaphene concentrations arrived at using this approach should be considered rough estimates.

[5] Octanol-water partition coefficient, a measure of a chemical's tendency to associate with the organic fraction in water

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Data Quality

Laboratory Case Narrative Summary

Manchester Laboratory prepared written case narratives assessing the quality of the data collected for this project. These reviews include a description of analytical methods and an assessment of holding times, initial and continuing calibration and degradation checks, method blanks, surrogate recoveries, matrix spike recoveries, laboratory control samples, and laboratory duplicates. The reviews and the complete Manchester data reports are available from the author on request.

Data quality issues pertinent to the pesticide/PCB analyses are summarized below. No significant problems were encountered in the conventional water quality analyses. The complete pesticide/PCB data set for the SPMD, whole water, effluent, and fish samples, including data qualifiers, is in Appendix D. The data are also available electronically through the Ecology Environmental Information Management System (EIM) at http://www.ecy.wa.gov/ecyhome.html.

SPMD Extracts

Pesticide peaks in the SPMD extracts were generally large and easily distinguishable, and the data required little qualification. The main toxaphene congeners appeared to elute in both the 0% and 50% Florisil fractions. Because of the analyte split, the overall pattern of toxaphene could not be determined and consequently all of the detections were qualified as estimated values. The dieldrin data for the May-June 2002 deployment were qualified as estimates due to possible losses during the analysis. Except for Garrison, Mill, and Yellowhawk creeks, most of the PCB concentrations were below the reporting limit of 100 ng and therefore qualified as estimates.

Surface Water Grabs

A number of problems were encountered in attempting to analyze the low levels of dieldrin, hexachlorobenzene, and heptachlor epoxide present in the whole water samples. These included interferences, method blank contamination, poor spike recoveries, and imprecision. There were also some low-level interferences affecting the ability to identify 4,4'-DDT and 4,4'-DDD. Therefore, the use of these data in the present report is limited to 4,4'-DDE.

WWTP Effluents

Pesticide extracts from the WWTP effluent samples contained high levels of many unknowns that obscured analyte peaks. Due to the severe interferences, all pesticide data were qualified, either at an estimated reporting limit or as an estimated result. The PCB congener data required no special qualification.

Fish Tissue

All fish tissue results above the reporting limits for cis-nonachlor, toxaphene, and 4,4'-DDT were qualified as estimates. These analytes elute in both the 0% and 50% fractions. For each compound, the concentration of one of the fractions could not be determined due to interferences from other analytes present in the sample.

PCB mixtures in the fish tissues most closely resembled Aroclor-1254 and -1260. The results were qualified as estimates due to weathering and/or interferences from other Aroclors or toxaphene.

Field Quality Control Samples

Replicates and Splits

The results from replicate SPMDs and grab samples provide estimates of the total variability (field + laboratory) associated with the water column and effluent data contained in the present report.

Two sets of SPMDs were deployed side-by-side in Yellowhawk Creek during August-September 2002. The concentrations calculated from these samplers agreed within 15% or better for all chemicals except heptachlor epoxide where results differed by 32% (Appendix E).

Replicate surface water grabs were taken on one occasion each from the lower Walla Walla River, Pine Creek, and the East Little Walla Walla River (Appendix E). Four pesticide compounds were detected in these samples. Only 4,4'DDE and heptachlor epoxide were quantified in each replicate pair, and concentrations varied by 0 – 7%. Variability greater than 21 – 23% was associated with the detection of 4,4'-DDT and dieldrin. Results for conventional water quality parameters agreed within 20%.

Effluent samples were collected from the Walla Walla and College Place WWTPs on two consecutive days to assess short-term variability in pesticide/PCB concentrations. The Walla Walla samples for the second day were analyzed in duplicate (laboratory splits) to obtain estimates of analytical precision. The results (Appendix E), indicate day-to-day variability ranged from >1– > 65% for pesticides and 16 – 27% for PCBs. Similar variability was encountered for pesticides in the split samples. Good analytical precision was indicated for PCBs where the duplicates agreed within 7%.

The field variability inherent in fish tissue data was minimized by using composite samples. Estimates of analytical precision were obtained by analyzing laboratory splits (Appendix E). Except for chemicals present in trace amounts, duplicate analyses generally agreed within 30% or better for pesticides and 12% or better for PCBs. The toxaphene analysis was less precise, for reasons previously explained. Poor precision was achieved in the carp fillet composite, even for chemicals present in substantial concentrations. Recovery of pesticide and PCB surrogate spikes were similar, so the imprecision is likely due to a poorly homogenized sample.

All results from replicate and split samples were averaged for use in the remainder of this report.

Field Blanks

Because SPMDs sample vapors while being exposed to air, field blanks were used to assess chemical accumulation during deployment and retrieval. The SPMD field blank consisted of five membranes in an argon-filled stainless steel can. It was opened to the air for the average amount of time it took to open and place the SPMDs in the water. The blank was then resealed and refrozen. It was taken back into the field and opened and closed again to mimic the retrieval process. The blank was prepared, processed, and analyzed the same as deployed SPMDs. There was one field blank for each sampling period. The total time each blank was exposed to air ranged from three to seven minutes.

The results from analyzing the SPMD field blanks are in Appendix D. Pesticide concentrations in the blank were subtracted from concentrations measured in deployed SPMDs. Blank concentrations were generally lower than the samples by an order of magnitude or more, except for chlordane. At the time of the survey, the EST laboratory had chronic low-level chlordane contamination.

A PCB background was detected in the SPMD field blanks for November-December and February-March, but not for the other deployments. Analysis of laboratory blanks suggested the source was at EST. PCB concentrations less than three times the blank for these two time periods are flagged but not blank corrected.

Transfer and bottle blanks for pesticides and PCBs were analyzed for the surface water grabs and the effluent samples. These consisted of sample bottles filled with organic-free water at Manchester and AXYS laboratories. The transfer blank was prepared by pouring the blank water into sample containers while in the field. No significant contamination was evident in any of these samples.

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Results of Field Study

Surface Water

Flow Conditions

Flows in the Walla Walla River during the 2002-03 monitoring period for the chlorinated pesticide/PCB TMDL study are compared to historical averages in Figure 10. The data are for USGS gaging station #14018500 near Touchet (http://waterdata.usgs.gov/nwis/sw). The period of record is 1952 – 2002.

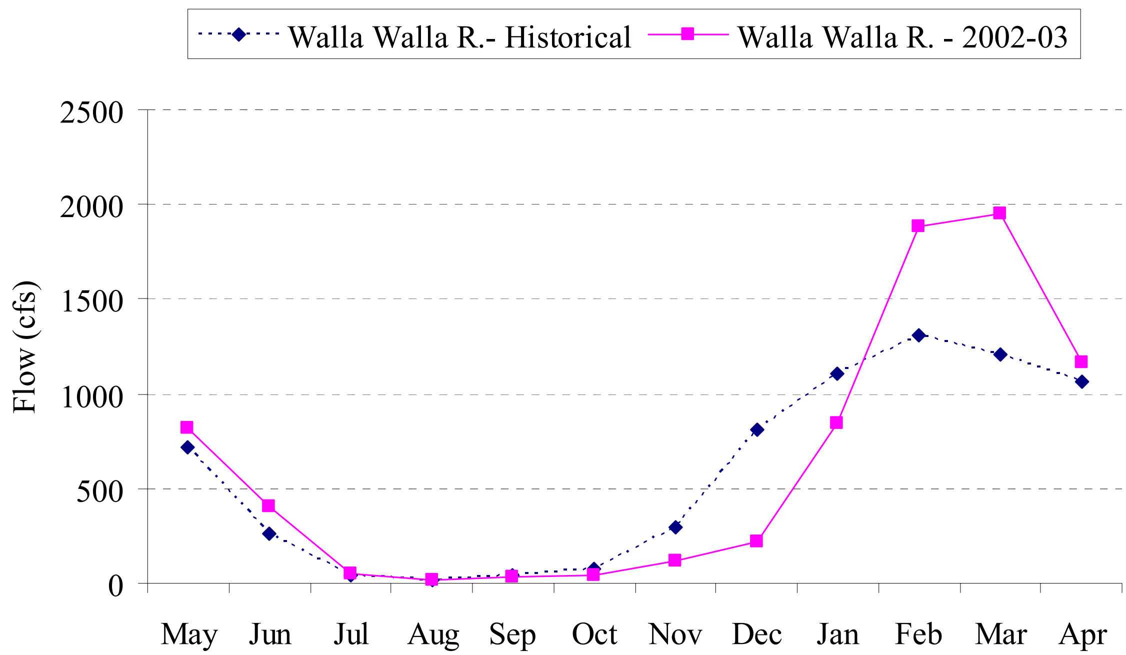


Figure 10. Walla Walla River Flow During the 2002 - 2003 TMDL Study Compared to Historical Averages (USGS data).

From May through October 2002, river flows were at or slightly above normal, ranging from a monthly average of 817 cubic feet per second (cfs) in May to 13 cfs in August. Historical averages are 721 cfs and 19 cfs, respectively. This time frame included the first two SPMD deployments and associated grab samples of May-June and August-September.

Since 2000, three large irrigation districts – two in Oregon, one in Washington – have been bypassing 18 to 28 cfs to maintain flows in the Walla Walla mainstem, as part of an agreement with the U.S. Fish & Wildlife Service. As a result, flows from the Oregon state line down to the Lowden area have been higher than those prior to 2000 (Bill Neve, Ecology Eastern Regional Office, personal communication, 2002).

The winter of 2002-03 was unusually dry, followed by a wet spring. Flows in the Walla Walla were lower than normal in November-December 2002 when the third set of SPMDs was deployed, averaging 115 – 845 cfs. For the fourth deployment in February-March, flows averaged around 1,900 cfs which is higher than normal. A possible effect of the atypical winter flows for 2002-2003 is that the November-December data may underestimate typical pesticide/PCB concentrations in the drainage, while the concentrations measured in February-March could be higher than normal.

Dissolved Pesticide/PCB Concentrations

Chlorinated pesticide and PCB concentrations measured in the SPMD samples are shown in Table 13. These monthly averages are condensed to annual averages in Table 14. The results are for the dissolved form of the chemical. Flow and conventional water quality data collected in conjunction with the SPMDs are in Appendix F.

Table 13. Monthly Average Pesticide/PCB Concentrations Measured Using SPMDs in the Walla Walla Drainage During 2002-2003 [ng/L dissolved; parts per trillion].

Chemical	Upper Mill Cr.	Upper Walla Walla	Yellow-hawk Cr.	Garrison Creek	Lower Mill Cr.	Middle Walla Walla	Dry Creek	Pine Creek	Touchet River	Lower Walla Walla
May - June 2002										
Sample No.	208091	208090	208089	208088	208086	208085	208083	208084	244011	244010
Total DDT	0.60	1.3	6.5	4.4	2.2	4.3	2.7	5.5	0.46	2.7
Total Chlordane	0.70	1.0	2.4	6.4	2.4	2.0	3.3	2.3	0.23	2.0
Dieldrin	0.45	<0.2	2.0	0.68	0.88	1.3	2.8	0.70	0.07	0.43
Hexachlorobenzene	0.15	0.22	0.57	0.93	0.51	0.68	3.3	0.80	0.21	0.57
Heptachlor Epoxide	<0.1	<0.1	0.24	0.18	0.06	0.16	1.9	0.61	0.09	0.30
Toxaphene	<0.3	<0.3	~0.3	<0.3	~0.57	~0.57	~0.51	~40	~0.24	~8.3
Total PCBs	<1	<1	1.1	9.2	<1	0.80	0.65	<1	0.21	0.84
August - September 2002										
Sample No.	038091	038090	038088/89	038084	038085	038087	038083	038082	038081	038080
Total DDT	0.18	0.43	2.2	2.1	0.91	1.4	0.40	0.60	0.75	0.84
Total Chlordane	0.19	0.31	1.1	2.4	1.2	0.81	0.44	0.29	0.42	0.35
Dieldrin	0.05	0.03	0.64	<0.8	1.2	0.44	0.36	0.26	<0.03	0.19
Hexachlorobenzene	0.10	0.14	0.14	0.38	0.34	0.23	1.4	0.32	0.67	0.34
Heptachlor Epoxide	0.01	0.03	0.06	0.11	0.14	0.14	0.18	0.34	0.12	0.13
Toxaphene	<0.3	<0.3	<0.3	~1.8	<0.3	~0.62	<0.3	~1.7	~0.74	~0.93
Total PCBs	<0.3	<0.7	1.1	3.2	<0.9	<0.5	<0.7	<0.8	0.26	0.26
November - December 2002										
Sample No.	078967	078966	078964	078962	078963	078965	078961	078960	078959	078958
Total DDT	0.06	0.17	1.6	0.34	0.71	0.76	0.13	0.51	0.06	0.28
Total Chlordane	<0.05	<0.05	5.6	0.35	0.37	0.27	<0.05	<0.05	<0.05	<0.05
Dieldrin	0.04	0.02	12	<0.4	1.1	0.80	0.34	0.19	0.03	0.13
Hexachlorobenzene	0.13	0.12	0.09	0.20	0.42	0.34	0.63	0.07	0.13	0.17
Heptachlor Epoxide	0.04	0.01	0.06	0.04	0.07	0.05	0.13	0.07	0.03	0.03

Chemical	Upper Mill Cr.	Upper Walla Walla	Yellow-hawk Cr.	Garrison Creek	Lower Mill Cr.	Middle Walla Walla	Dry Creek	Pine Creek	Touchet River	Lower Walla Walla
Toxaphene	<0.3	<0.3	~0.57	<0.3	<0.3	~0.28	~0.30	~5.4	<0.3	~1.7
Total PCBs	0.11*	0.18*	0.32	0.77	0.54	0.35	0.14*	<0.6	0.14*	0.17*
February - March 2003										
Sample No.	157510	157509	157507	157504	157505	157508	157503	157502	157501	157500
Total DDT	0.39	0.37	4.6	0.93	1.9	3.3	0.6	1.6	0.40	1.4
Total Chlordane	0.06	<0.05	1.7	0.73	0.32	0.81	0.07	0.30	0.02	0.16
Dieldrin	0.18	<0.04	0.30	<0.4	0.55	0.46	0.32	0.84	0.06	0.21
Hexachlorobenzene	0.10	0.05	0.56	0.46	0.49	0.52	0.62	0.57	0.26	0.34
Heptachlor Epoxide	0.01	<0.02	0.06	0.04	0.03	0.07	0.09	0.38	0.03	0.07
Toxaphene	<0.3	<0.3	~1.6	<0.3	<0.3	~0.45	~0.45	~3.4	<0.3	~1.9
Total PCBs	0.13*	0.17*	<0.5	1.0	0.84	0.67	0.18*	<0.8	0.09*	<0.6

*Laboratory contamination may have contributed to this result

Table 14. Annual Average Pesticide/PCB Concentrations Measured Using SPMDs in the Walla Walla Drainage During 2002-2003 [ng/L dissolved; parts per trillion].

Chemical	Upper Mill Cr.	Upper Walla Walla	Yellow-hawk Cr.	Garrison Creek	Lower Mill Cr.	Middle Walla Walla	Dry Creek	Pine Creek	Touchet River	Lower Walla Walla
Total DDT	0.31	0.56	3.7	1.9	1.4	2.4	0.95	2.0	0.42	1.3
Total Chlordane	0.25	0.36	2.7	2.5	1.1	1.0	1.0	0.73	0.18	0.65
Dieldrin	0.18	0.07	3.8	0.57	0.92	0.75	1.0	0.50	0.05	0.24
Hexachlorobenzene	0.12	0.13	0.34	0.49	0.44	0.44	1.5	0.44	0.32	0.36
Heptachlor Epoxide	0.04	0.04	0.10	0.09	0.08	0.11	0.58	0.35	0.07	0.1
Toxaphene	<0.3	<0.3	~0.70	~0.68	~0.37	~0.48	~0.39	~13	~0.39	~3.2
Total PCBs	0.12*	0.18*	0.86	3.6	0.69	0.61	0.32*	nd	0.18*	0.42

Note: Detection limit used to calculate averages, except total PCB averages are measured values only.
*Laboratory contamination may have contributed to this result.
nd = not detected

In these and subsequent tables and figures, t-DDT (total DDT) is the sum of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD. T-chlordane is the sum of *cis* and *trans* chlordane, *cis* and *trans* nonachlor, and oxychlordane. T-PCBs is the sum of detected aroclor-equivalents. Heptachlor and 2,4' isomers of DDT, DDE, and DDD were analyzed for this study but rarely detected or present at low concentrations; these data are in Appendix D.

Pesticide concentrations in the Walla Walla drainage generally decreased following the order t-DDT > t-chlordane > dieldrin >hexachlorobenzene > heptachlor epoxide. Toxaphene and PCBs were quantified less consistently than these other compounds, and concentrations were more variable.

Upper Mill Creek and the upper Walla Walla River at the state line had the lowest concentrations of both pesticides and PCBs. The Touchet River also had a consistently low level of contamination relative to the Walla Walla River and other tributaries.

On average, the highest t-DDT, t-chlordane, and dieldrin concentrations were found in Yellowhawk Creek, 3.7, 2.7, and 3.8 ng/L, respectively. Maximum t-DDT and dieldrin concentrations of 6.5 and 12 ng/L were recorded here. The maximum t-chlordane concentration however was in Garrison Creek at 6.4 ng/L. Dry Creek had the highest concentrations of hexachlorobenzene and heptachlor epoxide, averaging 1.5 and 0.6 ng/L.

Large amounts of toxaphene were detected in Pine Creek, where concentrations up to approximately 40 ng/L were found. Toxaphene had not been reported previously in the Walla Walla drainage and was initially not a target compound for the TMDL. As described elsewhere in this report, the toxaphene concentrations determined from the SPMDs are considered to be rough estimates.

Creeks in the urbanized Mill Creek watershed had higher PCB concentrations than those that drained farming areas. The maximum t-PCB concentrations, 0.77 – 9.2 ng/L, were measured in Garrison Creek. Lower Mill Creek and Yellowhawk Creek had the second highest PCB levels, 0.54 – 1.1 ng/L, for the two monitoring periods where PCBs were detected in these streams. PCBs could not be quantified in a number of samples due to interferences.

Table 15 has a ranked list of the mainstem sampling sites and tributaries ordered from highest to lowest annual average concentrations of pesticides and PCBs.

Table 15. SPMD Monitoring Sites in the Walla Walla Drainage, Ranked from Highest to Lowest Annual Average Pesticide/PCB Concentrations.

Rank	Total DDT	Total Chlordane	Dieldrin
1	Yellowhawk Creek	Yellowhawk Creek	Yellowhawk Creek
2	Middle Walla Walla	Garrison Creek	Dry Creek
3	Pine Creek	Lower Mill Creek	Lower Mill Creek
4	Garrison Creek	Dry Creek	Middle Walla Walla
5	Lower Mill Creek	Middle Walla Walla	Garrison Creek
6	Lower Walla Walla	Pine Creek	Pine Creek
7	Dry Creek	Lower Walla Walla	Lower Walla Walla
8	Upper Walla Walla	Upper Walla Walla	Upper Mill Creek
9	Touchet River	Upper Mill Creek	Upper Walla Walla
10	Upper Mill Creek	Touchet River	Touchet River

Rank	Hexachlorobenzene	Heptachlor Epoxide	Toxaphene
1	Dry Creek	Dry Creek	Pine Creek
2	Garrison Creek	Pine Creek	Lower Walla Walla
3	Lower Mill Creek	Lower Walla Walla	Yellowhawk Creek
4	Middle Walla Walla	Middle Walla Walla	Garrison Creek
5	Pine Creek	Yellowhawk Creek	Middle Walla Walla
6	Lower Walla Walla	Garrison Creek	Touchet River
7	Yellowhawk Creek	Lower Mill Creek	Dry Creek
8	Touchet River	Touchet River	Lower Mill Creek
9	Upper Walla Walla	Upper Mill Creek	Upper Mill Creek
10	Upper Mill Creek	Upper Walla Walla	Upper Walla Walla

Rank	Total PCBs
1	Garrison Creek
2	Yellowhawk Creek
3	Lower Mill Creek
4	Middle Walla Walla
5	Lower Walla Walla
6	Dry Creek
7	Upper Walla Walla/ Touchet River
8	Upper Mill Creek
9	Pine Creek*

*elevated detection limits

Temporal and Spatial Patterns

Figure 11 plots the pesticide and PCB data for the SPMD monitoring sites in the upper, middle, and lower Walla Walla River. For purposes of illustration, the detection limit was used where a pesticide was not detected. Because interferences resulted in variable detection limits for PCBs, non-detects were not plotted for these compounds.

The level of pesticide/PCB contamination in the mainstem showed marked seasonal variation. The highest pesticide concentrations always occurred during May-June; the lowest concentrations almost always occurred in November-December. February-March generally saw the second highest levels concentrations. The May-June peak is likely attributable to the beginning of the irrigation season. Runoff from agricultural land is lowest in November-December, thus minimal concentrations are observed. The highest PCB concentrations were similarly recorded in May-June and February-March.

Seasonal fluctuations in pesticide/PCB levels were also pronounced in the tributaries (see Table 13). Again, the May-June period generally saw the highest concentrations, although there were exceptions.

Pesticides and PCBs increased substantially in the Walla Walla mainstem between the Oregon border and middle river (Detour Road). On average, concentrations increased by factors of 2-to-4 from the upper to middle river, with an 11-fold increase for dieldrin. Except for toxaphene, concentrations generally decreased in the lower Walla Walla River (below Cummins Bridge). The reduced lower river concentrations are largely attributable to dilution by the Touchet River (see following section). The lower river averaged five times the toxaphene concentrations measured upstream.

An appreciation for the overall spatial distribution of contaminant sources within the watershed and their effect on the Walla Walla River can be gained from Figures 12 – 18 which plot the annual average pesticide/PCB concentrations (from Table 14).

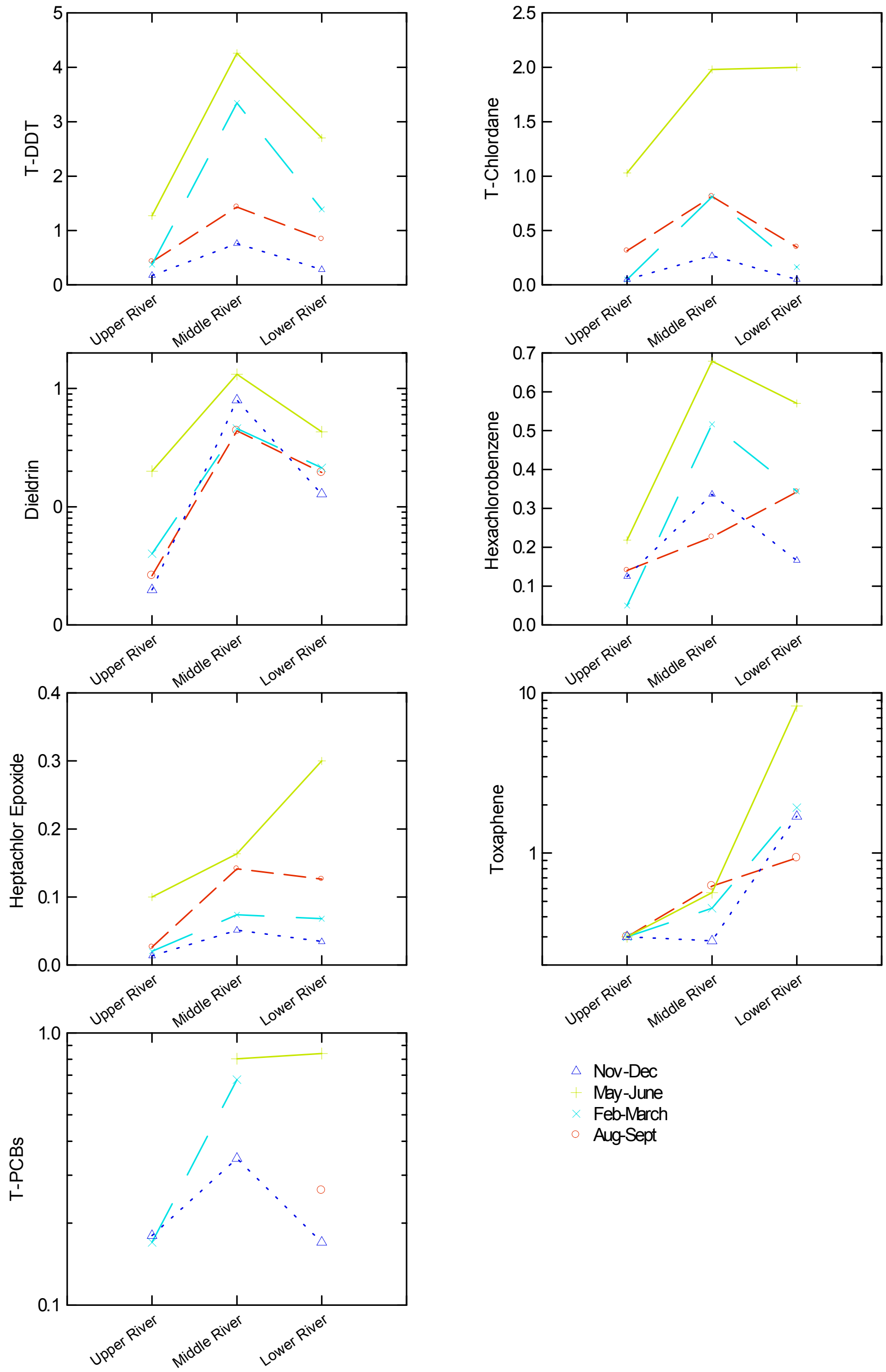


Figure 11. Seasonal Patterns of Pesticide/PCB Concentrations in the Mainstem Walla Walla River (ng/L dissolved).

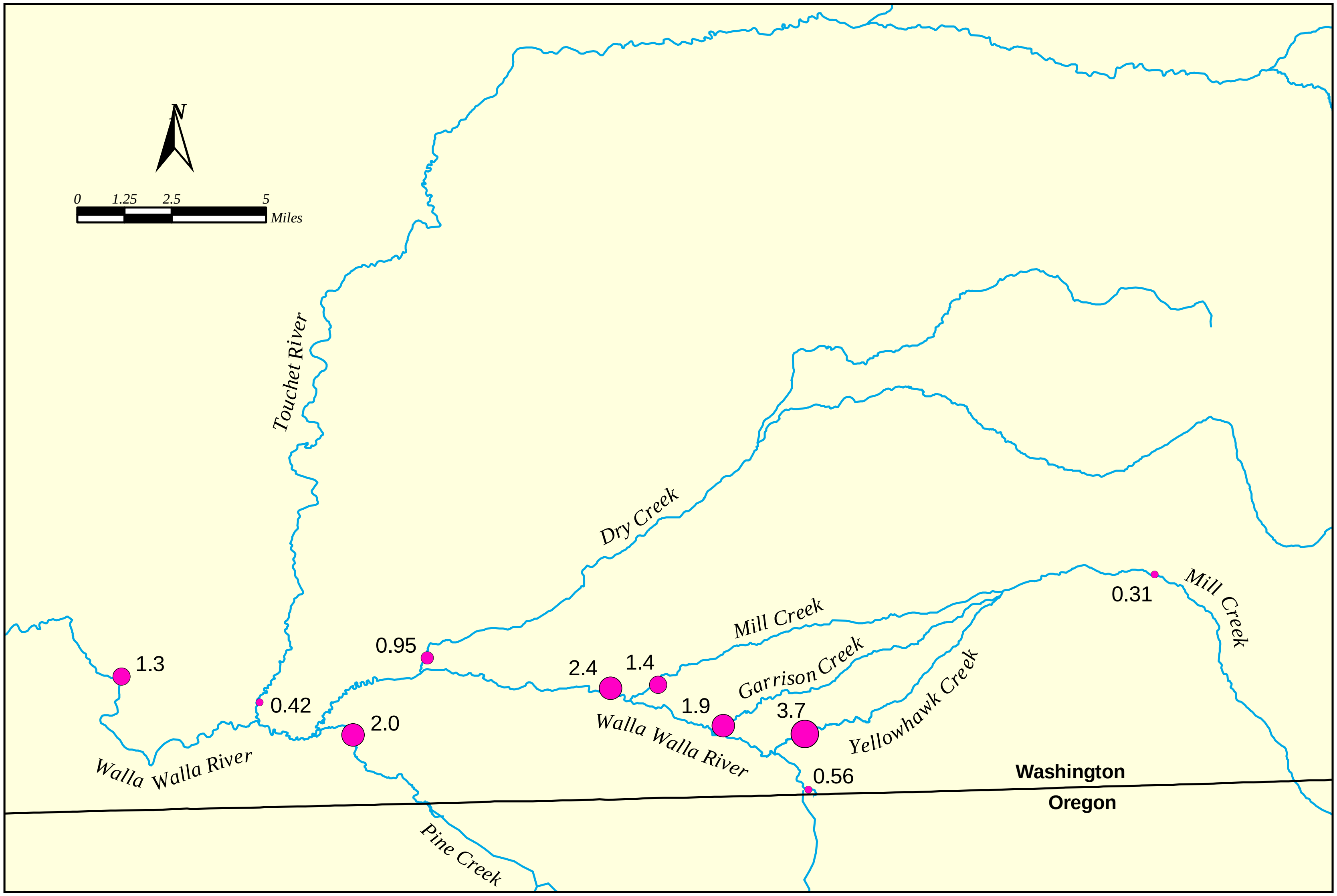


Figure 12. Annual Average Total DDT Concentrations Measured in the Walla Walla Drainage (ng/L dissolved; parts per trillion).

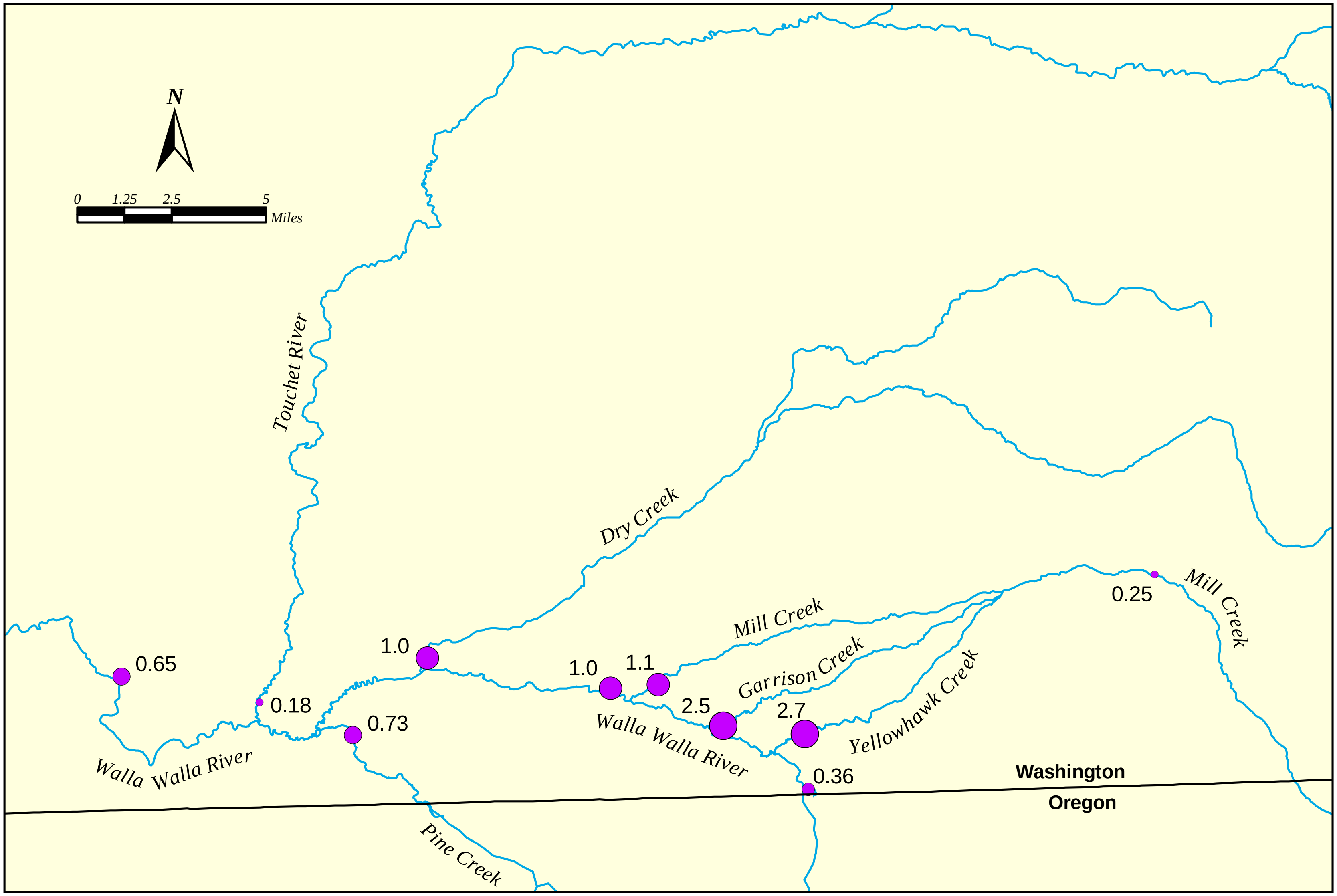


Figure 13. Annual Average Total Chlordane Concentrations Measured in the Walla Walla Drainage (ng/L dissolved; parts per trillion).

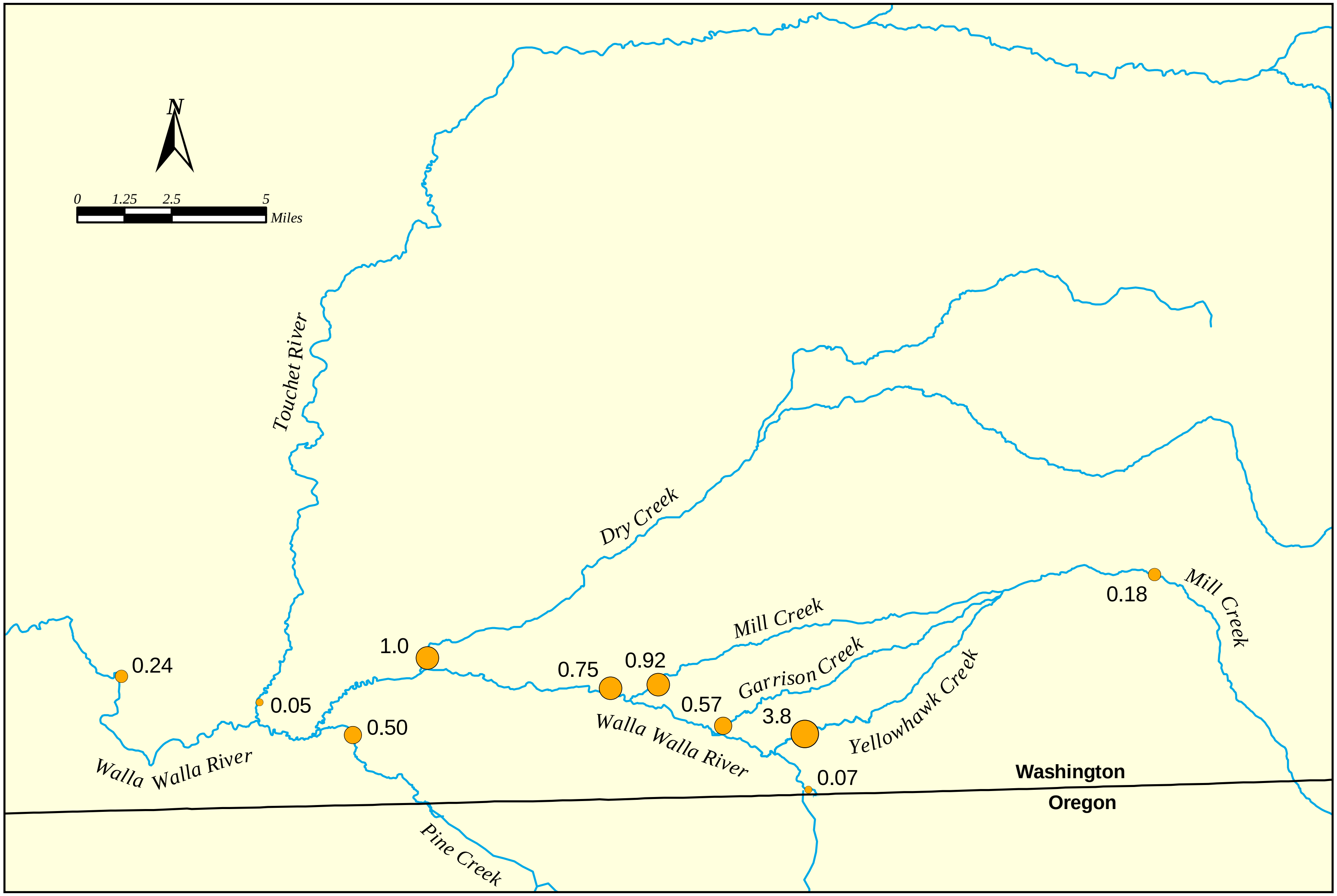


Figure 14. Annual Average Dieldrin Concentrations Measured in the Walla Walla Drainage (ng/L dissolved; parts per trillion).

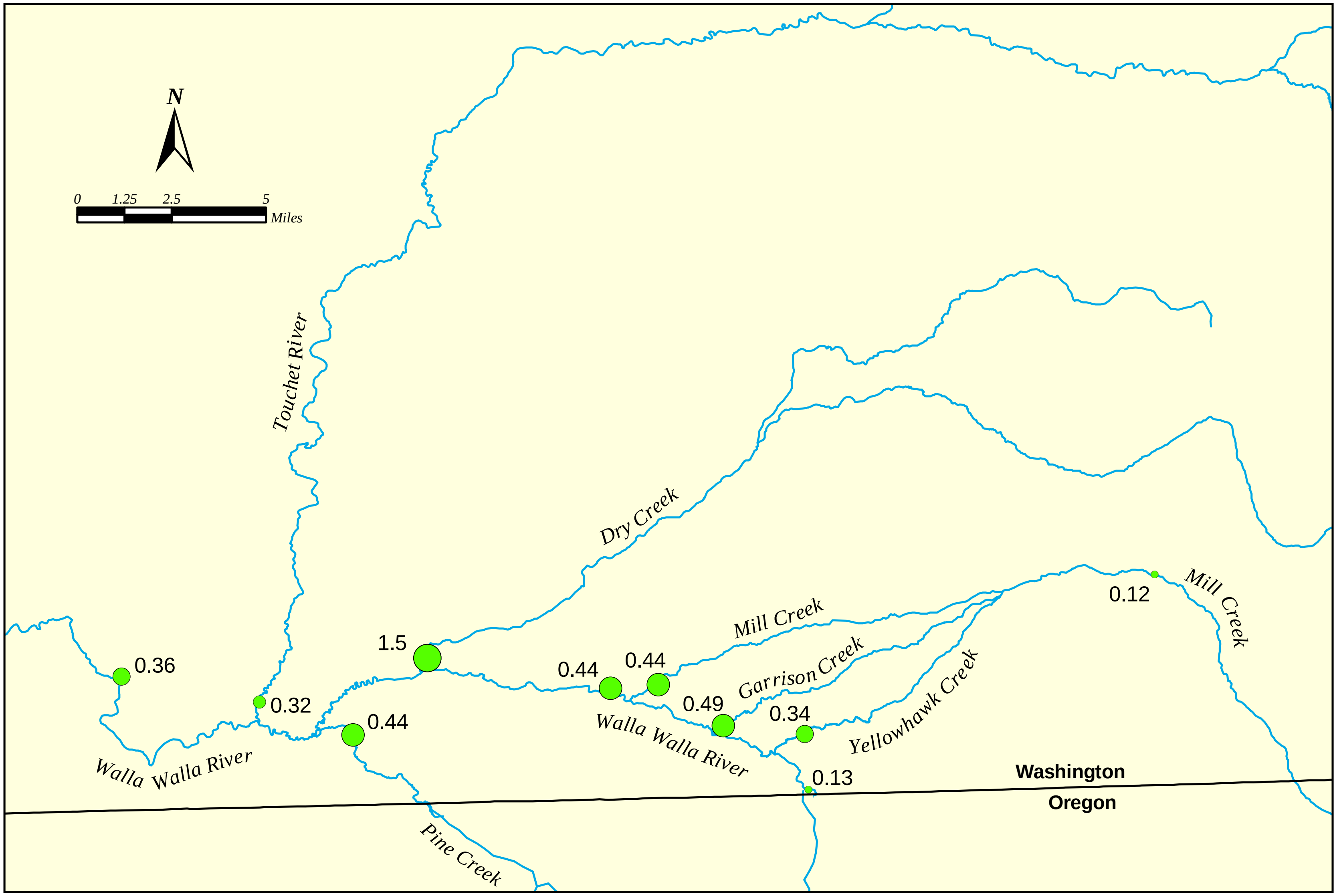


Figure 15. Annual Average Hexachlorobenzene Concentrations Measured in the Walla Walla Drainage (ng/L dissolved; parts per trillion).

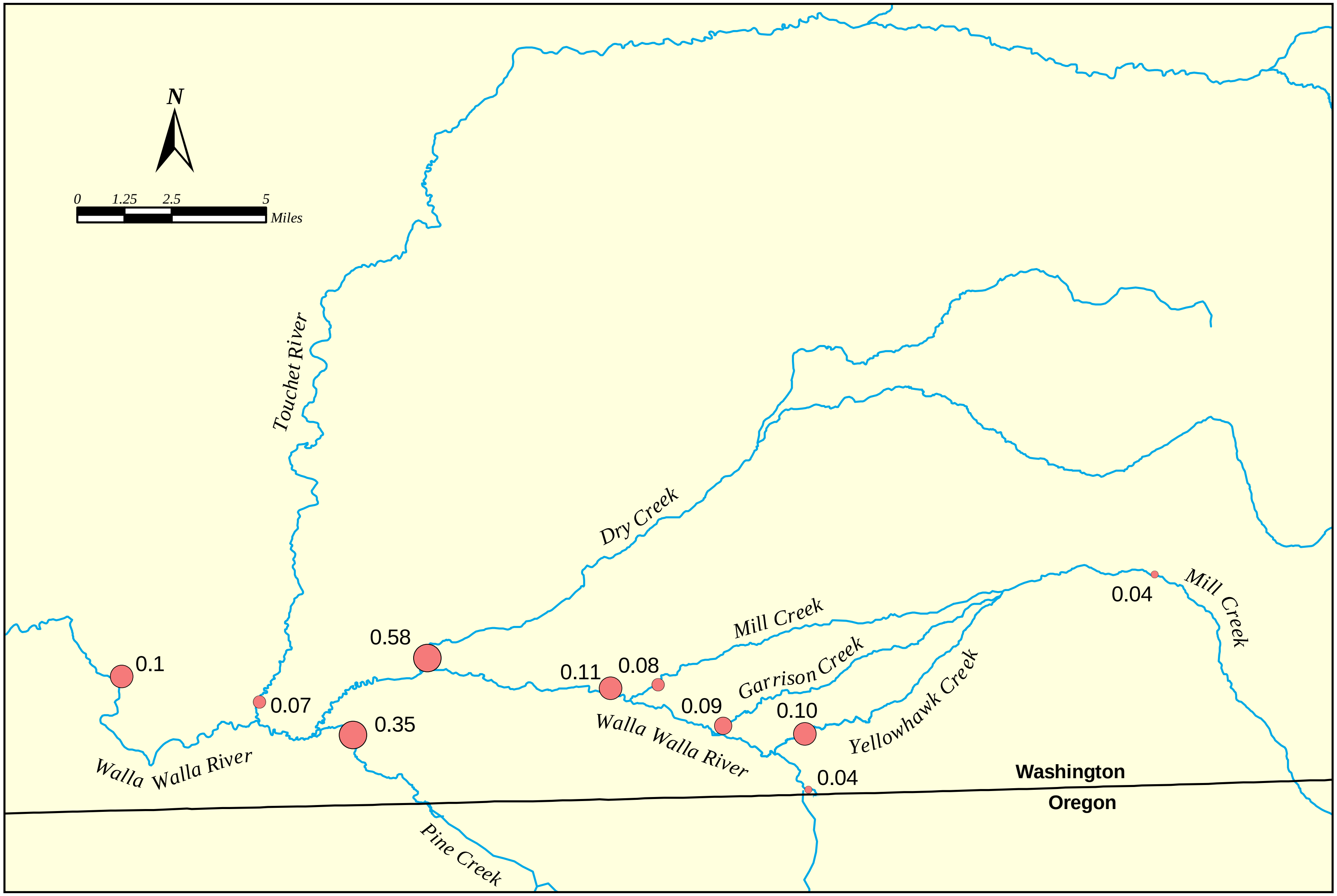


Figure 16. Annual Average Heptachlor Epoxide Concentrations Measured in the Walla Walla Drainage (ng/L dissolved; parts per trillion).

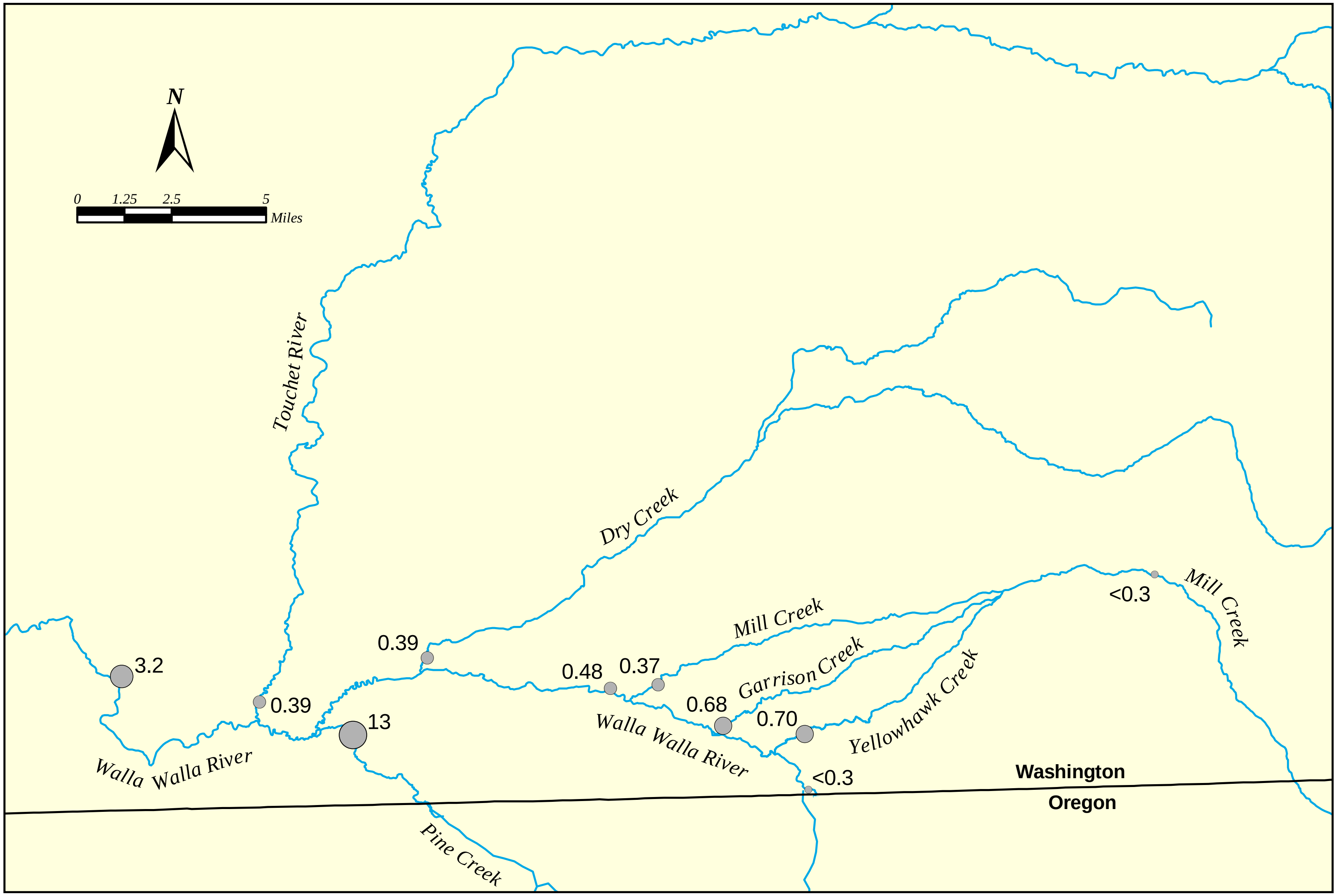


Figure 17. Annual Average Estimated Toxaphene Concentrations Measured in the Walla Walla Drainage (ng/L dissolved; parts per trillion).

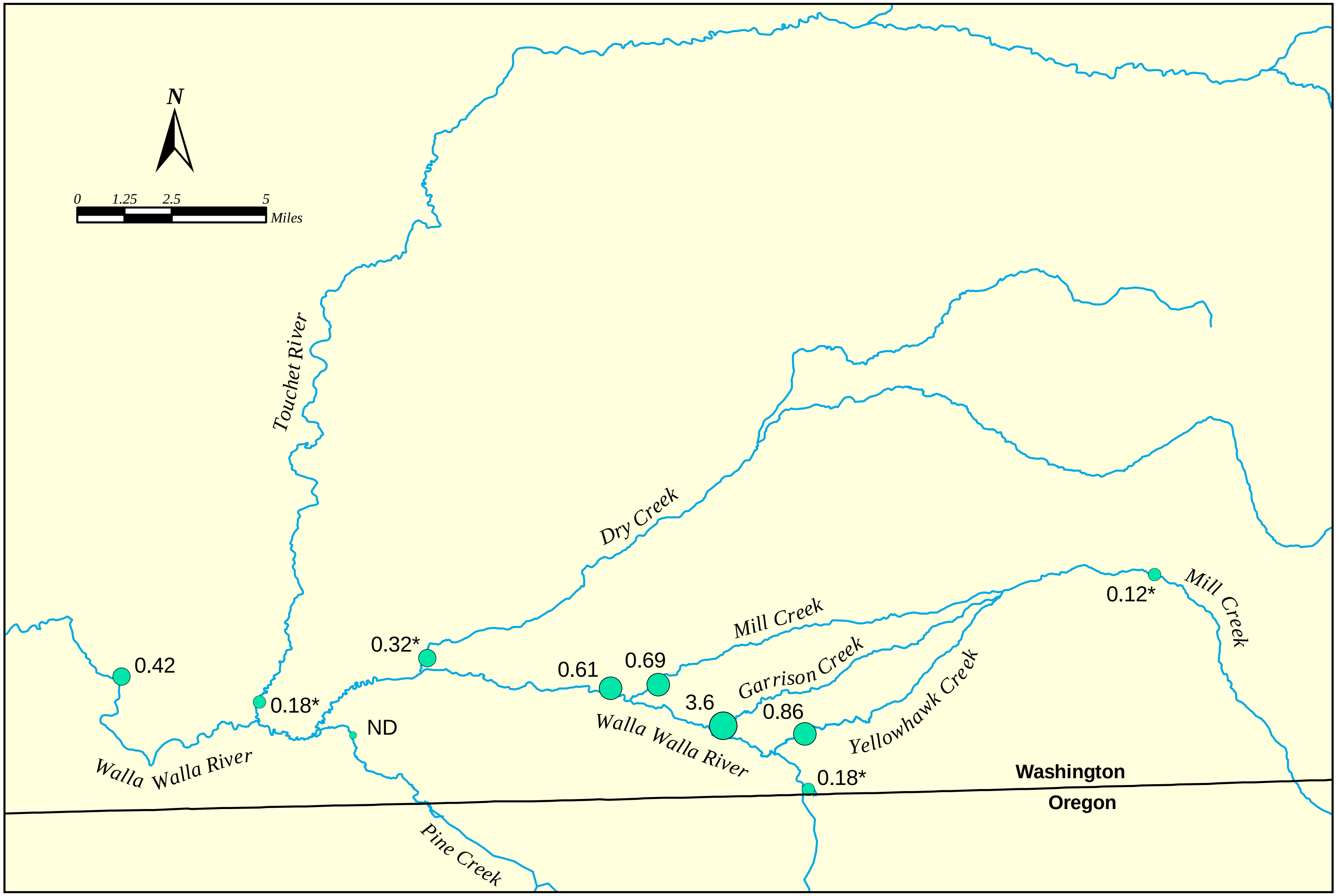


Figure 18. Annual Average Total PCB Concentrations Measured in the Walla Walla Drainage (ng/L dissolved; parts per trillion).
*Laboratory contamination may have contributed to this result

Total Pesticide/PCB Concentrations

When chlorinated organic compounds are discharged to surface waters, they partition between dissolved and particulate fractions. Total pesticide/PCB concentrations in the Walla Walla drainage were estimated from the dissolved SPMD data using the equation $C_{w\text{-}tot} = C_w (1 + TOC (K_{oc}/M_w))$ where C_w is the dissolved concentration, K_{oc} is the organic carbon-water equilibrium partition coefficient, and M_w is the mass of water (Meadows et al., 1998). The TOC data are in Appendix F. K_{oc} was calculated from the K_{ow} values used to determine the dissolved concentrations (Appendix C) and Karickhoff's (1981) approximation $K_{oc} = 0.411K_{ow}$. Results of these calculations are shown in Table 16.

In most cases, the relative amount of dissolved chemical was consistent from one part of the drainage to another. Table 17 summarizes the dissolved percentages for the mainstem Walla Walla River. Calculations indicate that more than 90% of the toxaphene, heptachlor epoxide, and dieldrin would be expected to be in dissolved form. Hexachlorobenzene would be approximately 70% dissolved. T-DDT and t-chlordane split about equally between dissolved and particulate fractions. Most of the PCBs are associated with particulates.

Table 16. Estimates of Total Pesticide/PCB Concentrations in the Walla Walla Drainage During 2002-2003 [ng/L; parts per trillion].

Chemical	Upper Mill Cr.	Upper Walla Walla	Yellow-hawk Cr.	Garrison Creek	Lower Mill Cr.	Middle Walla Walla	Dry Creek	Pine Creek	Touchet River	Lower Walla Walla
May - June 2002										
Total DDT	0.90	2.3	12	11	3.9	7.6	11	11	1.0	5.6
Total Chlordane	1.3	1.9	4.3	17	4.0	3.3	10	11	0.45	4.1
Dieldrin	0.47	<0.2	2.1	0.73	0.91	1.4	3.2	0.73	0.07	0.45
Hexachlorobenzene	0.20	0.31	0.85	1.7	0.73	0.96	9.2	1.3	0.34	0.91
Heptachlor Epoxide	<0.1	<0.1	0.25	0.19	0.06	0.17	2.1	0.63	0.09	0.31
Toxaphene	<0.3	<0.3	~0.31	<.3	~0.58	~0.58	~0.55	~41	~0.24	~8.5
Total PCBs	<3	<3	3.8	45	<3	2.5	6.3	<4	0.83	3.3
August - September 2002										
Total DDT	0.24	0.65	3.8	6.4	1.5	2.3	0.72	1.8	1.5	1.9
Total Chlordane	0.28	0.52	1.8	8.3	2.0	1.2	0.83	1.1	0.81	0.92
Dieldrin	0.05	0.03	0.66	<0.9	1.2	0.45	0.37	0.28	<0.03	0.20
Hexachlorobenzene	0.12	0.18	0.19	0.84	0.48	0.29	1.9	0.68	1.0	0.57
Heptachlor Epoxide	0.01	0.03	0.06	0.12	0.14	0.14	0.18	0.36	0.12	0.13
Toxaphene	<0.3	<0.3	<0.3	~1.9	<0.3	~0.63	<0.3	~1.8	~0.75	~1.0
Total PCBs	<0.6	<2	3.1	22	<3	<1	<2	<5	1.0	1.1
November - December 2002										
Total DDT	0.10	0.31	2.9	1.2	1.4	1.6	0.39	1.2	0.18	0.63
Total Chlordane	<0.3	<0.4	9.4	1.2	0.92	0.60	<0.4	<0.6	<0.5	<0.3
Dieldrin	0.04	0.02	13	<0.4	1.1	0.83	0.36	0.21	0.03	0.13
Hexachlorobenzene	0.18	0.17	0.13	0.45	0.68	0.51	1.1	0.13	0.20	0.27
Heptachlor Epoxide	0.04	0.01	0.06	0.04	0.07	0.05	0.14	0.07	0.03	0.04
Toxaphene	<0.3	<0.3	~0.58	<0.3	<0.3	~0.29	~0.31	~5.6	<0.3	~1.7
Total PCBs	0.34*	0.50*	1.1	5.7	2.2	1.2	0.66*	<3	0.52*	0.70*

Chemical	Upper Mill Cr.	Upper Walla Walla	Yellow-hawk Cr.	Garrison Creek	Lower Mill Cr.	Middle Walla Walla	Dry Creek	Pine Creek	Touchet River	Lower Walla Walla
February - March 2003										
Total DDT	0.58	0.65	10	1.9	3.3	6.3	1.3	3.7	0.89	2.7
Total Chlordane	0.27	<0.2	3.5	1.6	0.78	1.6	0.17	0.74	0.16	0.35
Dieldrin	0.18	<0.04	0.32	<0.4	0.58	0.48	0.33	0.89	0.06	0.22
Hexachlorobenzene	0.14	0.07	0.94	0.73	0.75	0.78	1.0	1.1	0.43	0.54
Heptachlor Epoxide	0.01	<0.02	0.06	0.04	0.03	0.08	0.10	0.4	0.03	0.07
Toxaphene	<0.3	<0.3	~1.7	<0.3	<0.3	~0.46	~0.47	~3.5	<0.3	~2.0
Total PCBs	0.43*	0.52*	<2	4.1	3.0	2.3	0.74*	<4	0.37*	<2

*Laboratory contamination may have contributed to this result

Table 17. Estimates of the Dissolved Fraction (%) of Pesticides and PCBs in the Mainstem Walla Walla River During 2002-2003.

Chemical	Mean	Minimum	Maximum
Toxaphene	98	97	99
Heptachlor Epoxide	97	96	98
Dieldrin	96	95	98
Hexachlorobenzene	68	60	80
Total DDT	54	44	65
Total Chlordane	51	38	66
Total PCBs	27	24	33

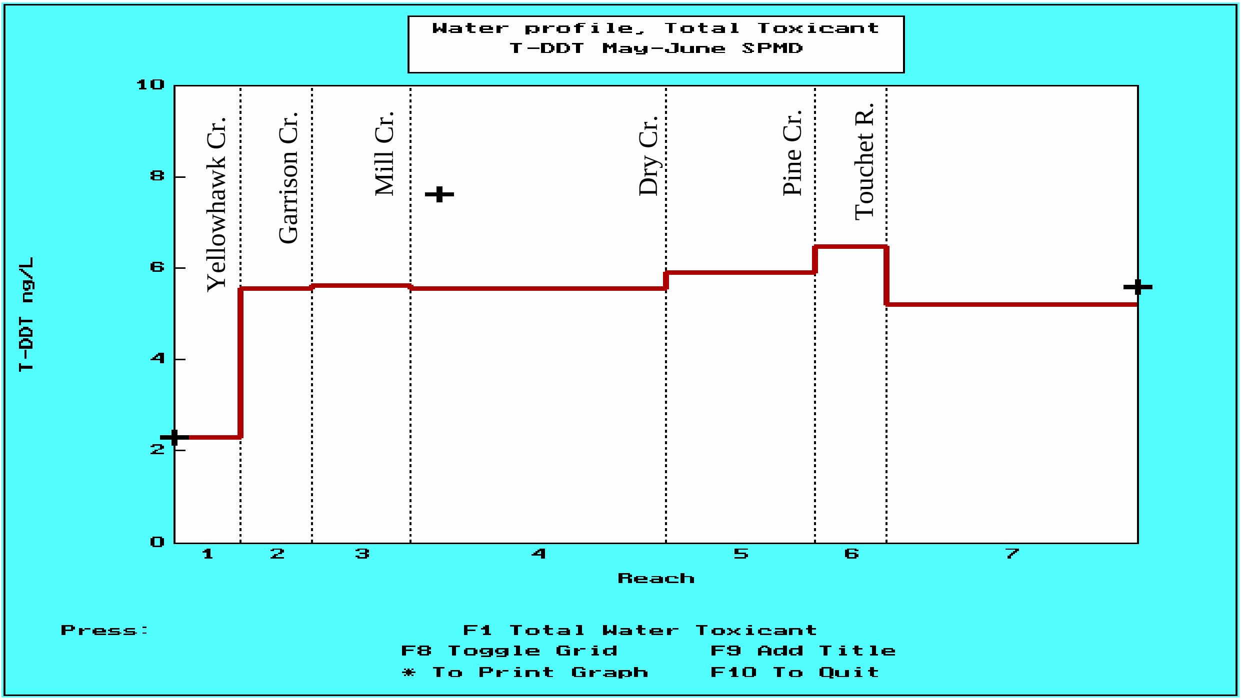
Similar findings have been reported for other eastern Washington tributaries draining agricultural areas. USGS deployed SPMDs in the Yakima and Wenatchee rivers during 1997 (McCarthy and Gale, 1999). They estimated the dissolved fractions of hexachlorobenzene, DDT compounds, chlordane compounds, and PCB congeners were 63 – 67%, 52 – 66%, 47 – 51%, and <15% of the total, respectively. A higher particulate fraction was estimated for heptachlor epoxide and dieldrin than in the Walla Walla drainage. USGS calculated that 80% of the heptachlor epoxide and 78% of the dieldrin was dissolved.

Estimates of the total concentrations were used to simulate the effects of tributary discharges on t-DDT levels in the Walla Walla mainstem, using EPA's SMPTOX program (http://epa.gov/ceampubl/swater/smptox3/index.htm). For this application, the program was set to calculate water column concentrations through simple dilution, and t-DDT was assumed to act conservatively. The May-June and November-December data were used to represent the periods associated with the highest and lowest impacts on the river. Because of gaps in the flow data, the May-June plot should be considered a semi-quantitative depiction of changes in mainstem concentrations. An average upstream flow of 42 cfs at Peppers Bridge was used, based on Ecology flow monitoring the following spring (http://www.ecy.wa.gov/programs/eap/flow/shu_main.html). Irrigation diversions were not factored in.

Results of the t-DDT simulations are shown in Figure 19. For May-June, the main features of note are the large impact of Yellowhawk Creek and the diluting effect of the Touchet River. Garrison and Mill creeks were having a minor influence on the mainstem, while Dry and Pine creeks both cause concentrations to increase. The observed mainstem concentration at Detour Road (+) was higher than can be accounted for by Yellowhawk alone. As described later in this report, grab samples showed the East Little Walla Walla River to be a significant source of DDT compounds to this reach.

During November-December, tributaries other than Yellowhawk were having little or no impact on the river, probably reflecting low runoff from fields. Again, the Touchet is seen as a source of dilution water with respect to t-DDT. Observed mainstem concentrations agree fairly closely with simulated concentrations.

Other simulations showed a similar picture for t-chlordane and dieldrin. In the case of hexachlorobenzene and heptachlor epoxide, Dry Creek is relatively more important than Yellowhawk Creek. Figure 20 has a May-June plot for heptachlor epoxide. There were too many non-detects to simulate toxaphene or PCB concentrations in the mainstem.



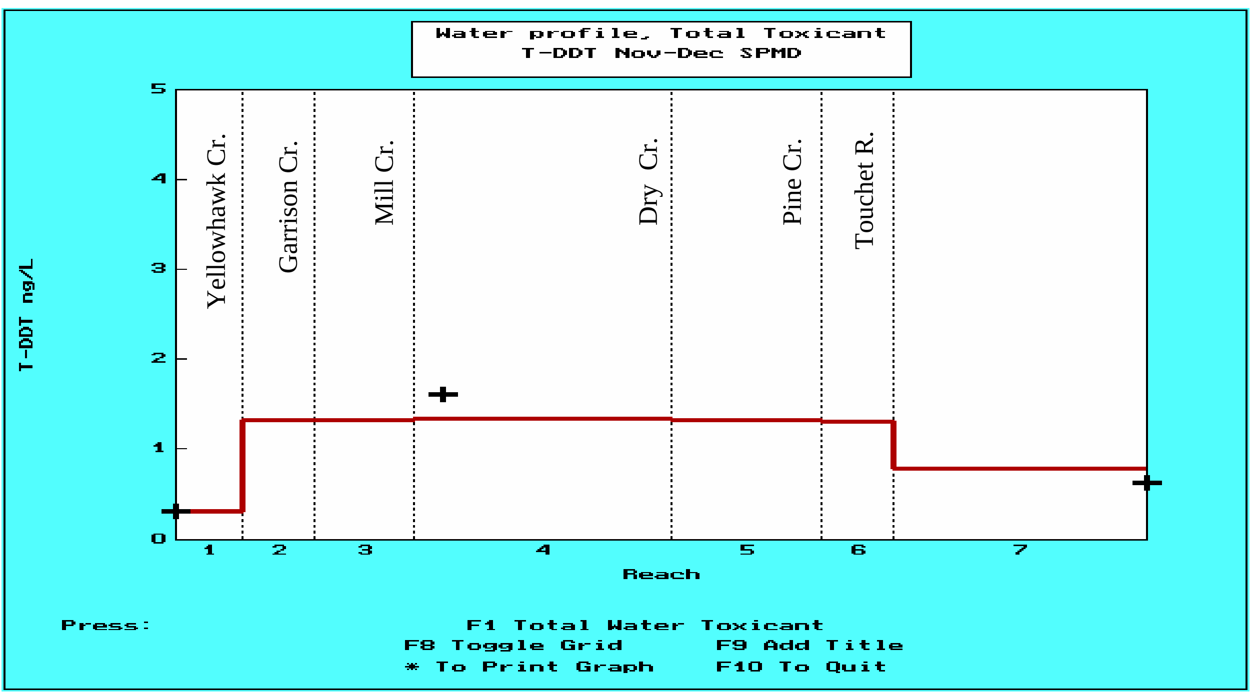


Figure 19. Simulations of Tributary Impacts on t-DDT Concentrations in the Mainstem Walla Walla River (+ are observed mainstem concentrations)

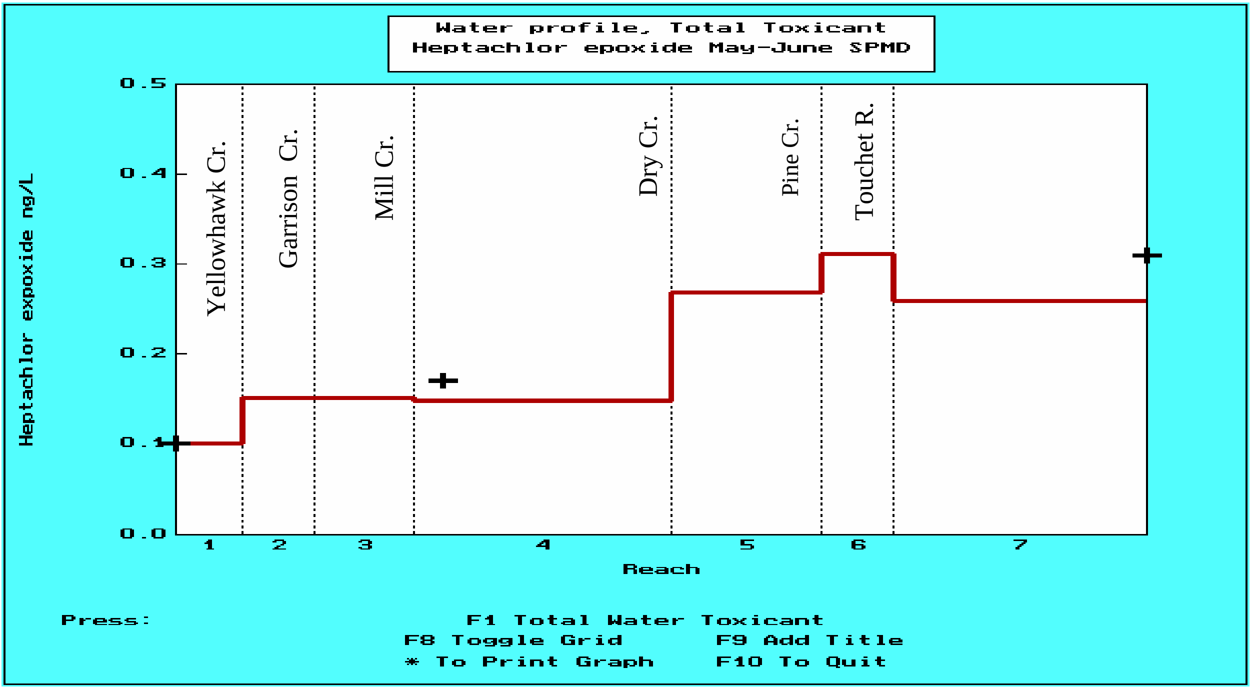


Figure 20. Simulation of Tributary Impacts on Heptachlor Epoxide Concentrations in the Mainstem Walla Walla River (+ are observed mainstem concentrations)

Comparison to Water Quality Standards

Figure 21 compares the pesticide and PCB concentrations measured in the Walla Walla drainage with the Washington State human health criteria (see Table 5). The criteria are for a one in one million increased lifetime cancer risk from fish consumption, as previously described.

The figure shows the ratio of the dissolved water column concentration divided by the criterion. A value greater than 1.0 exceeds the state standard. For pesticides the detection limit was used to calculate the ratio for non-detects. PCB non-detects and flagged PCB data were not plotted.

The dissolved data were used in this comparison because it more accurately reflects the chemical fraction available for uptake by fish (EPA, 2000a). The 0.59 ng/L criterion for DDT and DDE was applied to t-DDT.

As seen in Figure 21, the human health criteria for t-DDT and dieldrin were chronically exceeded in the Walla Walla drainage. The exceedances primarily occurred in and downstream of Yellowhawk Creek. Toxaphene commonly exceeded criteria in Pine Creek and downstream in the lower Walla Walla River. T-chlordane exceedances were scattered throughout the drainage. There were relatively few exceedances for heptachlor epoxide and fewer yet for hexachlorobenzene, these being mostly restricted to lower parts of the drainage.

PCB detection limits in some samples were not low enough to compare to the human health criterion. However, in every instance where PCB concentrations could be unambiguously quantified the criterion was exceeded.

Water quality criteria for protection of aquatic life are less restrictive than human health criteria (see Table 5). Exceedances of the state aquatic life criteria for chronic exposure were primarily limited to t-DDT, with toxaphene also exceeding criteria in Pine Creek and once in the lower Walla Walla River (Figure 22). Dieldrin exceeded aquatic life criteria once each in Yellowhawk Creek and Dry Creek. Except for Yellowhawk Creek, the exceedances were almost entirely restricted to the May-June period (see Table 13).

Aquatic life criteria for acute exposure to these pesticides range from 520 ng/L for heptachlor epoxide (from EPA, 2002a) to 2,500 ng/L for dieldrin, and were never exceeded. Neither the chronic nor acute aquatic life standards for PCBs – 14 and 2,000 ng/L – were exceeded.

There are currently no Washington State or EPA aquatic life criteria for hexachlorobenzene. In the past, EPA (1993) proposed chronic and acute criteria of 3,680 ng/L and 6,000 ng/L. Various other aquatic life criteria have been suggested, including as low as 6.5 ng/L (Environment Ontario, 1985). None of these hexachlorobenzene criteria were exceeded in the Walla Walla drainage.

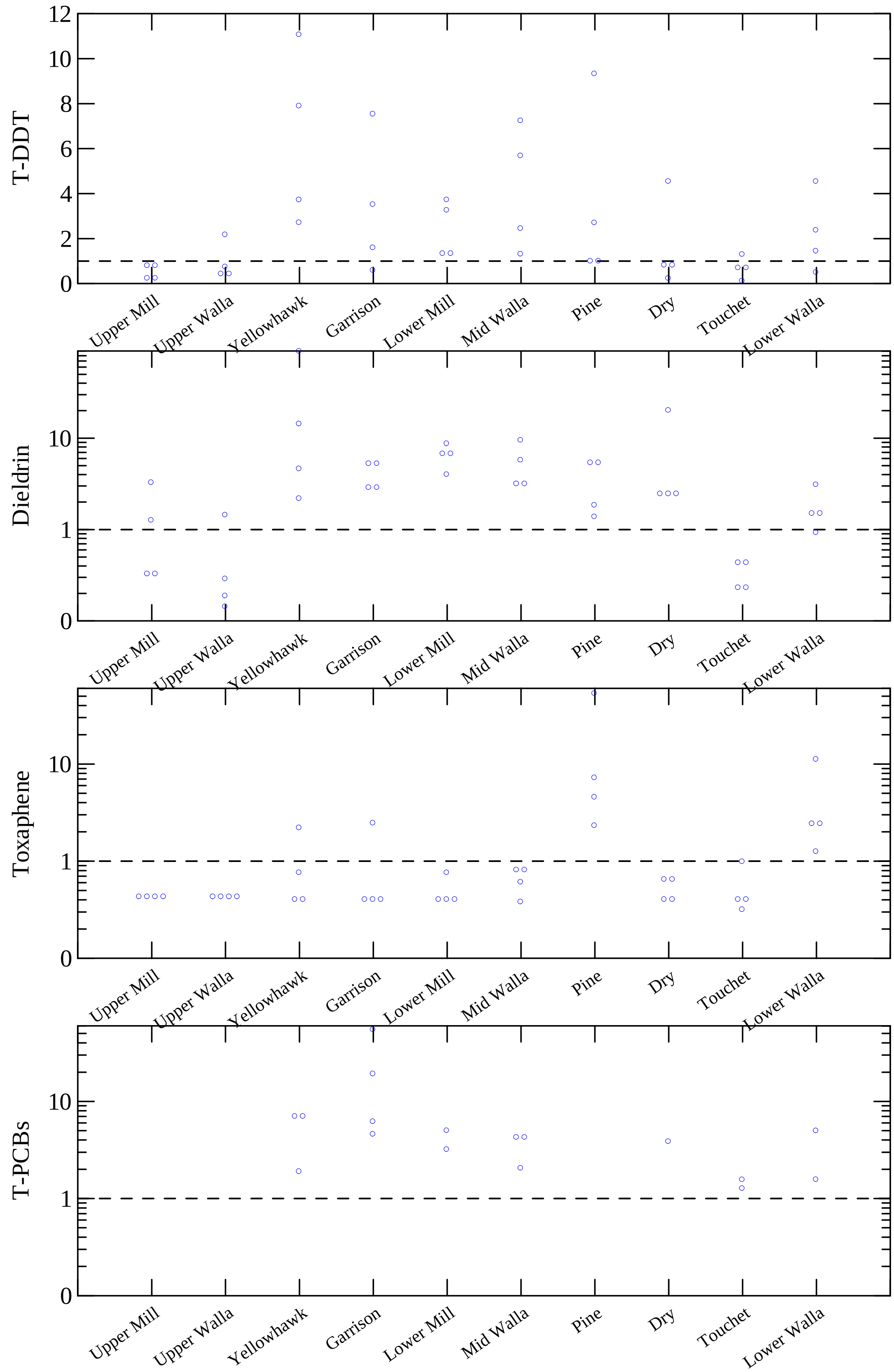


Figure 21. Exceedances of Human Health Water Quality Criteria in the Walla Walla Drainage (ratios > 1 exceed criteria)

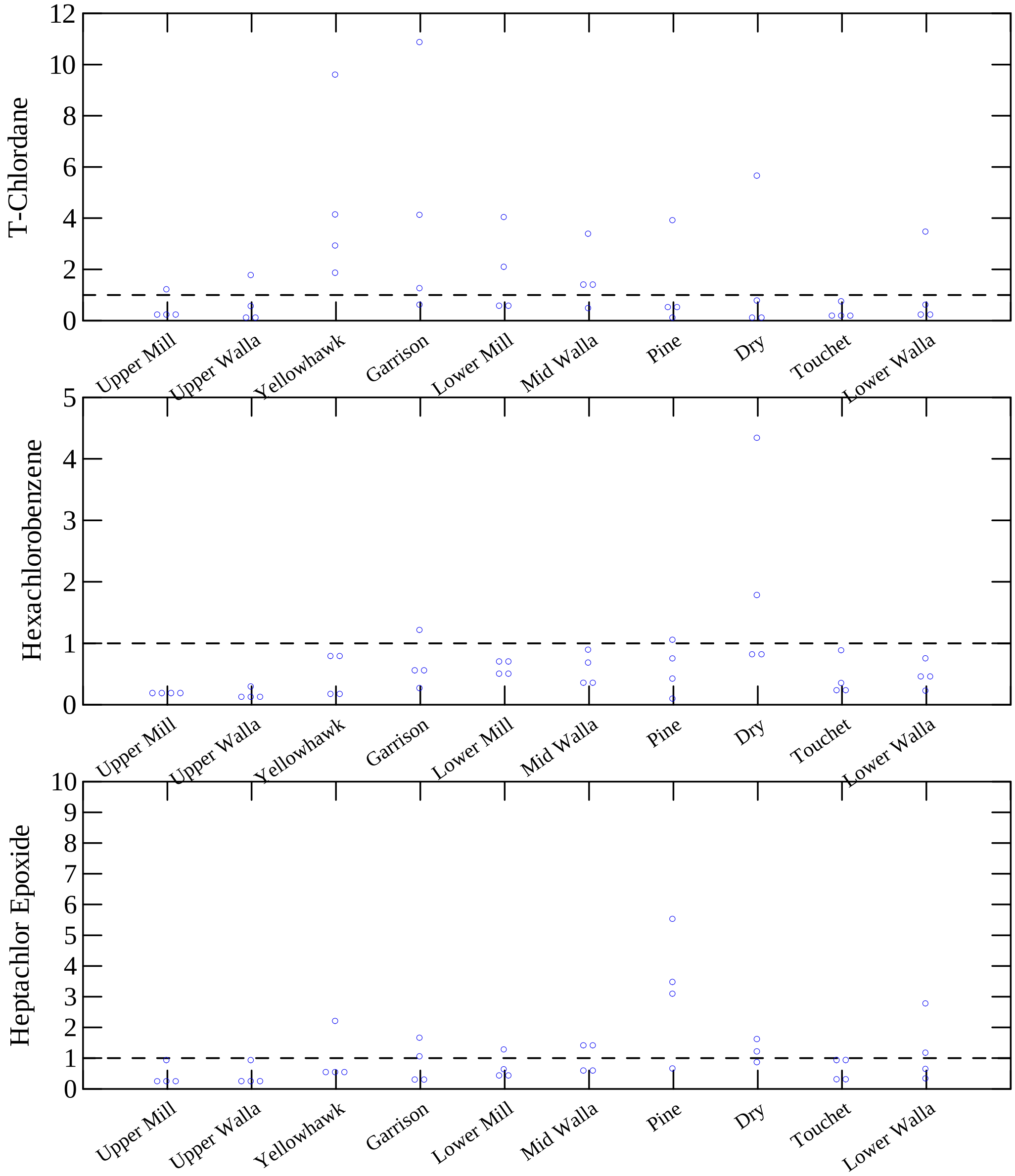


Figure 21 (continued).

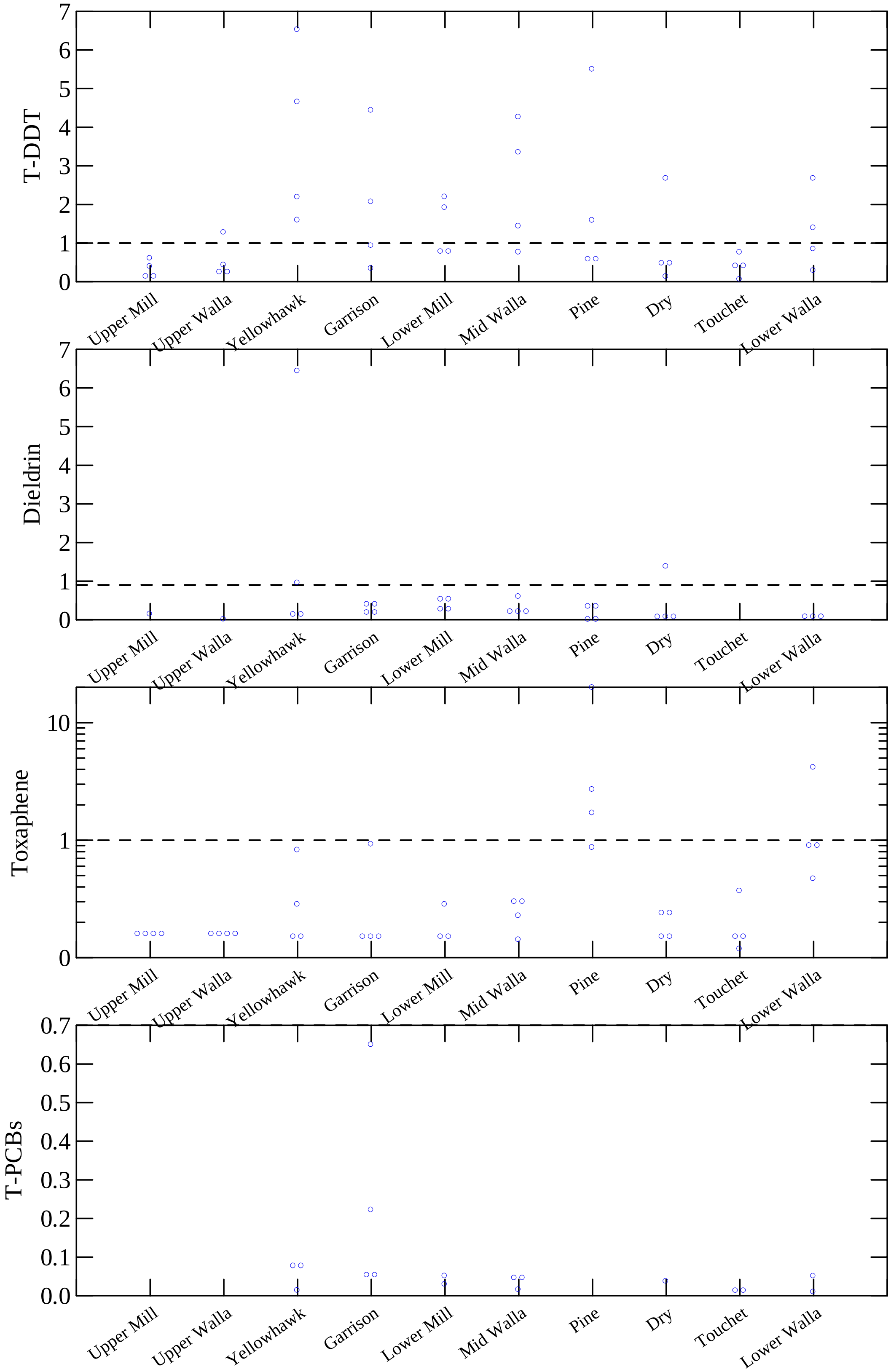


Figure 22. Exceedances of Aquatic Life Criteria in the Walla Walla Drainage (ratios > 1 exceed criteria)

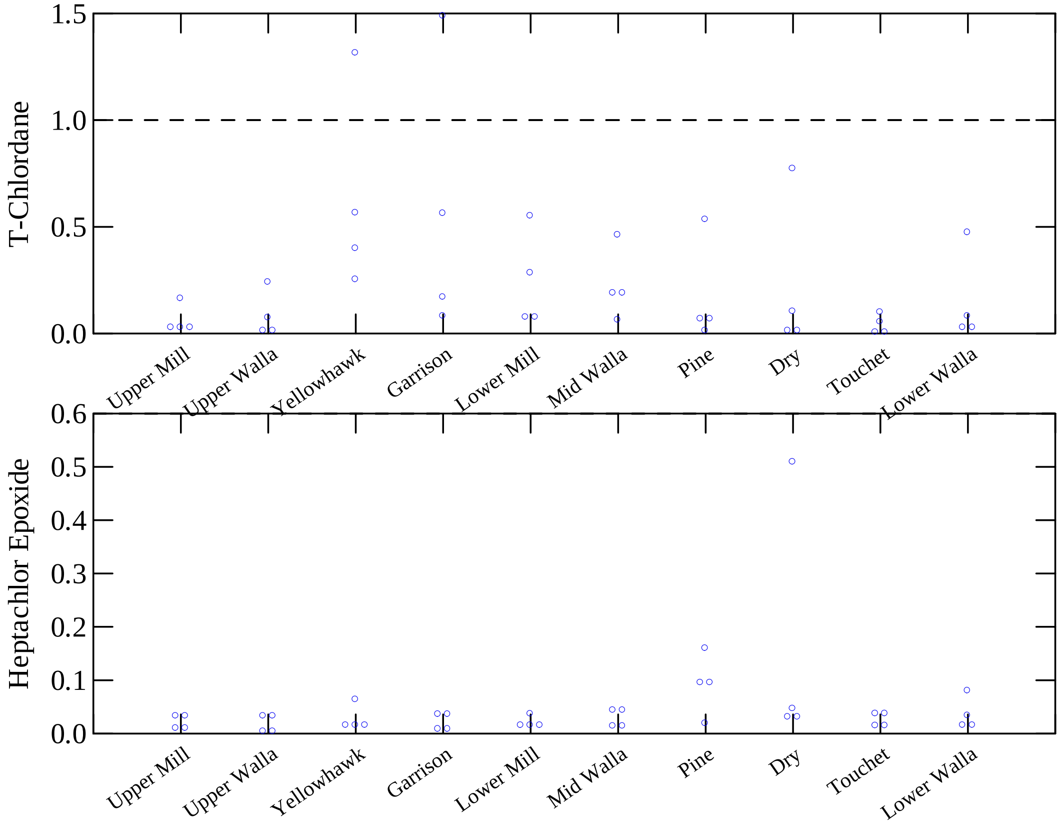


Figure 22 (continued)

Fish Tissue

Pesticide/PCB Concentrations

Results from analyzing chlorinated pesticides and PCBs in fillets from Walla Walla River fish are summarized in Table 18. As noted previously, this analysis was limited to resident mainstem species, with upper river fish being analyzed separately from lower river fish. Data on pesticides, PCBs, and other contaminants in migratory fish species that inhabit the Walla Walla River can be found in EPA (2002b) or online at http://yosemite.epa.gov/r10/oea.nsf .

Over 120 fish were analyzed for the TMDL study. Each sample typically consisted of pooled tissues from five fish. Limited numbers of catfish and upper river bass and carp were obtained. Because the fish collection effort was fairly intensive, the number of specimens analyzed is considered to reflect the relative abundance of each species at the time the field work was conducted.

DDT compounds were present in the highest concentrations in the fillets, followed by PCBs/toxaphene, t-chlordane, dieldrin, hexachlorobenzene, and heptachlor epoxide, in that order. The relative amounts of these compounds generally mirrored what was found in the mainstem water column. The similar chemical profile among species suggests a common exposure history indicative of water quality conditions in the Walla Walla River.

Average concentrations of t-DDT ranged from 30 – 657 ug/Kg. T-PCB and toxaphene concentrations averaged 8.9 – 238 ug/Kg and 16 – 56 ug/Kg, respectively. For most species, the average t-DDT concentrations were 105 ug/Kg or less, and the average PCB concentrations 48 ug/Kg or less. Total chlordane concentrations averaged 2.7 – 19 ug/Kg. Dieldrin, hexachlorobenzene, and heptachlor epoxide concentrations were 2.1ug/Kg or less. The highest pesticide/PCB concentrations were in carp, while the lowest were in smallmouth bass.

Figure 23 plots the data for each composite fillet sample[6]. There is qualitative evidence of differences between contaminant levels in upper vs. lower river fish. Bridgelip suckers and northern pike minnow were the only species where large numbers were obtained from both areas. For these species, upper river samples generally had higher concentrations of t-DDT, t-chlordane, dieldrin, and PCBs, but lower concentrations of toxaphene and hexachlorobenzene. These findings are consistent with results from water sampling.

Not enough bass or carp were analyzed to draw strong conclusions about upstream/downstream differences. The bass data also suggest generally higher concentrations in the upper river, but the opposite was true of carp. However, only one upper river composite was analyzed for each of these species.

[6] In these box-and-whisker plots, the center horizontal line is the median and the edges of the box (hinges) mark the first and third quartiles. The whiskers show the range of values that fall within a 1.5 spread of the hinges. Outside and far outside values are marked as asterisks and circles, respectively.

Table 18. Mean Pesticide/PCB Concentrations in *Fillets* from Walla Walla River Fish Collected during July - September 2002 (ug/Kg wet weight; parts per billion).

Species	Channel Catfish	Smallmouth Bass	Bridgelip Sucker	Common Carp	N. Pike Minnow
Upper River					
No. of Individuals	0	2	20	3	20
No. of Composites	- -	1	4	1	4
Sample Number		438182	438183-86	438181	438188-91
Mean Age (yr)	- -	4	5	11	6
Mean Total Length (mm)	- -	320	438	577	372
Mean Weight (gm)	- -	543	718	2.397	305
Percent Lipids	- -	2.1	2.5	2.0	1.6
Total DDT	- -	54	105	46	333
Toxaphene	- -	26	16	17	20
Total Chlordane	- -	5.5	4.9	5.7	17
Dieldrin	- -	0.99	0.70	1.1	1.2
Hexachlorobenzene	- -	0.79	0.53	1.1	0.65
Heptachlor Epoxide	- -	<0.55	<0.51	<0.54	0.56
Total PCBs	- -	17	26	35	48
Lower River					
No. of Individuals	2	20	20	20	10
No. of Composites	1	4	4	4	2
Sample Nos.	438192	438205-08	438193-96	438198-201	438203-04
Mean Age (yr)	11	3	5	12	6
Mean Total Length (mm)	500	273	386	579	256
Mean Weight (gm)	1.101	355	593	2.634	148
Percent Lipids	3.8	0.89	2.2	4.6	1.2
Total DDT	277	30	75	647	59
Toxaphene	58	10	20	56	27
Total Chlordane	9.7	2.7	3.8	19	3.8
Dieldrin	2.1	<0.55	0.59	1.8	<0.55
Hexachlorobenzene	2.2	0.84	1.4	6.6	1.3
Heptachlor Epoxide	0.61	<0.55	<0.55	1.4	<0.55
Total PCBs	56	8.9	14	238	32

The whole fish data are summarized in Table 19. Pesticide and PCB concentrations in whole suckers and pike minnow were typically 2 – 3 times higher than the average concentration found in fillets. For bass, the whole fish sample was 5 – 10 times higher than fillets. This is usually interpreted as reflecting the higher lipid (fat) content in whole fish, chlorinated organic compounds being preferentially soluble in lipid.

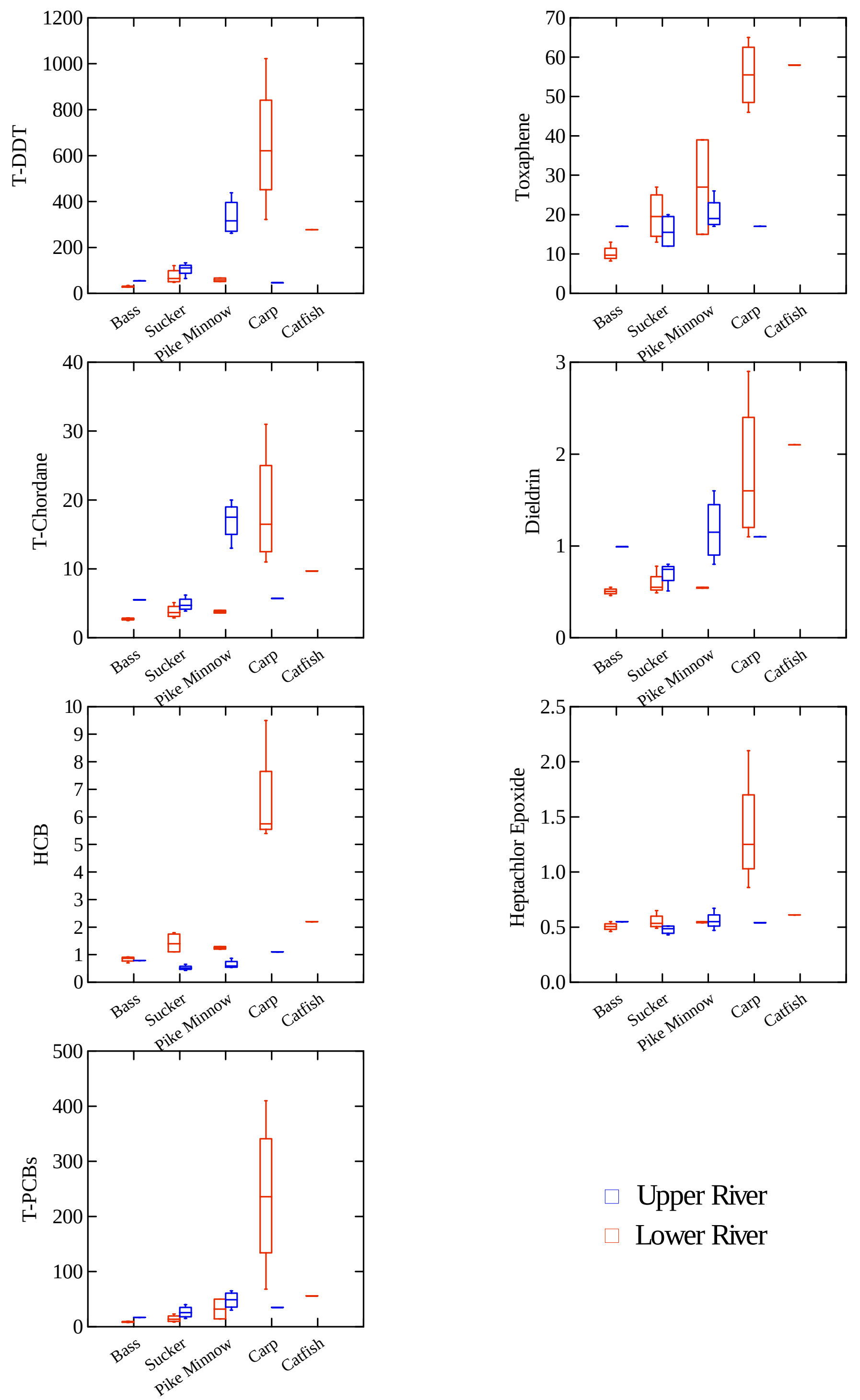


Figure 23. Pesticide/PCB Concentrations in Walla Walla Fish Fillets: Upper vs. Lower River (ug/Kg, wet weight; parts per billion).

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Table 19. Pesticide/PCB Concentrations in *Whole Fish* Samples from the Walla Walla River Collected during July - September 2002 (ug/Kg wet weight; parts per billion).

	Upper River		Lower River	
Species	Bridgelip Sucker	N. Pike Minnow*	Bridgelip Sucker	Smallmouth Bass*
No. of Individuals	5	5	5	5
No. of Composites	1	1	1	1
Sample Number	438187	438210	438197	438209
Mean Age (yr)	5	7	4	3
Mean Total Length (mm)	459	334	404	335
Mean Weight (gm)	718	305	537	490
Percent Lipids	5.5	4.5	4.4	5.3
Total DDT	178	779	192	311
Toxaphene	27	36	36	50
Total Chlordane	8.9	41	6.9	13
Dieldrin	1.5	2.0	0.97	1.6
Hexachlorobenzene	1.4	2.4	3.8	5.8
Heptachlor Epoxide	<0.54	0.83	0.77	1.6
Total PCBs	30	137	28	89

*whole body concentrations estimated from separate analysis of carcass and fillets

Comparison to 303(d) Criteria

The 303(d) listings for the Walla Walla River are based on fish tissue data that are more than 10 years old (1992-93). Figure 24 compares the newer 2002 data with the human health criteria used for listing. In this figure, the upper and lower river data have been combined.

The majority of samples from the 2002 collection continue to substantially exceed 303(d) criteria for t-DDT, dieldrin, and PCBs. Toxaphene also greatly exceeds criteria. Toxaphene had not been detected previously in Walla Walla fish because the analyses were not optimized for this pesticide. Three out of five species – pike minnow, carp, and catfish – commonly exceeded for t-chlordane. No samples exceeded for hexachlorobenzene, and only two carp samples exceed for heptachlor epoxide.

The fish and water data concur in showing that the Walla Walla River no longer exceeds criteria for hexachlorobenzene. While the fish tissue data provide only marginal evidence in support of a heptachlor epoxide listing, the water data show a number of exceedances. The fish tissue data may indicate some improvement in water quality since 1992-93 or simply reflect the larger, more representative sample size in 2002.

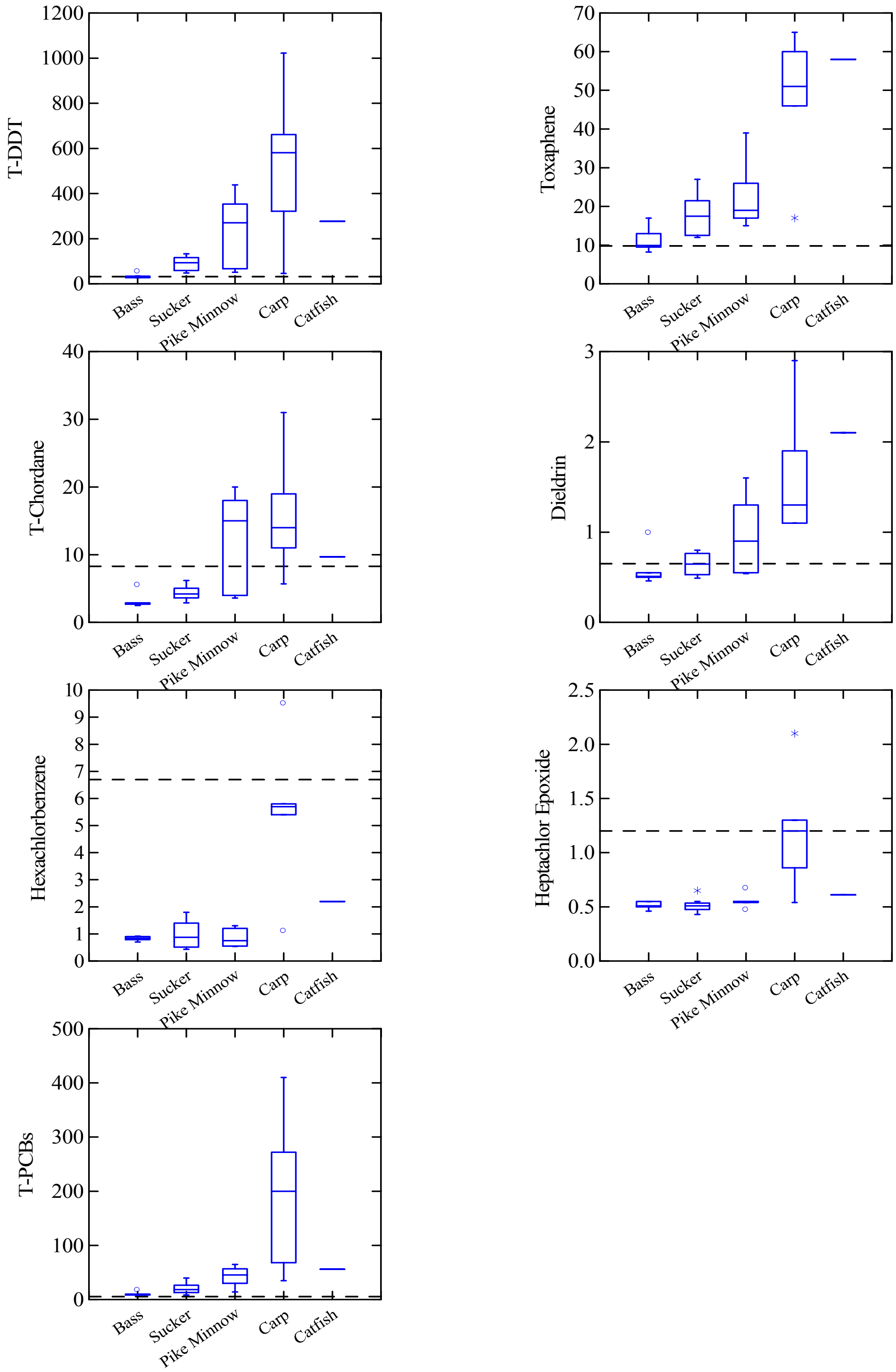

Figure 24. Pesticide/PCB Concentrations in Fillets from Walla Walla River Fish Compared to 303(d) Listing Criteria (ug/Kg wet weight: parts per billion; pooled upper and lower river data).

Bioaccumulation Factors

The state water quality standards for protection of human health are based on EPA determined bioconcentration factors (BCFs). Because the BCFs are national averages, an effort was made to determine how well they apply to the Walla Walla River.

Table 20 shows site-specific pesticide and PCB bioaccumulation factors (BAFs) calculated for the Walla Walla River using the water column and fish tissue data obtained in the present study. BCFs and BAFs differ in that the former do not include uptake from food as do field determined values. The results are compared to EPA BCFs used to calculate the National Toxics Rule (NTR) criteria adopted as state standards.

Table 20. Site Specific Bioaccumulation Factors (BAFs) for Walla Walla River Fish Compared to EPA Bioconcentration Factors (BCFs) Used to Calculate Human Health Water Quality Criteria.

Chemical	Mean Fish Tissue Concentration* (ug/Kg, wet)		Mean Water Column Concentration† (ng/L)		Walla Walla BAF		Mean Walla Walla BAF	EPA BCF
	Upper River	Lower River	Upper River	Lower River	Upper River	Lower River		
Total DDT	135	218	2.8	3.5	48,629	62,808	**55,700**	**53,600**
Toxaphene	20	34	**	4.4	- -	7,773	**7,770**	**13,100**
Total Chlordane	8.3	7.8	1.5	2.0	5,499	3,889	**4,690**	**14,100**
Dieldrin	1.0	1.1	**	0.87	- -	1,280	**1,280**	**4,670**
Hexachlorobenzene	0.77	2.5	0.45	0.62	1,711	3,951	**2,830**	**8,690**
Heptachlor Epoxide	0.54	0.73	**	0.23	- -	3,131	**3,130**	**11,200**
Total PCBs	32	70	**	0.82	- -	84,965	**85,000**	**31,200**

*Pooled species
†May - June SPMD data
**mean upper river concentration uncertain

The water column data are the average mainstem dissolved concentrations measured during May-June 2002 (see Table 13). These should be broadly representative of water column concentrations the fish were exposed to for several months prior to capture, as most of the fish (85%) were collected in July. EPA recommends using dissolved concentrations in assessing bioconcentration since this is the bioavailable fraction (EPA, 2000a). The calculations were done separately for upper and lower river fish, using the mean fillet concentration for each species.

Results of this exercise indicate that the EPA BCFs, and by extension the state standards, are appropriate for determining what levels of t-DDT and other chlorinated pesticides would protect the average individual among the general public who consumes fish from the Walla Walla River. The mean Walla Walla BAF for t-DDT is similar to the EPA BCF, 55,700 vs. 53,600. The Walla Walla BAFs for toxaphene, t-chlordane, dieldrin, hexachlorobenzene, and heptachlor epoxide are all lower than the EPA values by factors of about 2 to 4. For these chemicals, the state standards are clearly protective for average consumers of resident Walla Walla fish species.

EPA's BCF for PCBs appears to be too low for the Walla Walla River. Present study results suggest it should be on the order of 85,000 as opposed to 31,200. For superlipophilic chemicals like PCBs, uptake through food has been shown to be a more important pathway than uptake from water (Mackay and Fraser, 2000). As a result, BCFs typically underestimate PCB bioaccumulation (EPA, 2002). It may be appropriate to adjust the PCB human health water quality criterion downward when applied to the Walla Walla River.

WWTP Effluents

Results from monitoring chlorinated pesticides and PCBs in final effluents from the Walla Walla WWTP and College Place WWTP are shown in Tables 21 and 22. Data on flow and conventional water quality parameters are in Appendix G. The pesticide extract from the February 2003 College Place samples was lost in a laboratory accident. This effluent was re-sampled for pesticides the following month.

Table 21. Pesticides and PCBs Detected in Walla Walla WWTP Final Effluent (ng/L; parts per trillion).

Date: Sample No:	5/28-30/02 228030,-32,-34	9/10-11/02 378881	12/2-3/02 498958	2/24-25/03 098997
4,4'-DDT	<0.091	<0.067	<0.11	<0.093
4,4'-DDE	0.090	0.080	<0.069	0.073
4,4'-DDD	<0.065	<0.067	<0.069	<0.066
Dieldrin	<1.6	<0.73	<0.079	0.25
Heptachlor	<0.065	<0.067	<0.069	<0.066
Heptachlor epoxide	<1.6	<0.77	<0.069	<0.066
Hexachlorobenzene	<0.094	0.33	<0.085	<0.096
cis-Chlordane	0.18	0.19	0.12	0.12
trans-Chlordane	0.13	0.16	0.10	0.09
cis-Nonachlor	<0.065	<0.067	<0.069	<0.066
trans-Nonachlor	<0.065	0.087	<0.069	<0.066
Oxychlordane	<0.065	<0.067	<0.069	<0.066
Total PCBs	0.88	0.65	0.75	0.87

Table 22. Pesticides and PCBs Detected in College Place WWTP Final Effluent (ng/L; parts per trillion).

Date: Sample No:	5/28-29/02 228031,-33	9/10-11/02 378882	12/2-3/02 498959	2/24-25/03 098998	3/24-25/03 138164
4,4'-DDT	<0.092	<0.069	<0.073	la	<0.093
4,4'-DDE	0.10	0.10	<0.067	la	<0.066
4,4'-DDD	<0.066	<0.069	<0.067	la	<0.066
Dieldrin	<1.6	<0.22	<0.54	la	0.21
Heptachlor	<0.066	<0.069	<0.067	la	<0.066
Heptachlor epoxide	<1.6	<0.14	<0.067	la	<0.066
Hexachlorobenzene	<0.093	<0.069	<0.17	la	0.15
cis-Chlordane	0.098	0.086	<0.067	la	<0.066
trans-Chlordane	0.071	<0.069	0.073	la	<0.066
cis-Nonachlor	<0.066	<0.069	<0.067	la	<0.066
trans-Nonachlor	<0.066	<0.069	<0.067	la	<0.066
Oxychlordane	<0.066	<0.069	<0.067	la	<0.066
Total PCBs	2.5	0.92	1.3	0.53	naf

la = sample lost in lab accident
naf = not analyzed for

The only compounds consistently detected in WWTP effluents were DDE, chlordane, and PCBs. Concentrations ranged from <0.066 – 0.11 ng/L for DDE, <0.066 – 0.20 ng/L for chlordane, and 0.53 – 2.5 ng/L for t-PCBs. Dieldrin was also detected in one or two samples from each plant at concentrations of 0.21 – 0.25 ng/L.

The higher PCB and chlordane levels were found in College Place effluent. Only PCBs were detected consistently in both plants, and the levels were not significantly different (Mann-Whitney test, p=0.25). DDE and dieldrin concentrations were similar in each effluent.

Without further dilution, the average t-PCB concentration in the College Place and Walla Walla effluents would exceed the human health criterion of 0.17 ng/L by factors of approximately 7 and 5, respectively. The reporting limit in the dieldrin analysis exceeded the dieldrin criterion. In the few instances where dieldrin was detectable, the 0.14 ng/L criterion was slightly exceeded at both plants, but by less than a factor of 2. Effluent concentrations of DDE, chlordane, and the other pesticides analyzed were always within human health criteria.

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Numerical Water Quality Targets

DDT:TSS Correlation

Historical application of chlorinated pesticides to soils and crops is the primary source of river and stream contamination in agricultural areas like the Walla Walla basin (e.g., Risebrough and Jarman, 1984; Munn and Gruber, 1997). This reservoir of contamination is supplemented by current-day atmospheric deposition to agricultural and non-agricultural land (e.g., Wania and Mackay, 1996). Once applied or air deposited, chlorinated pesticides bind to soil particles. The key to meeting pesticide standards in the Walla Walla River and its tributaries is to reduce the amount of soil entering these waterbodies and maintain low TSS levels in the water column.

In this TMDL evaluation, TSS and turbidity are proposed as water quality indicators and surrogate numerical targets for chlorinated pesticides in the Walla Walla River. Setting water quality targets based on TSS and turbidity has the advantage of translating more directly into land use practices and being easier and less expensive to monitor than trace chemical concentrations. Additionally, TSS and turbidity levels in rivers and streams have a direct and quantifiable effect on the health of fish and other aquatic organisms as well as aesthetic values. As noted previously, a similar approach has been used successfully in a pesticide TMDL for the lower Yakima River (Joy and Patterson, 1997).

In the present study, pesticide, TSS, and turbidity data were obtained on 88 sets of whole water samples from the Walla Walla drainage. These data were examined to determine how pesticide concentrations vary with TSS and turbidity. The analysis focused on 4,4'-DDE since this was the compound most consistently quantified in the samples. The data have been tabulated in Appendix H.

There was a strong positive correlation between DDE and TSS concentrations in all parts of the watershed. Correlation coefficients (R) ranged from 0.6 – 1.0 depending on the waterbody.[7]

An equation relating TSS to DDE concentrations was developed for the mainstem Walla Walla River using SYSTAT 6.0 (Figure 25). All 22 data pairs were analyzed. Examination of the data using a probability plot showed a log-normal distribution. The data were therefore log transformed and then fitted to the model: $\log TSS = \beta_o + \beta_1 \log DDE + \varepsilon$. The resulting best-fit equation was $TSS = 263 \times DDE^{1.8}$, with an R^2 of 0.73. Solving for the DDE human health criterion of 0.59 ng/L gives a TSS value of 103 mg/L or, rounding to two significant figures, 100 mg/L (parts per million). Therefore, when TSS concentrations are below 100 mg/L in the Walla Walla River, DDE concentrations would be expected to meet the water quality criterion of 0.59 ng/L.

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[7] The correlation coefficient (R) represents the linear relationship between two variables and ranges from -1 to +1. A value of -1 represents a perfect negative correlation while a value of +1 represents a perfect positive correlation. If the correlation coefficient is squared, then the resulting value, R^2 the coefficient of determination, represents the proportion of common variation in the two variables (i.e., the strength or magnitude of the relationship).

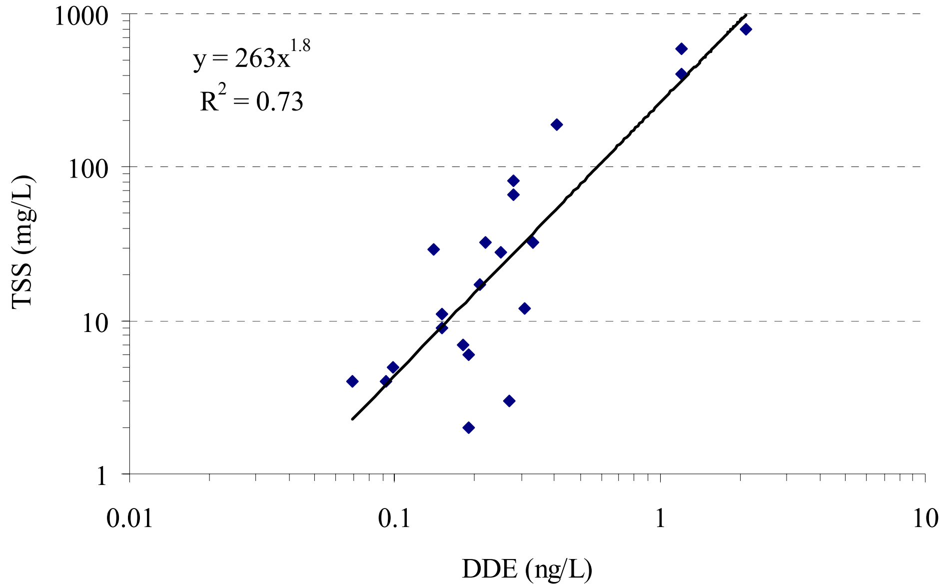

Figure 25. Relationship Between TSS and 4,4'-DDE in the Mainstem Walla Walla River.

A similar exercise using the combined data from the entire project yielded a weaker R^2 of 0.45 and a TSS target of 45 mg/L. Examination of the data in Appendix H shows a target of 45 mg/L TSS would not predict DDE violations.

An alternate approach to linear regression was used to confirm that a DDE-based TSS target of 100 mg/L is accurate and reasonable to apply to the watershed as a whole. A quantile plot was made of all the TSS data (Figure 26). TSS samples associated with an exceedance of the DDE criterion were plotted separately from those TSS samples where DDE did not exceed. This figure shows two tributaries – the East Little Walla Walla River and Yellowhawk Creek – where DDE levels are inconsistent with a TSS target of 100 mg/L.

All four samples from the East Little Walla Walla River exceeded the DDE criterion at TSS concentrations between 6 - 38 mg/L, much lower than in other samples. DDT compounds, dieldrin, and heptachlor epoxide were all unusually high in this tributary, based on grab samples (Appendix D). DDE concentrations in Yellowhawk Creek were at or close to the criterion at TSS concentrations of 18 – 29 mg/L (0.49 – 0.59 ng/L DDE), and one sample exceeded (0.85 ng/L) at a low TSS concentration of 7 mg/L. Yellowhawk also had the highest t-DDT, t-chlordane, and dieldrin concentrations in the SPMD samples. These results suggest DDT and other chlorinated pesticides were applied in these two watersheds at higher rates or for a longer period of time than elsewhere in the drainage.

To more clearly illustrate the 100 mg/L breakpoint for TSS-associated DDE, the data were re-plotted without the East Little Walla Walla and Yellowhawk data (Figure 27). This figure shows that for all other parts of the Walla Walla drainage DDE concentrations begin to exceed the criterion at about 80 mg/L and consistently exceed once TSS levels surpass 100 mg/L. These

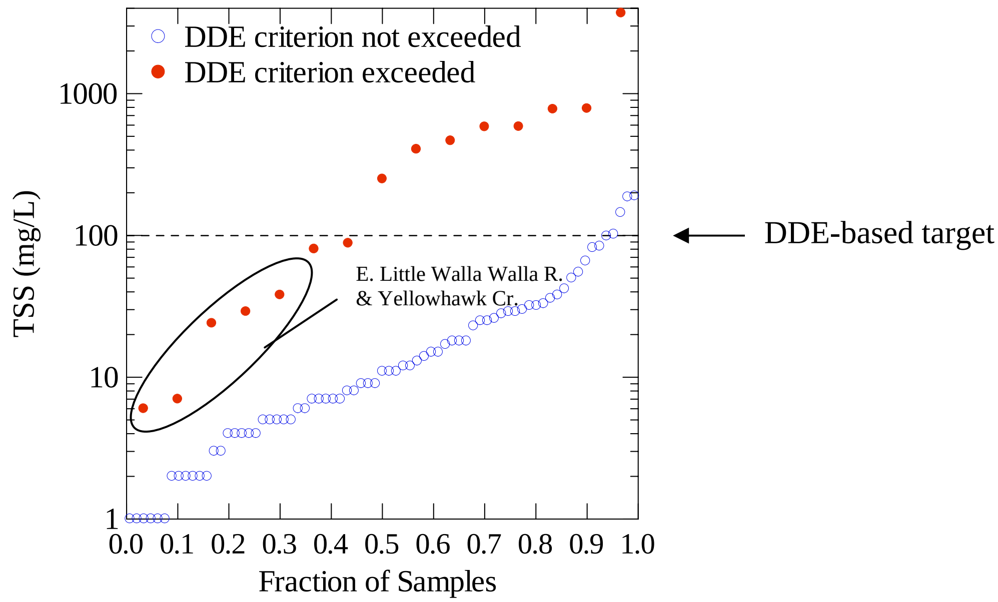

Figure 26. Quantile Plot of TSS Data for the Walla Walla Drainage Showing Instances Where 4,4'-DDE Concentrations Exceeded the Human Health Criterion (all data)

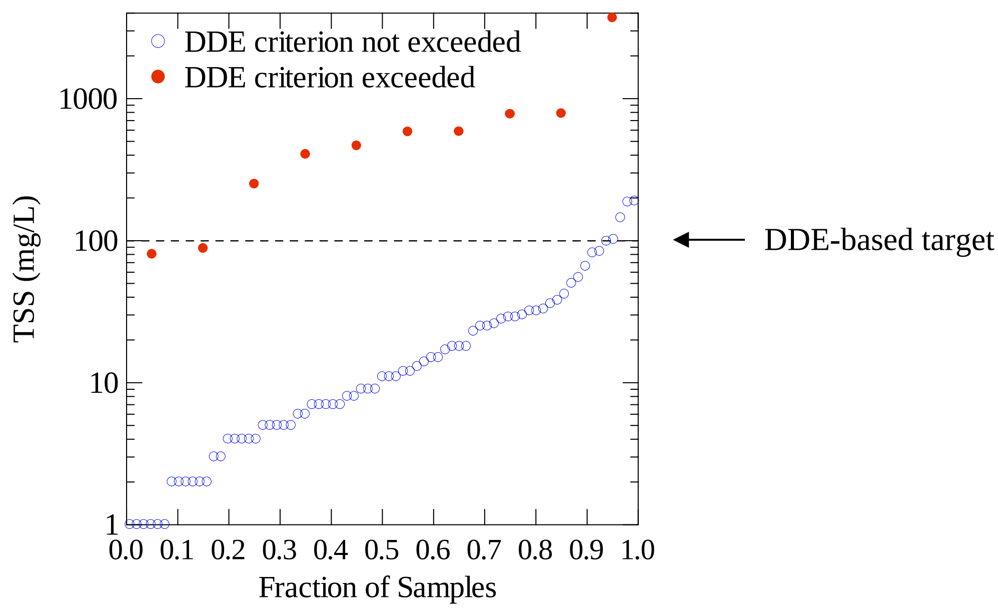

Figure 27. Quantile Plot of TSS Data for the Walla Walla Drainage Showing Instances Where 4,4'-DDE Concentrations Exceeded the Human Health Criterion
(East Little Walla Walla River and Yellowhawk Creek data excluded)

observations provide independent support for a TSS concentration of 100 mg/L being an appropriate, minimally protective target for reducing DDE concentrations in the Walla Walla drainage. Alternate targets for the East Little Walla Walla River and Yellowhawk Creek are proposed later in this report.

Since the other pesticides of concern are generally present at lower levels than DDE and exceed their criteria to a lesser degree, land use changes directed at meeting a DDE-based target would also effectively address these chemicals. However, because DDE occurs in association with its parent compound 4,4'-DDT and co-metabolite 4,4'-DDD, the target must be adjusted to account for the total amount of DDT compounds in the water column.

The SPMD data show that the relative amounts of DDT, DDE, and DDD in the Walla Walla mainstem and tributaries are fairly constant, with DDE accounting for 50 ± 4 percent of the t-DDT (Figure 28). Therefore the DDE-based TSS target of 100 mg/L should be reduced to 50 mg/L to meet a t-DDT criterion (divide by a factor of 2). Additivity is appropriate since these compounds have the same or similar criteria and the same toxic endpoints and modes of action (EPA, 2000). Although t-DDT is not specifically addressed in the National Toxics Rule, water quality criteria for DDT compounds are commonly expressed in terms of t-DDT (e.g., EPA, 1990b, 1992a). The WDOH fish advisory for the Walla Walla River will be based on a reference dose for t-DDT.

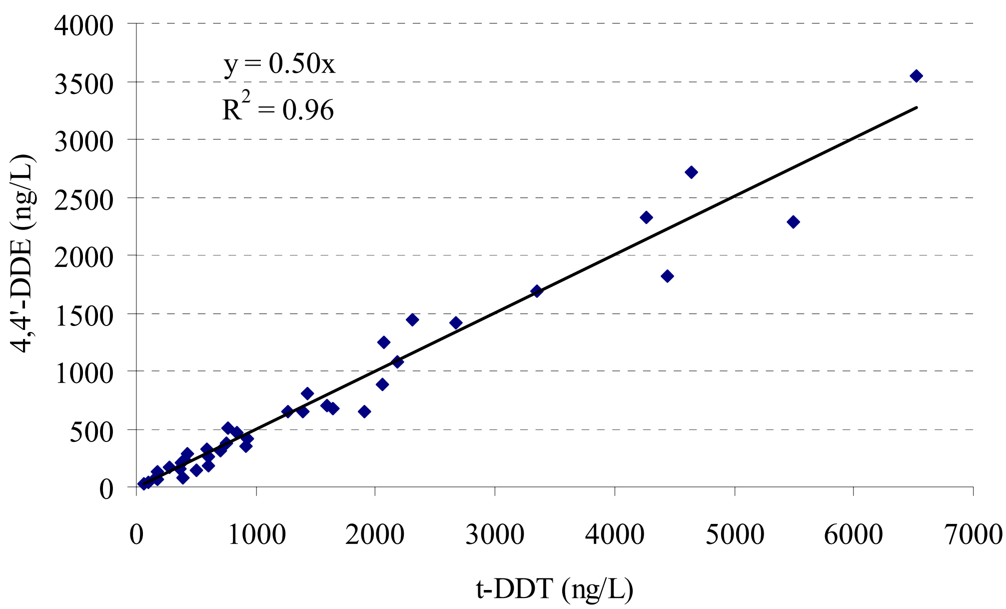

Figure 28. 4,4'-DDE vs. t-DDT in the Walla Walla Drainage.

Fish Consumption Rates

Washington State's human health water quality criteria for DDT compounds and other toxics are based on an average lifetime fish consumption rate of 6.5 grams per day[8]. More restrictive TSS targets would be needed to protect people who consume Walla Walla fish at higher rates.

EPA recently conducted a health risk assessment for people eating fish from the Columbia River basin (EPA, 2002c). The following fish consumption rates were used in that work:

Population	Fish Consumption Rate (g/day)
General Public – average consumer	7.5
Tribal Members – average consumer	63
General Public – high consumer	142
Tribal Members – high consumer	389

EPA based their ingestion rates for the general public on a national report of fish consumption (EPA, 2002c). Their national rate for the average consumer, 7.5 grams per day, is similar to the rate behind the current state standards. The tribal consumption rates were for Columbia River Intertribal Fish Commission (CRITFC) member tribes – Umatilla Confederated Tribes, Yakama Nation, Warm Springs Tribe, and Nez Perce Tribe – as determined in a CRITFC (1994) fish consumption study.

Using the values EPA selected for tribal members and for high consumption individuals from the general public, the following numerical TSS targets are proposed to protect the various groups of people who consume fish from the Walla Walla River:

TSS Target	Estimated Water Column t-DDT Concentration	Population Subgroup Being Protected
50 mg/L	0.59 ng/L (state standard)	General Public – average fish consumer
5 mg/L	0.059 ng/L	Tribal Members – average fish consumer
2 mg/L	0.024 ng/L	General Public – high fish consumer
1 mg/L	0.012 ng/L	Tribal Members – high fish consumer

TSS Effects on Aquatic Life

There are no Washington State or EPA numeric water quality criteria for TSS. TSS can, however, be addressed through the state narrative criteria which are used to control toxic, radioactive, and deleterious materials, and to maintain aesthetic values (see Applicable Water Quality Standards). The state water quality criteria for Class A waterbodies like the Walla Walla

[8] A water consumption rate of 2 liters per day is also assumed, but has little or no effect on the criteria since the chemical dose comes almost entirely from fish.

River state that "Water quality of this class shall meet or exceed the requirements for . . . salmonid (and other fish) migration, rearing, spawning (Class A only for salmonids), and harvesting."

EPA has classified impairment of aquatic habitats or organisms due to TSS as follows (Mills et al., 1985):

TSS Concentration	Aquatic Community Impairment
< 10 mg/L	Improbable
10 - 100 mg/L	Potential
> 100 mg/L	Probable

Similar ranges of TSS concentrations have been suggested by the National Academy of Sciences (1973) and endorsed by the American Fisheries Society (1979):

TSS Concentration	Aquatic Community Protection Level
< 25 mg/L	High
25 - 80 mg/L	Moderate
80 - 400 mg/L	Low
> 400 mg/L	Very Low

These authorities conclude that TSS levels should be at or below 10 – 25 mg/L for healthy aquatic communities and that levels over 100 mg/L result in impairments. Based on the above recommendations, British Columbia established a water quality guideline that induced TSS should not exceed 10 mg/L when background is equal to or less than 100 mg/L (CCREM, 1987).

The upper TSS target of 50 mg/L proposed here for chlorinated pesticides in the Walla Walla drainage would convey a moderate level of habitat protection. The TSS target of 5 mg/L would be highly protective.

Figure 29 shows the recent historical record on TSS concentrations in the lower Walla Walla River. These data are for the period 1990 – 2003, as reported for Ecology's ambient monitoring station 32A070 "Walla Walla River near Touchet" (http://www.ecy.wa.gov/programs/eap/ fw_ riv/rv_main.html). The figure shows where the samples fall in relation to the EPA recommendations for aquatic habitat. The proposed human health targets of 50 mg/L and 5 mg/L TSS are also indicated.

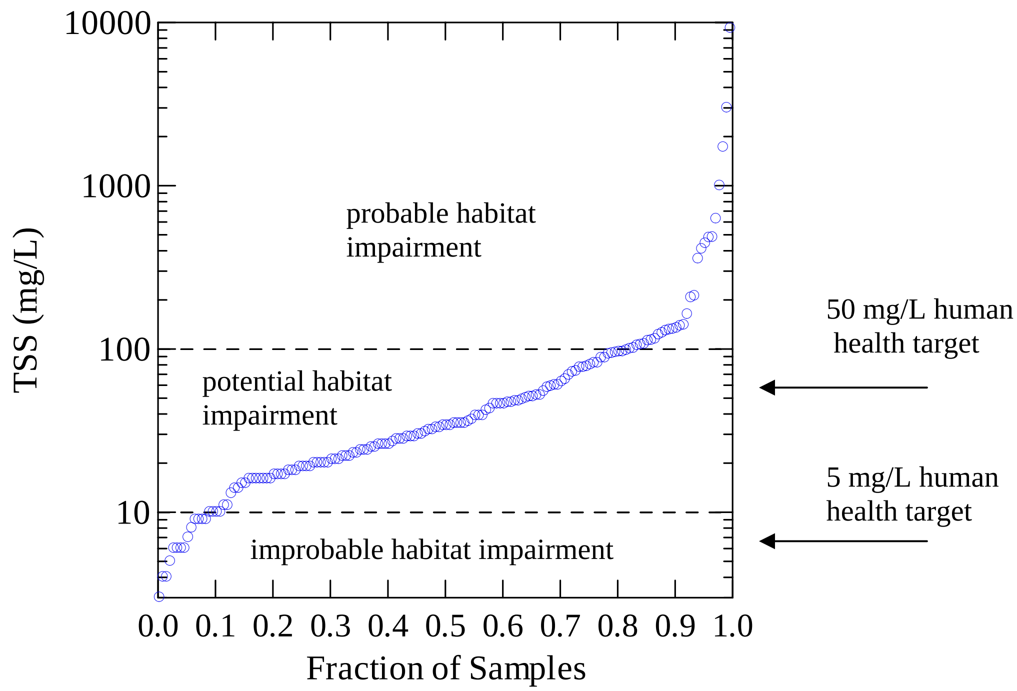

Figure 29. Recent Record on TSS Concentrations in the Lower Walla Walla River, Showing Zones of Biological Impairment and Proposed t-DDT-based TSS Targets (1990-2003 data).

The frequency with which the EPA habitat recommendations and proposed human health targets are exceeded by TSS levels in the mainstem lower Walla Walla River can be summarized as follows:

TSS Concentration	Exceedance Frequency in Lower Walla Walla River (1990-2003)	Implication
5 mg/L	98%	Increased health risk for the average fish consumer among tribal members
10 mg/L	90%	Potential habitat impairment
50 mg/L	46%	Increased health risk for the average fish consumer among the general public
100 mg/L	17%	Probable habitat impairment

Table 23 has data on the effects of TSS to some salmonid species of interest in the Walla Walla River. Newcombe and MacDonald (1991) emphasize the importance of looking at both concentration and duration of suspended sediment to assess impacts to salmonids and other species. Although larger juvenile and adult salmon can withstand short periods of high turbidity and TSS, they will avoid chronically turbid water (Lloyd et al., 1987; Bjornn and Reiser, 1991). This may be why sport fishing is affected when TSS concentrations persist at low levels over a period of a week or more. However, events of two to four days may disrupt feeding and territorial behavior of some juvenile salmon (Berg, 1982; Bjornn and Reiser, 1991). According to these data, prolonged exposure to TSS concentrations under 100 mg/L can seriously affect salmonid fry health and growth.

Spiny-ray fishes appear to be less sensitive than salmonids, although not as much data was found. Buck (1956) compared fish yields among farm ponds with TSS concentrations of <25 mg/L, 25 – 100 mg/L, and >100 mg/L. After two years, the yields were 181, 105, and 33 Kg/hectare, respectively. The critical concentrations for largemouth bass, bluegill, and sunfish were reported to be around 75 – 100 mg/L. Buck reported that young bass were not found in waters with greater than 84 mg/L TSS. Carp, on the other hand, are relatively insensitive to high TSS levels (Gammon, 1970).

Macroinvertebrate populations are depressed under chronically elevated TSS conditions. Some data presented by Newcombe and MacDonald (1991) indicate macroinvertebrates experience lethal conditions or avoid habitat when TSS concentrations are as low as 8 mg/L for 60 days (Table 24).

Table 23. Effects of Suspended Sediments on Walla Walla River Salmonids (from Newcombe and McDonald, 1991).

Species	Water Column Concentration (mg/L)	Duration of Exposure (days)	Effect
Spring Chinook	82,000	0.25	60% mortality of juveniles
“	19,364	4	50% mortality of smolts
“	488	4	50% mortality of smolts
“	1,547	4	Histological damage to gills
“	650	0.04	Homing performance disrupted
“	84	14	Reduction in growth rate
“	75	7	Harm to quality of habitat
“	6	60	Reduction in growth rate
“	1.5 - 2.0	60	Gill hyperplasia of fry
Rainbow Trout	19,364	4	50% mortality of smolts
“	157	72	100% mortality of eggs
“	90	19	5% mortality of sub-adults
“	37	60	46% reduction in egg to fry survival
“	21	48	62% reduction in egg to fry survival
“	7	48	17% reduction in egg to fry survival
“	171	4	Histological damage
“	100	0.04	Avoidance response
“	50	77	Reduction in growth rate
Salmon (general)	8	1	Sport fishing declines
Steelhead	84	14	Reduction in growth rate
Whitefish	16,613	4	50% mortality of smolts

Table 24. Effects of Suspended Sediments on Aquatic Insects and other Stream Fauna (from Newcombe and McDonald, 1991).

Species	Water Column Concentration (mg/L)	Duration of Exposure (days)	Effect
Benthic invertebrates	5,108	100	94% reduction in population size
“	743	100	85% reduction in population size
“	278	100	80% reduction in population size
“	62	100	77% reduction in population size
“	8	0.1	Increased rate of drift
“	8	60	50% reduction in standing crop
Stream invertebrates	130	365	40% reduction in species diversity
“	29	30	Populations of Trichoptera, Ephemeroptera, Crustacea, and Mollusca disappear

Lloyd et al. (1987) concluded that a TSS increase of 25 – 100 mg/L will reduce primary productivity in clear water streams by 13 – 50%. A 5 – 25 mg/L increase was associated with a 3 – 13% reduction in primary production.

TSS:Turbidity Correlation

Although there are no state standards for TSS, elevated levels of suspended sediment increase turbidity, and turbidity is addressed in the water quality standards. The Washington turbidity criteria are based on the relative change above background. For Class A waters (Chapter 173-201A-030-2 WAC): "Turbidity shall not exceed 5 NTU[9] over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background is more than 50 NTU."

The Washington criteria do not set a maximum acceptable turbidity level based on beneficial use considerations, but they do limit the effect of an identified source on raising the turbidity in the receiving water. Background conditions are further defined in Washington as ". . . the biological, chemical, and physical conditions of the water body, outside the area of influence of the discharge under consideration" except in headwaters where ". . . it may be necessary to use the background conditions of a neighboring or similar watershed . . ." (Chapter 173-201A-020 WAC).

There is no long-term record on background turbidities in the Walla Walla River that can be used for a comparison to standards. The historical TSS data however indicate that violations of the Class A turbidity standard are routine in the lower river.

The turbidity data obtained for the upper and lower Walla Walla River in the present study are plotted in Figure 30 and compared to the turbidity equivalent to a 5 NTU increase over the upper river. These results show that the river was in violation of 5 NTU allowable increase during most of the winter and spring of 2002-2003 (65% of samples).

In light of chronic violations of the turbidity standard and link between turbidity and TSS, a regression equation was developed for these two parameters in the Walla Walla drainage, using the pooled data from Appendix H (Figure 31). The resulting equation was Turbidity = $0.80 \times TSS^{0.87}$ ($R^2 = 0.92$).

[9] nephelometric turbidity units

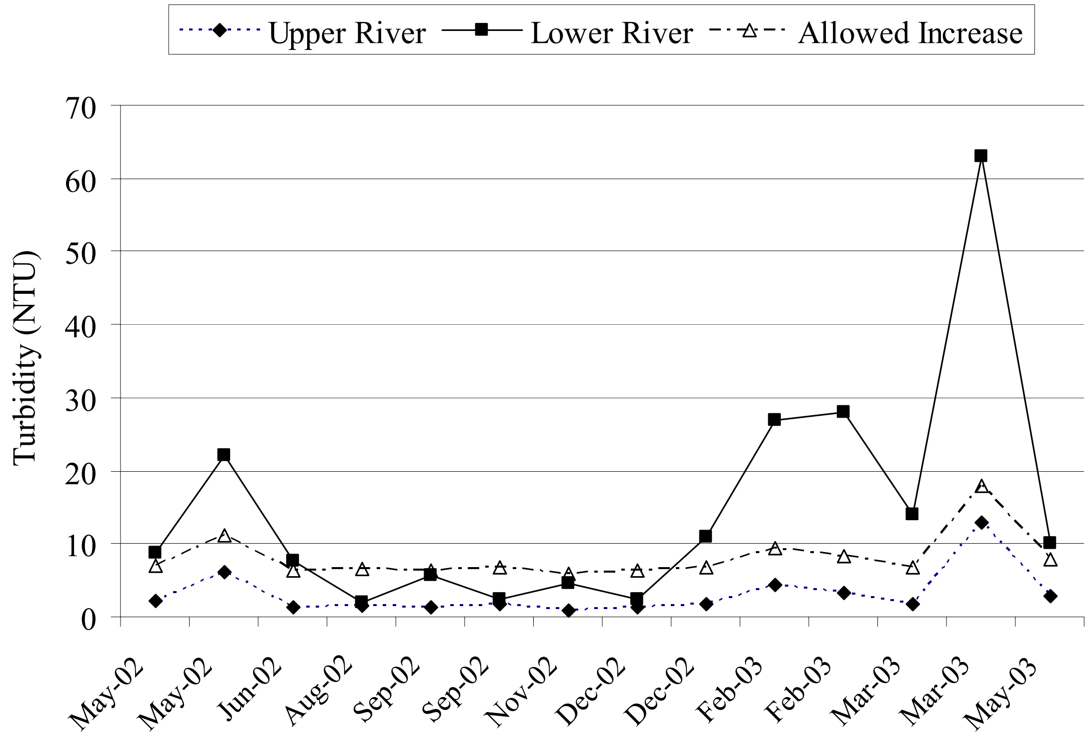

Figure 30. Exceedances of the Class A Turbidity Standard in the Walla Walla River [Walla Walla River @ state line vs. Walla Walla River below Cummins Bridge].

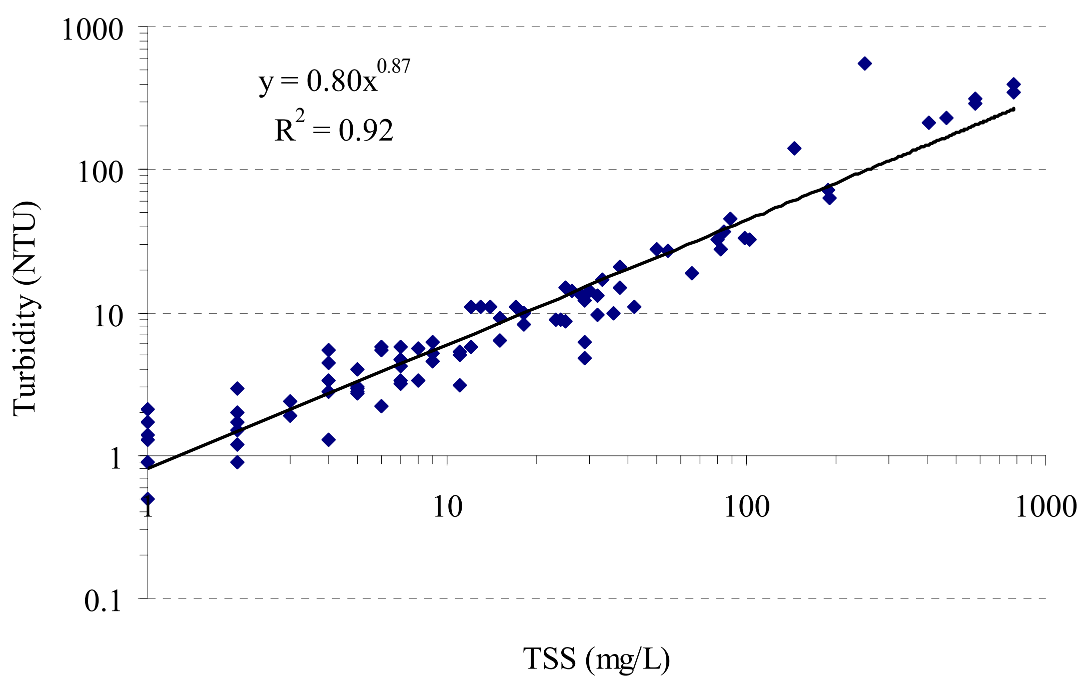

Figure 31. Relationship Between Turbidity and TSS in the Walla Walla Drainage.

This equation was used to calculated turbidity levels that correspond to the TSS targets for t-DDT. The results are shown below:

TSS Target	Equivalent Turbidity Target
50 mg/L	24 NTU
5 mg/L	3 NTU
2 mg/L	1 NTU
1 mg/L	<1 NTU

The monitoring data show that a water quality target needs to be set for meeting the Class A turbidity standard in the Walla Walla River. The EPA-approved procedure for the lower Yakima River TMDL used the 90th percentile background turbidity as the water quality target (Joy and Patterson, 1997). The 90th percentile is the concentration exceeded by 10% of samples. The 90th percentile value allows for seasonal variability, supports full beneficial use protection under EPA policy (EPA, 1995), and is adequate for background definition under Ecology policy (Ecology, 1994, 1996).

Based on the data in Appendix F, the 90th percentile turbidity in the upper Walla Walla River is 10 NTU (15 measurements at state line between 5/02 and 5/03). With the 5 NTU increase over background allowed in the Class A standards, the turbidity target downstream of the state line would be 15 NTU. A turbidity target of 15 NTU equates to 30 mg/L TSS (regression equation). A similar target is obtained by taking the 90th percentile of the more extensive TSS data for this site (29 mg/L, n=31) and applying the regression equation.

East Little Walla Walla River and Yellowhawk Creek

As previously shown, more restrictive water quality targets will be needed to meet pesticide standards in the East Little Walla Walla River and Yellowhawk Creek. The same approach can be used that gave the basic 50 mg/L TSS target for other parts of the drainage.

A plot of the TSS and DDE data for these two tributaries is shown in Figure 32. The best-fit regression equations were $TSS = 20 \times DDE^{1.9}$ ($R^2 = 0.88$) for the East Little Walla Walla River and $TSS = 44 \times DDE^{2.0}$ ($R^2 = 0.72$) for Yellowhawk Creek. Solving for the 0.59 ng/L DDE criterion and dividing by 2 to account for t-DDT as before, gives TSS concentrations of 4 and 7 mg/L, respectively. These values bracket the 5 mg/L TSS target suggested as a third tier goal for other parts of the drainage. It is therefore proposed that the 5 mg/L: 3 NTU target be applied to the East Little Walla Walla River and Yellowhawk Creek.

A 5 mg/L: 3 NTU target for the East Little Walla Walla River and Yellowhawk Creek should protect average fish consumers among the general public. The data collected indicate that TSS/turbidity levels that would meet human health criteria for high fish consumers among the general public and for tribal consumers approach zero for these two waterbodies and so are not proposed as targets at this time. Appropriate targets should ultimately be developed to protect these groups. This effort would best be initiated after some water quality improvements have been realized, at which point the relationship between TSS, turbidity, and trace-level pesticide contamination may be more easily and accurately discerned.

A more restrictive target is also needed for Yellowhawk Creek to meet turbidity standards in the Mill Creek drainage. Present survey data show that background turbidity in upper Mill Creek (Seven Mile bridge) ranges from 1 to 5 NTU (n=16). The 90th percentile value is 3 NTU. With the 5 NTU increase allowed in the standards, turbidity in Yellowhawk Creek should be at or below 8 NTU.

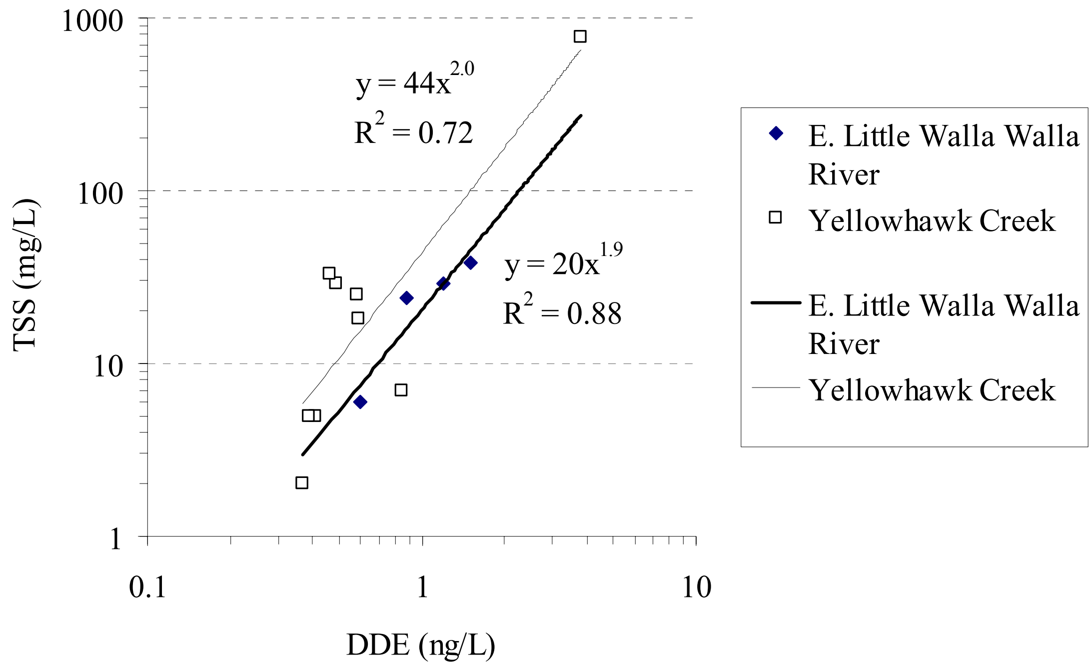

Figure 32. Relationship Between TSS and 4,4'-DDE in Yellowhawk Creek and the East Little Walla Walla River.

Target Summary

The following table summarizes the numerical water quality targets recommended for the Walla Walla River drainage; except for the East Little Walla Walla River and Yellowhawk Creek:

TSS Target	Turbidity Target	Effect of Meeting the Target
50 mg/L	24 NTU	• achieves compliance with human health water quality criteria for chlorinated pesticides • protects average fish consumers among the general public • provides a moderate level of habitat protection
30 mg/L	15 NTU	• achieves compliance with the Class A turbidity standard
5 mg/L	3 NTU	• protects average tribal fish consumers • provides a high level of habitat protection
2 mg/L	1 NTU	• protects high fish consumers among the general public
1 mg/L	<1 NTU	• protects high fish consumers among tribal members

The following targets are recommended specifically for the East Little Walla Walla River and Yellowhawk Creek:

TSS Target	Turbidity Target	Effect of Meeting the Target
30 mg/L	15 NTU	• achieves compliance with the Class A turbidity standard (for mainstem Walla Walla) • provides a moderate level of habitat protection
15 mg/L (Yellowhawk Creek)	8 NTU (Yellowhawk Creek)	• achieves compliance with the Class A turbidity standard (for Mill Creek drainage)
5 mg/L	3 NTU	• achieves compliance with human health water quality criteria for chlorinated pesticides • protects average fish consumers among the general public • provides a high level of habitat protection
Targets to protect high fish consumers among the general public and tribal consumers to be developed at a later date.		

Applying the Walla Walla Targets

In order to meet the water quality standards at issue in this TMDL, it is recommended that the targets be applied to the Walla Walla River at the state line and at the mouths of all mainstem tributaries in Washington. This is the most straightforward and equitable approach. Each tributary is a natural waterbody with fisheries and aesthetic resource values deserving of protection, and the targets protect these values. It would be shortsighted to allow problems to persist in tributaries even if ameliorated to varying degrees to address the mainstem 303(d) listings. Also, it is obvious that water quality would be degraded and beneficial uses lost if background were defined as upgradient from each discharge (e.g., if a 5 NTU increase were allowed for each tributary).

A phased approach should be adopted for meeting the targets, starting with the 30 mg/L:15 NTU target in the East Little Walla Walla River and Yellowhawk Creek, and the 50 mg/L:24 NTU target in other parts of the drainage. The 50 mg/L:24 NTU target is overprotective for chlorinated pesticides in the Touchet River. The target retains its value for habitat protection and meeting the turbidity standard nonetheless. For the East Little Walla Walla River and Yellowhawk Creek, the ultimate 5 mg/L:3 NTU target is overprotective for habitat and turbidity, but appears necessary to meet pesticide standards.

Initially, the targets should be applied directly to all irrigation returns at the point they enter the mainstem or tributaries. As water quality improvements become realized and the TSS/turbidity targets progressively achieved in rivers and streams, it may be appropriate to develop different targets for the returns.

The 2 mg/L:1 NTU and 1 mg/L:<1 NTU targets imply exceptional water quality conditions and will be difficult to achieve in an agricultural basin like the Walla Walla. Because they were extrapolated to equate to t-DDT concentrations below the detection limit, there is a substantial amount of uncertainty in their accuracy. The appropriateness of these values should be re-assessed once the more easily achieved targets are met. The ultimate goal of any future re-assessment of these targets should be to return the Walla Walla River to conditions consistent with CTUIR treaty rights.

In the Yakima River a decrease has been observed in the t-DDT:TSS ratio as sources of erosion are brought under control (Joseph Rinella, USGS, personal communication). This is likely due to DDT degradation over time and that a greater portion of the suspended sediment now comes from non-agricultural sources. A similar phenomenon would be expected to occur in the Walla Walla. If so, the 2 mg/L and 1 mg/L TSS targets may turn out to be unnecessarily low, and the TMDL target for TSS could be increased.

Progress on the Yakima River TMDL

The lower Yakima River TMDL set water quality targets for TSS and turbidity similar to those proposed here (Joy and Patterson, 1997). As with the Walla Walla, the concerns were meeting standards for chlorinated pesticides and turbidity, and protecting aquatic habitat. The success achieved in making land use changes to meet the Yakima targets is worth mentioning here.

The numerical targets being pursued in the lower Yakima can be summarized as follows:

Year	Target	Applies To
2003	$\leq$ 5 NTU increase above background	Yakima River mainstem
2003	56 mg/L TSS:25 NTU	Mouths of all Yakima tributaries and drains
2008	56 mg/L TSS:25 NTU	All points within Yakima tributaries and drains
2013	7 mg/L TSS:4 NTU	All Yakima tributaries, drains, and the mainstem

Joy and Patterson (1997) estimated that TSS concentrations in the lower Yakima would need to be reduced between 49 and 53% to meet the 5 NTU goal. In order to achieve the 56 mg/L:25 NTU target for drains and tributaries, they estimated that TSS loading should be reduced 74 – 93% in the major discharges. Reductions of similar scale will be needed in the Walla Walla drainage (see Loading Capacity).

Ecology has been conducting effectiveness monitoring for the lower Yakima River TMDL. The results obtained so far indicate the 2003 goals are close to being met. Figures 33 and 34 show some of the data. Anderson (2003) summarized progress in meeting the water quality targets as follows:

"Preliminary results show that turbidity has improved in the lower Yakima River considerably. The 90th percentile values, the means, and the number of excursions over 5 NTU between sites have decreased. Also, three out of four of the drains of biggest concern reported 90th percentile turbidities under 25 NTU. Granger Drain was not under 25 NTU, but reported a 90th percentile turbidity of 34. This is nearly an order of magnitude of improvement as the 90th percentile turbidity of Granger Drain was 335 NTU during the 1995 irrigation season."

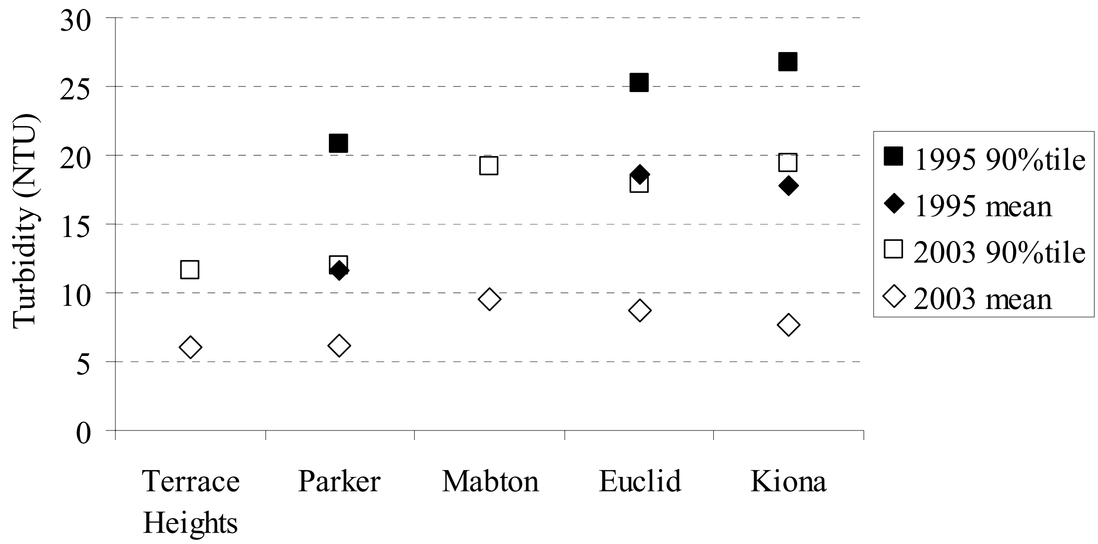

Figure 33. Turbidity Improvements in the Mainstem Lower Yakima River. [Unpublished data provided by R. Anderson, Ecology Central Regional Office].

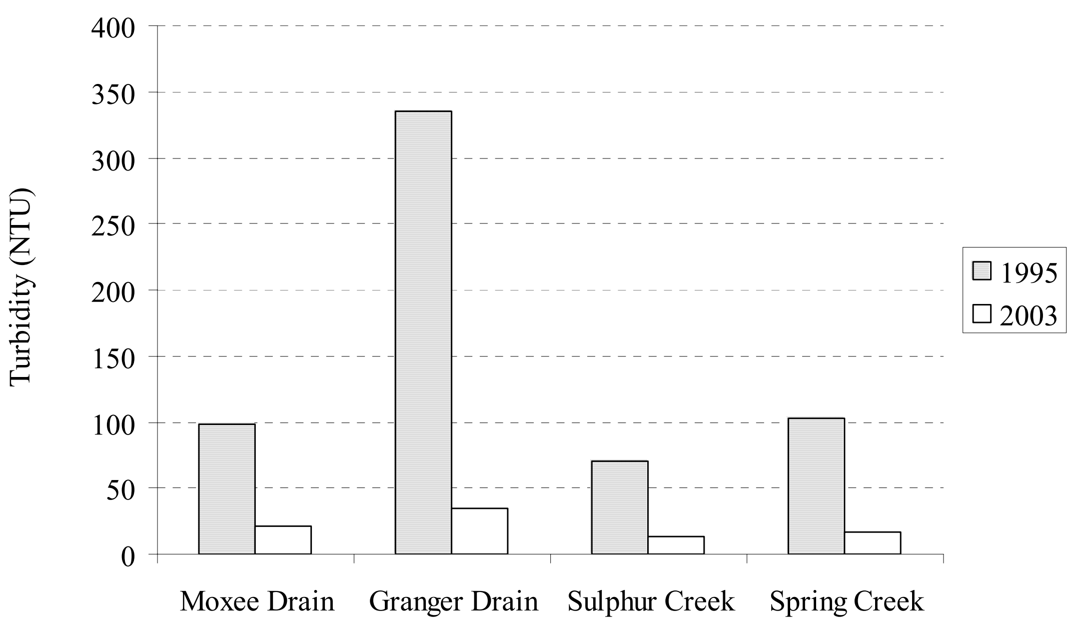

Figure 34. Improvements in 90th Percentile Turbidity in Major Irrigation Returns to the Lower Yakima River [Unpublished data provided by R. Anderson, Ecology Central Regional Office].

The Yakima River targets cover approximately the same range of TSS and turbidity values as some of the targets proposed for the Walla Walla River. The Yakima experience suggests that the Walla Walla 50 mg/L:24 NTU and 30 mg/L:15 NTU targets are achievable in the not too distant future.

PCBs

Because of the difficulty inherent in measuring low levels of PCBs in surface waters, TSS and turbidity targets could not be derived specifically for PCBs in the Walla Walla River. PCBs also have a strong affinity for soil particles, and atmospheric deposition to soils is and has been an important source. Deposition occurs because PCBs and other persistent organic compounds are volatile enough to evaporate from tropical and subtropical regions and deposit in cooler latitudes (Wania and Mackay, 1996). Meijer et al. (2003), for example, showed that >80% of the soil burden of PCBs in the Northern Hemisphere was derived from atmospheric as opposed to local sources. While air deposition also occurs for chlorinated pesticides, it is a minor source in areas where these chemicals have been applied directly to the land.

Meeting the TSS/turbidity targets in the Walla Walla drainage will reduce PCB concentrations in the river and its tributaries. A simple calculation suggests the water quality targets proposed for pesticides would also result in the state human health criterion for PCBs being met: If one assumes PCB concentration is a simple function of TSS levels (Table 17) and taking the average total PCB concentration in the lower river to be 1.5 ng/L (Table 16), then reducing the current median TSS level of 50 mg/L to approximately 5 mg/L would result in water column concentrations in the vicinity of the 0.17 ng/L PCB criterion.

Historical uses of PCBs have been associated with urban/industrial applications more than agriculture. SPMD results show there are major PCB sources in urbanized parts of the Walla Walla drainage. It is, therefore, uncertain if the proposed TSS/turbidity targets will have the requisite effectiveness for PCBs in Mill and Garrison creeks. As described at the end of this report, other programs, current and proposed, have the potential to further reduce or eliminate sources of PCBs to the Mill Creek watershed. Periodic monitoring of fish should be conducted in these creeks and in the mainstem Walla Walla to track the anticipated reduction of PCB concentrations in edible fish tissue and assess compliance with standards.

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Loading Capacity

Pesticides and PCBs

Loading capacity is the maximum amount of a pollutant that can be delivered to a waterbody and still achieve water quality standards. The Walla Walla River is over its loading capacity for chlorinated pesticides, chiefly as a result of excessive erosion of agricultural soils. The river is also over its loading capacity for PCBs from a combination of sources that include but may not be limited to urban/industrial runoff, wastewater treatment plant (WWTP) effluents, soil erosion, and atmospheric deposition.

Loading capacity can be calculated by multiplying streamflow by the pollutant water quality standard. EPA recommends using the long-term harmonic mean flow for carcinogens, since the adverse impacts are realized over a lifetime of exposure (EPA, 1991). The harmonic mean is always less than the arithmetic mean and is expressed as $Q_h = n/\sum(1/Q_i)$ where n is the number of recorded flows Q_i.

Table 25 has estimates of the Walla Walla River's loading capacity for chlorinated pesticides and PCBs, based on the flow record for the lower river (USGS gage near Touchet, 1951 – 2002). The loading capacity for chlorinated pesticides ranges from 0.012 – 0.070 grams/day. For PCBs the loading capacity is 0.014 grams/day. The previous assessment of bioaccumulation in the Walla Walla River suggests the loading capacity for PCBs may be lower.

Table 25. Loading Capacity for Chlorinated Pesticides and PCBs in the Lower Walla Walla River (@ 34 cfs - harmonic mean flow).

Chemical	Human Health Water Quality Criteria (ng/L)	Loading Capacity (grams/day)
4,4'-DDT	0.59	0.049
4,4'-DDE	0.59	0.049
4,4'-DDD	0.84	0.070
Total DDT	0.59	0.049
Dieldrin	0.14	0.012
Hexachlorobenzene	0.77	0.064
Heptachlor Epoxide	0.59	0.049
Toxaphene	0.75	0.062
Total PCBs	0.17	0.014

The WWTPs that discharge to Garrison and Mill creeks are the only known point sources for the chemicals of concern in this TMDL. Sampling results (see Tables 21 and 22) show that final effluents from the College Place and Walla Walla facilities exceed human health criteria for PCBs but not for pesticides.

PCB loadings for the WWTPs and receiving waters were compared to assess what impact these effluents may have on Garrison and Mill creeks (Table 26). The loading capacity of the creeks is approximately 0.0028 and 0.029 grams/day, respectively. Because Garrison Creek is an effluent dominated stream, the long-term mean was used to calculate loading capacity (EPA, 1991). The harmonic mean was used for Mill Creek. Mill Creek's loading capacity was calculated for the December through April period when effluent is discharged to the creek. There was only a two-year flow record for the lower creek, so the loading capacity estimate may not be representative of long-term average conditions.

Table 26. PCB Loading Estimates for WWTPs on Garrison and Mill Creeks.

	College Place WWTP/ Garrison Creek	Walla Walla WWTP/ Mill Creek
Receiving Water Loading Capacity		
Mean Flow (cfs)*†	6.7	69
Human Health PCB Criteria (ng/L)	0.17	0.17
Loading Capacity (gm/day)	0.0028	0.029
WWTP Load		
Average Flow for Maximum Month (mgd)	1.65	9.6
Total PCB Concentration (ng/L)	1.3	0.79
Total PCB Loading (gm/day)	0.0081	0.029
Receiving Water Load		
Mean Flow (cfs)	6.7	62
Dissolved PCB Concentration (ng/L)	3.5	0.69
Estimated Total PCB Concentration (ng/L)	18	2.7
Total PCB Load (gm/day)	0.30	0.40
WWTP as % of Receiving Water Load	**3**	**7**

*Based on historical mean flow for Garrison Creek and harmonic mean flow for Mill Creek
†Flow data from: present study; Joy and Swanson (in prep.); White et al. (1998); Mendel et al. (2002); WDFW unpublished data; USGS flow data http://waterdata.usgs.gov/nwis/sw; Ecology flow data http://www.ecy.wa.gov/programs/eap/flow/shu_main.html

Based on the average maximum monthly flow stipulated in the NPDES permits and results of effluent sampling, maximal PCB loads from the College Place and Walla Walla facilities were estimated at 0.0081 and 0.029 grams/day, respectively. Total PCB loads of 0.30 and 0.40 grams/day in Garrison and Mill creeks were estimated from the SPMD results (see Table 16).

The current PCB loads in the effluents and receiving waters exceed loading capacity of these streams. A comparison of loading estimates suggests that the WWTPs contribute less than 10%

of the receiving water load and thus are insignificant relative to nonpoint sources in these watersheds.

Total Suspended Solids

This TMDL evaluation recommends using TSS as a surrogate parameter for chlorinated pesticides in the Walla Walla River. Loading capacities for TSS in the mainstem and tributaries were estimated as follows:

Sediment rating curves (TSS vs. flow) and regression equations were developed from the available data. These relationships were used to estimate TSS concentrations and loads during critical times of the year. This approach for load estimation is described in Thomann and Mueller (1987).

The critical season for TSS loading was identified by plotting Ecology's historical lower river data by month (Figure 35). As shown, the interim 50 mg/L TSS target is routinely exceeded from January through June. TSS concentrations also exceed 50 mg/L during July – December, but infrequently. Therefore, for purposes of this TMDL, January – June is considered to be the critical period. This is the same time frame where the SPMD data show the highest pesticide and PCB levels in surface waters.

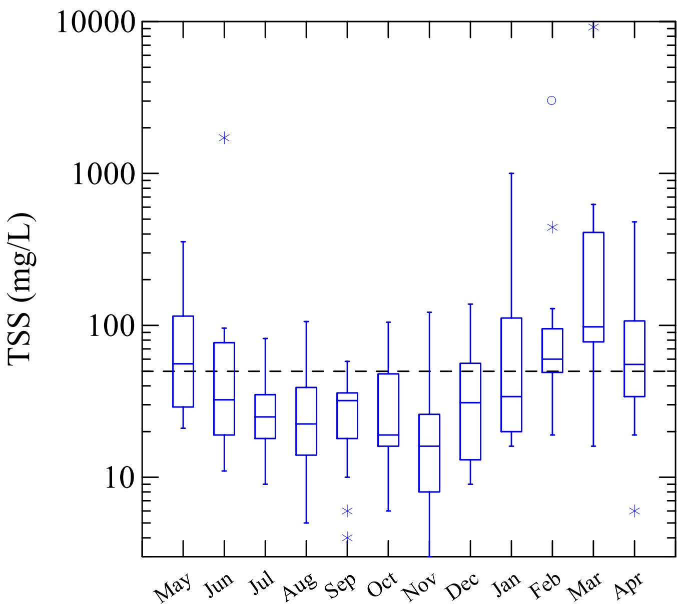

Figure 35. Seasonal Pattern of TSS Concentrations in the Lower Walla Walla River Showing the Recommended Interim 50 mg/L Water Quality Target (Ecology 1990-2003 data).

The estimated TSS loads during critical season flows were then compared to loads at the TSS targets, i.e., the loading capacity. The 90^{th} percentile flow was used to assess loading capacity. At the 90^{th} percentile, TSS concentrations would be expected to exceed loading capacity no more than 10% of the time.

Table 27 shows results of this exercise for the 50, 30, and 5 mg/L TSS targets. There was a limited amount of TSS and flow data available for the West Little Walla Walla River, Mud Creek, and Gardena Creek. Loading estimates for these streams should be considered gross approximations. There was not enough data to estimate TSS loads in the East Little Walla Walla River or Stone Creek.

In order to meet the 50 mg/L target 90% of the time during January through June, it is estimated that TSS loads in the mainstem lower Walla Walla River would need to be reduced by approximately 74%. To achieve the same target, TSS loads in the Touchet River, Gardena Creek, Dry Creek, and Pine Creek need to be reduced by approximately 67%, 37%, 34%, and 22%, respectively. To meet the more restrictive 5 mg/L target proposed for Yellowhawk Creek, an 83% reduction may be required.

TSS loads would need to be reduced proportionally to achieve the 30 mg/L and 5 mg/L targets. The needed load reductions in the lower river for January through June were estimated to be 84% and 97%, respectively.

The calculations indicate that no load reductions would be needed in Oregon in order for the Walla Walla River to meet either the 50 mg/L or 30 mg/L targets at the state line. TSS reductions on the Oregon side do appear to be called for to meet the 5 mg/L target. Under this scenario, very large TSS reductions would be needed basin-wide. Oregon's contribution of TSS may need to be considered in efforts to meet water quality targets for the East Little Walla Walla River, West Little Walla Walla River, Pine Creek, and Mud Creek as the upper portions of these streams extend into Oregon.

From July through December, the Walla Walla River meets the 50 mg/L TSS target more than 90% of the time. Under current conditions, a modest load reduction of 20% would meet the 30 mg/L TSS target for the lower river. A reduction of approximately 86% in the lower river is indicated for the 5 mg/L target during July through December.

The loading reductions that appear to be called for in the mainstem lower Walla Walla River for January-June and July-December can be summarized as follows:

Estimates of Loading Reductions Needed in the Mainstem Lower Walla Walla River To Meet Water Quality Targets for TSS			
Time Period	@ 50mg/L TSS Target	@ 30 mg/L TSS Target	@ 5 mg/L TSS Target
January - June	74%	84%	97%
July - December	0%	20%	86%

Table 27. Loading Capacity Estimates for TSS in the Walla Walla River Drainage, January through June.

Waterbody	Flow (cfs)	TSS (mg/L)	TSS Load (lbs/day)	Loading Capacity (lbs/day)	Percent Reduction Needed
	90th Percentile Conditions vs. 50 mg/L Target				
Walla Walla R. @ Peppers Bridge	426	19	43,708	115,020	0
Yellowhawk Creek	94	29	14,720	25,380	0
East Little Walla Walla River	*	*	*	*	*
Stone Creek	*	*	*	*	*
Garrison Creek	16	40	3,456	4,320	0
West Little Walla Walla River	5.8	13	407	1,566	0
Mill Creek	177	8	7,646	47,790	0
Dry Creek	72	76	29,549	19,440	34
Mud Creek	6	14	454	1,620	0
Pine Creek	61	64	21,082	16,470	22
Touchet River	750	153	619,650	202,500	67
Gardena Creek	8	79	3,413	2,160	37
Lower Walla Walla River	1,660	193	1,730,052	448,200	74

Waterbody	Flow (cfs)	TSS (mg/L)	TSS Load (lbs/day)	Loading Capacity (lbs/day)	Percent Reduction Needed
	90th Percentile Conditions vs. 30 mg/L Target				
Walla Walla R. @ Peppers Bridge	426	19	43,708	69,012	0
Yellowhawk Creek	94	29	14,720	15,228	0
East Little Walla Walla River	*	*	*	*	*
Stone Creek	*	*	*	*	*
Garrison Creek	16	40	3,456	2,592	25
West Little Walla Walla River	5.8	13	407	940	0
Mill Creek	177	8	7,646	28,674	0
Dry Creek	72	76	29,549	11,664	61
Mud Creek	6	14	454	972	0
Pine Creek	61	64	21,082	9,882	53
Touchet River	750	153	619,650	121,500	80
Gardena Creek	8	79	3,413	1,296	62
Lower Walla Walla River	1,660	193	1,730,052	268,920	84

Table 27 (continued). TSS Loading Capacity, January through June.

	90th Percentile Conditions vs. 5 mg/L Target				
Waterbody	Flow (cfs)	TSS (mg/L)	TSS Load (lbs/day)	Loading Capacity (lbs/day)	Percent Reduction Needed
Walla Walla R. @ Peppers Bridge	426	19	43,708	11,502	74
Yellowhawk Creek	94	29	14,720	2,538	83
East Little Walla Walla River	*	*	*	*	*
Stone Creek	*	*	*	*	*
Garrison Creek	16	40	3,456	432	88
West Little Walla Walla River	5.8	13	407	157	62
Mill Creek	177	8	7,646	4,779	38
Dry Creek	72	76	29,549	1,944	93
Mud Creek	6	14	454	162	64
Pine Creek	61	64	21,082	1,647	92
Touchet River	750	153	619,650	20,250	97
Gardena Creek	8	79	3,413	216	94
Lower Walla Walla River	1,660	193	1,730,052	44,820	97

* insufficient data
Sources of flow and TSS data: Appendix F; Joy and Swanson (in prep.); White et al. (1998); Mendel et al. (2002); WDFW unpublished data; USGS flow data http://waterdata.usgs.gov/nwis/sw; Ecology flow data http://www.ecy.wa.gov/programs/eap/flow/shu_main.html; Oregon Water Resources flow data http://www.wrd.state.or.us/index.shtml

Economic and Engineering Services Inc. recently modeled erosion and sediment yields in the Walla Walla basin (EES, 2003). This work was done for the Watershed Plan being developed by the WRIA 32 Watershed Planning Unit, with Walla Walla County serving as lead agency.

The modeling effort (SWAT) focused on one subbasin each in the Dry Creek and Touchet River watersheds. These two areas were considered to represent the majority of the watershed and account for land management practices common to the Walla Walla basin. EES concluded that "total sediment loading can be reduced by 85% by using no-till practices instead of historical cropping practices involving significant tillage operations." Thus, the present estimates of TSS load reductions needed to meet the 50 mg/L and 30 mg/L TSS targets appear to be achievable using established agricultural practices.

NPDES permits limit the amount of TSS that can be discharged by the College Place (permit #WA-002065-6) and Walla Walla (#WA-002442-7) WWTPs. The current limits state that the average monthly effluent concentrations for TSS "shall not exceed 15 mg/L or 15 percent of the respective monthly average influent concentrations, whichever is more stringent".

Discharge monitoring reports on file with Ecology show that the Walla Walla and College Place WWTPs are insignificant sources of TSS to the receiving waters. Monthly average TSS concentrations in the Walla Walla effluent ranged from 0.6 – 1.5 mg/L over the past two years.

College Place experienced periodic upsets during 2002. However, since February 2003, monthly TSS has averaged 0.1 – 4.4 mg/L. The city is developing an operations and maintenance program to prevent unexpected breakdowns or operator mistakes at College Place, and it is expected to continue to operate efficiently (Jerry Anderson, Ecology Eastern Regional Office, personal communication, 2004).

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Wasteload and Load Allocations

A TMDL must identify the total allowed pollutant amount and its components: appropriate wasteload allocations for point sources and load allocations for nonpoint sources and natural background. The following allocations are proposed for the Walla Walla River drainage:

Pesticides/PCBs/Total Suspended Solids

In this TMDL evaluation, TSS is proposed as a surrogate measure for chlorinated pesticides. Equivalent targets are provided for turbidity. Achieving the TSS and turbidity targets also addresses the PCB listings in the drainage. Because of the existence of both point and nonpoint sources of PCBs in the Mill Creek watershed, specific PCB allocations are proposed for Mill and Garrison creeks later in this section of the report.

The proposed load allocations for TSS in the upper and lower mainstem Walla Walla River are shown in Table 28. These allocations are for the critical January through June period and come directly from the loading capacities calculated in Table 27 (rounded to 2 significant figures). The loading capacities shown for tributaries in Table 27 are provided for information and planning purposes only and are not allocated loads.

As previously discussed, the relationship between pesticides and TSS levels in the river can be expected to change as erosion of agricultural soils is brought under control. For this reason, and because of acknowledged uncertainties in the analysis, TSS load allocations are not proposed for the 2 mg/L and 1 mg/L targets at this time.

Table 28. TSS Load Allocations for the Mainstem Walla Walla River, January through June.

Location	Load Allocation (lbs/day)		
	@ 50 mg/L TSS Target	@ 30 mg/L TSS Target	@ 5 mg/L TSS Target
Upper Walla Walla R. @ Peppers Bridge	120,000	69,000	12,000
Lower Walla Walla R. @ Cummins Bridge	450,000	270,000	45,000

TSS Allocation for Oregon

This TMDL evaluation did not attempt to differentiate between TSS loading from point sources, nonpoint sources, and background in Oregon. No significant TSS point sources to the Walla Walla River are present or anticipated in Oregon. Therefore wasteload allocations are zero. The entire TSS loading capacity of the Walla Walla River at the state line is allocated to nonpoint sources and background in Oregon. The river's load allocation at the state line for the initial 50 mg/L TSS target is 120,000 pounds per day.

TSS Allocation for Washington

No significant point sources of TSS are present or anticipated in the Washington portion of the Walla Walla watershed. Wasteload allocations are therefore zero, with the exception of the Walla Walla and College Place WWTPs. Adjustments to the NPDES permits for these WWTPs are not necessary at this time, and TSS allocations should be consistent with permit load limits.

This TMDL evaluation did not attempt to differentiate between TSS loading from nonpoint sources and background in Washington. Therefore, 100% of the TSS loading capacity is allocated to nonpoint sources and background. The load allocation for the lower Walla Walla River for the initial 50 mg/L target is 450,000 pounds per day.

Nonpoint and background sources in Oregon contribute an unknown part of the TSS load to the East Little Walla Walla River, West Little Walla Walla River, Pine Creek, and Mud Creek via their upper watersheds.

PCBs in Garrison and Mill Creeks

A TMDL must allocate a wasteload to each point source discharging the pollutants of concern unless it can be shown the discharge does not cause or contribute to exceedances of water quality standards. Therefore wasteload and load allocations were assigned for PCBs in Garrison Creek and Mill Creek in light of the concentrations detected in the College Place and Walla Walla WWTP effluents. Chlorinated pesticides were not found to exceed standards in these discharges.

Table 29 shows the proposed PCB allocations. The WWTP wasteload allocation was calculated as the product of the human health water quality criterion and the NPDES permit limit for the average monthly effluent flow. The wasteload allocation for the College Place WWTP is therefore 0.0011 grams/day, and for the Walla Walla WWTP it is 0.0062 grams/day. The difference between the loading capacity of the receiving water (Table 26) and the wasteload was assigned as the load allocation for nonpoint sources. (There is no natural background for PCBs.) The load allocations for Garrison and Mill creeks are therefore 0.0017 and 0.023 grams/day, respectively. The WWTP wasteload allocations for PCBs represent approximately 40% and 20% of the loading capacity of Garrison and Mill creeks, respectively.

Table 29. Wasteload and Load Allocations for PCBs in Garrison Creek and Mill Creek (gm/day).

	Garrison Creek	Mill Creek
Wasteload Allocation for WWTP	0.0011	0.0062
Load Allocation for Nonpoint	0.0017	0.023
Loading Capacity	0.0028	0.029

Margin of Safety

A margin of safety is required in a TMDL to account for uncertainty in understanding the relationship between pollutant discharges and water quality impacts. This TMDL evaluation incorporates several procedures and assumptions that confer a safety margin:

- Two methods were used to derive the TSS concentration on which the water quality targets were based, thereby increasing confidence in the appropriateness of the targets.
- The additive effects from the combined concentrations of DDT, DDE, and DDD were accounted for by basing the water quality targets on t-DDT.
- A t-DDT target provides a wider margin of safety for other chlorinated pesticides, since these are generally present at lower concentrations relative to criteria.
- The 90^{th} percentile statistic was used in developing the turbidity target and assessing loading capacity. This approach implicitly allocates 10% of the load to natural generation of suspended sediment and turbidity.
- The recommended approach of applying the water quality targets directly to tributaries and drains gives a wider margin of safety than requiring only the minimal water quality improvements needed to meet standards in the mainstem.
- A phased approach for implementing the targets is proposed; the ultimate targets are conservative.

Several sources of uncertainty could not be resolved with the information currently available:

- Because of difficulties in analyzing trace amounts of PCBs in surface water and a lack of information on sources, it is uncertain exactly how the decrease in PCB concentrations will track with the proposed water quality targets and at what point in the cleanup process standards will be achieved.
- As already described, there is uncertainty in the accuracy of the 2 mg/L:1 NTU and 1 mg/L:<1 NTU water quality targets, and the appropriateness of these values should be reassessed once the more easily achieved targets are met.
- Due to limited data, there is substantial uncertainty in the accuracy of the TSS loading capacities and loading reductions estimated for several tributaries, previously identified.
- Due to limited flow data for lower Mill Creek, the wasteload and load allocations for PCBs may not be representative of average conditions.
- Because estimated toxaphene concentrations exceeded t-DDT in Pine Creek, meeting water quality targets for TSS in this creek may not result in toxaphene meeting standards. Source investigation is recommended.

Finally, this study did not investigate the bottom sediments in the Columbia River backwater formed in the lower 10 miles of the Walla Walla River by McNary Dam. This area is a likely sink for chlorinated pesticides and PCBs associated with particulates transported by the Walla Walla River and a potential source of contamination to fish. Sediment recovery will occur as upstream water quality targets are met, but the time for recovery is unknown.

Seasonal Variation and Critical Conditions

A TMDL must describe the method used to account for seasonal variations and critical conditions. Both of these issues were previously addressed, most importantly:

- Seasonal patterns of contamination were identified through the use of SPMDs deployed on a quarterly basis, including associated grab samples.

- Harmonic mean flow was used to calculate loading capacity estimates for pesticides and PCBs.

- The critical season for TSS loading was identified by plotting the historical ambient monitoring data for by month.

- The 90^{th} percentile statistic was used in deriving the turbidity target and in estimates of loading capacity, which allows for seasonal variability.

Monitoring Plan

A TMDL must include monitoring to measure achievement of targets and water quality standards. An outline of a monitoring plan for the Walla Walla chlorinated pesticide/PCB TMDL is provided below.

The goal of monitoring would be to determine if land use changes are effective in reducing TSS loading to the Walla Walla River and bringing the river into compliance with standards. Objectives should include: 1) obtaining accurate and representative data on TSS and turbidity in the mainstem Walla Walla River and major tributary sources of TSS; 2) using the data to assess progress toward meeting water quality targets for these parameters; 3) re-surveying fish and the water column to verify that human health standards for chlorinated pesticides and PCBs are being met; 4) re-assessing the accuracy of the 2 mg/L:1 NTU and 1 mg/L:<1 NTU targets for the mainstem, and 5) developing water quality targets to protect high fish consumers in the East Little Walla Walla River and in Yellowhawk Creek.

It is suggested that water quality monitoring begin with collecting one year of baseline data on TSS and turbidity at the ten sites listed below. Sampling should be conducted at least twice weekly, similar to what is being done for effectiveness monitoring in the Yakima TMDL. In order to obtain representative and comparable data, depth integrating sampling procedures should be used. Streamflow should be measured.

The following sampling sites are suggested for TMDL effectiveness monitoring:

1. Walla Walla River @ state line
2. Yellowhawk Creek
3. East Little Walla Walla River
4. Garrison Creek
5. Mill Creek
6. Dry Creek
7. Pine Creek
8. Touchet River
9. Gardena Creek
10. Lower Walla Walla River @ Cummins Bridge

Once significant land use changes are deemed to have occurred, twice-weekly samples would be again collected from January through June, the critical period for TSS loading. The pre- and post-data for January-June would be tested for significant differences and the 90^{th} percentile values compared to the numerical targets. January-June monitoring would continue on a yearly or less frequent basis, depending on results of the comparisons and pace at which land use changes proceed in the watershed. Monitoring in July-December would be phased in as appropriate to assess progress in meeting the more restrictive targets.

As the water quality targets for TSS and turbidity are progressively achieved, chlorinated pesticides and PCBs should be periodically analyzed in resident mainstem fish species and the water column. PCBs should also be analyzed in fish samples from Mill and Garrison creeks. Sample size for fish should be appropriate for making a statistical comparison with criteria used to assess compliance with human health standards and WDOH should be consulted on the sampling design. Water column sampling and analysis should employ low-level techniques. Water samples should be focused on the mainstem and include the East Little Walla Walla River and Yellowhawk Creek. TSS and turbidity samples should be collected in conjunction with the pesticide sampling.

A Quality Assurance (QA) Project Plan should be prepared for whatever monitoring is conducted. The QA Project Plan should follow Ecology guidelines (Lombard and Kirchmer, 2004) paying particular attention to consistency in sampling and analytical methods.

Compliance Schedule

In the TMDL process, a flexible schedule is allowed for compliance with water quality targets since nonpoint source implementation is not an exact science. Interim targets are compared to monitoring data at regular intervals after best management practices, education programs, and other parts of the implementation strategy have been initiated. As the targets and data are compared, the progress toward improved water quality conditions is assessed, and adjustments or changes in the TMDL strategy are publicly discussed. The goal is to find practical and effective solutions to eliminate the water pollution problems addressed in the TMDL.

A Summary Implementation Strategy (SIS) is developed in the TMDL submittal report to EPA. In the SIS, dates for meeting the interim targets are stated. In addition, effectiveness monitoring is mentioned, which occurs five years after the Detailed Implementation Plan is complete. In both the SIS and the Detailed Implementation Plan, the advisory group may include a more detailed compliance schedule.

Recommendations for Follow-up Work

As of result of this TMDL study, the following recommendations are made:

- Chlorinated pesticides and PCBs should be analyzed in sediment samples from the Columbia River backwater in the lower Walla Walla River and an assessment made of potential for uptake of these chemicals by fish and of ecological risk. The rate of sediment deposition should be measured and results used to predict time to recovery under various cleanup scenarios for the upstream watershed.

- An effort should be made to determine if there are remediable PCB sources in the Mill Creek watershed. More intensive sampling of Mill and Garrison creeks may help determine if and where localized sources exist. The stormwater systems should be sampled for PCBs. Other potential sources in the watershed include agricultural, food processing, chemical, scrap, and waste sites.

- The City of Walla Walla is currently implementing a program throughout the city to identify and reduce or eliminate sources of pollutants, including PCBs. This program, in conjunction with recent and future treatment upgrades at the wastewater treatment plant (WWTP), will remove identified pollutants from the discharge. The city also will be delegated the EPA Pretreatment Program by the Department of Ecology that will give the city the tools to establish additional industrial and commercial effluent limits when discharging into the city sewer system. The local program also will allow the city to issue a permit to the dischargers with these effluent limitations and with compliance authority.

  The City of College Place, being a smaller community, will be assisted by Ecology to identify possible sources of pollutants. Through special conditions in the city's discharge permit, the city is required to identify and gather effluent data on local dischargers to the sewer system. These data will be analyzed by the city and Ecology for possible pollutants that may affect the treatment ability of the WWTP or exceed effluent requirements required by the TMDL.

- Sampling should be conducted to locate toxaphene sources in the Pine Creek drainage. Because of the analytical challenges presented by toxaphene, some kind of pre-concentration technique may be required to obtain useful data.

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Appendices

A. Sampling Site Locations for the Walla Walla Chlorinated Pesticide/PCB TMDL Field Study.

B. Biological Data on Walla Walla River Fish Samples.

C. Estimated Water Concentration Calculator from SPMD Data.

D. Pesticide/PCB Data from the Walla Walla Chlorinated Pesticide/PCB TMDL Field Study.

E. Results on Replicate and Split Samples Analyzed for the Walla Walla Chlorinated Pesticide/PCB Field Study.

F. Flow and Conventional Water Quality Data for the Walla Walla Drainage.

G. Conventional Data for Final Effluent from the College Place and Walla Walla WWTPs

H. DDE, TSS, and Turbidity Data on Whole Water Samples Collected in the Walla Walla Drainage, May 2002 - September 2003.

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Appendix A

Sampling Site Locations for the Walla Walla Chlorinated Pesticide/PCB TMDL Field Study

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Appendix A. Sampling Site Locations for the Walla Walla Chlorinated Pesticide/PCB TMDL Field Study.

Site Name	Location Description	Latitude North (NAD83)	Longitude West (NAD83)
Major Tributaries			
Upper Mill Creek	At the 7 Mile Road crossing - Creek Mile 14.8	46.081	118.189
Upper Walla Walla River	At the Pepper Road crossing - River Mile 39.6	46.003	118.383
Yellowhawk Creek	At the Old Milton Hwy crossing - Creek Mile 1.1	46.024	118.384
Garrison Creek	At the Mission Road crossing - Creek Mile 0.5	46.028	118.428
Lower Mill Creek	On Whitman Mission Refuge property at the railroad crossing - Creek Mile 0.7	46.044	118.464
Middle Walla Walla River	At the Detour Road crossing - River Mile 32.8	46.043	118.490
Dry Creek	At the Highway 12 crossing - Creek Mile 0.5	46.057	118.590
Pine Creek	At the Sand Pit Road crossing - Creek Mile 1.4	46.028	118.632
Touchet River	At Highway 12 crossing - River Mile 0.5	46.042	118.683
Lower Walla Walla River	At the old irrigation station off of Byrnes Road - River Mile 14.3	46.052	118.758
Minor Tributaries			
East Little Walla Walla R.	At a road crossing off of Beet Road - River Mile 0.7	46.013	118.412
Stone Creek	At mouth near the Mojonnier Road crossing of the Walla Walla River - Creek Mile 0.0	46.024	118.426
West Little Walla Walla R.	At the Stovall Road crossing - River Mile 0.8	46.034	118.472
Mud Creek	At the Borgen Road crossing - Creek Mile 0.5	46.042	118.615
Gardena Creek	At the Nelson Road crossing - Creek Mile 1.1	46.017	118.721
WWTPs			
Walla Walla WWTP	Final effluent from outfall box	46.065	118.376
College Place WWTP	Final effluent from the outfall of Lagoon 3	46.031	118.419
Fishing Sites			
Lower Walla Walla River	From Pierce's RV Park Property (River Mile 9.5) to River Mile 20.0	46.067	118.826
Upper Walla Walla River	From Dry Creek (River Mile 27.2) to Yellowhawk Creek (River Mile 38.1)	46.051	118.594

Note: Latitude/longitude for fish collection are downstream end of reach.

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Appendix B

Biological Data on
Walla Walla River Fish Samples

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Appendix B. Biological Data on Walla Walla River Fish Samples.

Collection Date	Sample ID*	Sample No.	Species	Fork** or Total Length (mm)	Total Weight (g)	Tissue Type[†]	Fillet Weight (g)	Sex	Age
7/17/02	UPCARP-1	438181	Carp	520	2350	S fillet	300	F	10
7/17/02	UPCARP-1	438181	Carp	547	2966	S fillet	475	M	17
7/18/02	UPCARP-1	438181	Carp	475	1876	S fillet	290	M	7
7/17/02	UPSMBS-1	438182	SMBS	396	897	S fillet	n/a	F	5
7/18/02	UPSMBS-1	438182	SMBS	220	189	S fillet	86	M	2
7/17/02	UPBLS-1	438183	BLS	432	877	S fillet	173	F	8
7/17/02	UPBLS-1	438183	BLS	405	723	S fillet	138	F	5
7/17/02	UPBLS-1	438183	BLS	443	974	S fillet	200	F	5
7/17/02	UPBLS-1	438183	BLS	450	809	S fillet	168	M	6
7/17/02	UPBLS-1	438183	BLS	447	824	S fillet	180	M	6
7/17/02	UPBLS-2	438184	BLS	405	704	S fillet	133	F	4
7/18/02	UPBLS-2	438184	BLS	370	552	S fillet	119	M	4
7/17/02	UPBLS-2	438184	BLS	420	797	S fillet	146	F	8
7/17/02	UPBLS-2	438184	BLS	310	396	S fillet	63	Ind	4
7/17/02	UPBLS-2	438184	BLS	350	442	S fillet	81	M	5
7/17/02	UPBLS-3	438185	BLS	353	469	S fillet	95	Ind	3
7/18/02	UPBLS-3	438185	BLS	348	397	S fillet	83	F	4
7/17/02	UPBLS-3	438185	BLS	432	740	S fillet	140	F	5
7/17/02	UPBLS-3	438185	BLS	448	824	S fillet	159	Ind	7
7/17/02	UPBLS-3	438185	BLS	428	1005	S fillet	172	M	7
7/17/02	UPBLS-4	438186	BLS	452	850	S fillet	148	F	5
7/17/02	UPBLS-4	438186	BLS	460	962	S fillet	160	F	6
7/17/02	UPBLS-4	438186	BLS	408	742	S fillet	138	F	5
7/17/02	UPBLS-4	438186	BLS	382	651	S fillet	130	M	5
7/17/02	UPBLS-4	438186	BLS	395	620	S fillet	94	Ind	4
7/17/02	UPBLS-5	438187	BLS	395	558	Whole	n/a	F	4
7/17/02	UPBLS-5	438187	BLS	498	1013	Whole	n/a	F	10
7/17/02	UPBLS-5	438187	BLS	455	938	Whole	n/a	Ind	5
7/17/02	UPBLS-5	438187	BLS	374	651	Whole	n/a	F	3
7/17/02	UPBLS-5	438187	BLS	410	676	Whole	n/a	M	5
7/17/02	UPNPM-1	438188	NPM	288	291	S fillet	50	M	5
7/17/02	UPNPM-1	438188	NPM	277	210	S fillet	41	F	5
7/17/02	UPNPM-1	438188	NPM	253	172	S fillet	33	F	6
7/17/02	UPNPM-1	438188	NPM	252	159	S fillet	32	F	6
7/17/02	UPNPM-1	438188	NPM	253	179	S fillet	30	M	4
7/17/02	UPNPM-2	438189	NPM	260	165	S fillet	47	F	5
7/17/02	UPNPM-2	438189	NPM	228	149	S fillet	58	M	4
7/17/02	UPNPM-2	438189	NPM	240	155	S fillet	50	M	5
7/17/02	UPNPM-2	438189	NPM	232	138	S fillet	43	M	6

Collection Date	Sample ID*	Sample No.	Species	Fork** or Total Length (mm)	Total Weight (g)	Tissue Type†	Fillet Weight (g)	Sex	Age
7/17/02	UPNPM-2	438189	NPM	397	536	S fillet	109	F	8
7/17/02	UPNPM-3	438190	NPM	298	262	S fillet	50	F	9
7/17/02	UPNPM-3	438190	NPM	230	125	S fillet	45	M	6
7/17/02	UPNPM-3	438190	NPM	298	254	S fillet	46	M	7
7/18/02	UPNPM-3	438190	NPM	358	512	S fillet	86	M	9
7/17/02	UPNPM-3	438190	NPM	303	287	S fillet	48	M	7
7/17/02	UPNPM-4F	438191	NPM	320	383	S fillet	48	M	9
7/17/02	UPNPM-4F	438191	NPM	302	327	S fillet	48	F	7
7/17/02	UPNPM-4F	438191	NPM	250	174	S fillet	41	F	4
7/17/02	UPNPM-4F	438191	NPM	280	234	S fillet	54	M	5
7/17/02	UPNPM-4F	438191	NPM	350	407	S fillet	57	F	8
7/17/02	UPNPM-4C	438210	NPM	320	383	carcass	n/a		9
7/17/02	UPNPM-4C	438210	NPM	302	327	carcass	n/a		7
7/17/02	UPNPM-4C	438210	NPM	250	174	carcass	n/a		4
7/17/02	UPNPM-4C	438210	NPM	280	234	carcass	n/a		5
7/17/02	UPNPM-4C	438210	NPM	350	407	carcass	n/a		8
7/29/02	LWRCAT-1	438192	CHCAT	525	1259	NS fillet	142	F	10
7/31/02	LWRCAT-1	438192	CHCAT	475	942	NS fillet	114	M	11
7/31/02	LWRBLS-1	438193	BLS	336	356	S fillet	73	Ind	4
7/29/02	LWRBLS-1	438193	BLS	374	532	S fillet	94	F	5
7/29/02	LWRBLS-1	438193	BLS	303	241	S fillet	98	Ind	3
7/29/02	LWRBLS-1	438193	BLS	482	1054	S fillet	161	F	6
7/29/02	LWRBLS-1	438193	BLS	492	1121	S fillet	188	M	6
7/29/02	LWRBLS-2	438194	BLS	441	489	S fillet	131	M	5
7/29/02	LWRBLS-2	438194	BLS	290	279	S fillet	95	Ind	4
7/30/02	LWRBLS-2	438194	BLS	419	743	S fillet	145	M	5
7/31/02	LWRBLS-2	438194	BLS	485	1165	S fillet	180	F	12
7/29/02	LWRBLS-2	438194	BLS	512	1270	S fillet	191	F	13
7/29/02	LWRBLS-3	438195	BLS	320	324	S fillet	69	Ind	3
7/30/02	LWRBLS-3	438195	BLS	294	251	S fillet	54	Ind	5
7/29/02	LWRBLS-3	438195	BLS	430	675	S fillet	125	M	5
7/29/02	LWRBLS-3	438195	BLS	408	633	S fillet	127	F	8
7/29/02	LWRBLS-3	438195	BLS	306	258	S fillet	51	M	2
7/29/02	LWRBLS-4	438196	BLS	469	825	S fillet	139	F	6
7/31/02	LWRBLS-4	438196	BLS	364	453	S fillet	89	M	5
7/30/02	LWRBLS-4	438196	BLS	310	301	S fillet	99	Ind	3
7/29/02	LWRBLS-4	438196	BLS	336	450	S fillet	102	Ind	4
7/29/02	LWRBLS-4	438196	BLS	357	447	S fillet	82	M	4
7/29/02	LWRBLS-5	438197	BLS	423	742	Whole	n/a	M	6
7/30/02	LWRBLS-5	438197	BLS	283	201	Whole	n/a	Ind	2
7/29/02	LWRBLS-5	438197	BLS	450	761	Whole	n/a	F	6
7/31/02	LWRBLS-5	438197	BLS	381	565	Whole	n/a	M	3
7/31/02	LWRBLS-5	438197	BLS	345	414	Whole	n/a	F	3

Collection Date	Sample ID*	Sample No.	Species	Fork** or Total Length (mm)	Total Weight (g)	Tissue Type†	Fillet Weight (g)	Sex	Age
9/10/02	LWRCARP-1	438198	Carp	610	2953	S fillet	338	M	12
7/29/02	LWRCARP-1	438198	Carp	610	2752	S fillet	277	M	14
7/29/02	LWRCARP-1	438198	Carp	584	2307	S fillet	292	M	19
9/10/02	LWRCARP-1	438198	Carp	590	2592	S fillet	261	M	10
9/10/02	LWRCARP-1	438198	Carp	570	2360	S fillet	246	F	15
9/10/02	LWRCARP-2	438199	Carp	606	3181	S fillet	336	F	9
7/29/02	LWRCARP-2	438199	Carp	580	2726	S fillet	274	F	10
7/29/02	LWRCARP-2	438199	Carp	544	1875	S fillet	268	M	10
7/29/02	LWRCARP-2	438199	Carp	482	1938	S fillet	174	M	5
7/29/02	LWRCARP-2	438199	Carp	540	1946	S fillet	210	M	11
9/10/02	LWRCARP-3	438200	Carp	602	2962	S fillet	279	M	13
9/10/02	LWRCARP-3	438200	Carp	590	2393	S fillet	270	F	10
7/29/02	LWRCARP-3	438200	Carp	585	2675	S fillet	267	M	12
9/10/02	LWRCARP-3	438200	Carp	606	3796	S fillet	331	F	13
7/29/02	LWRCARP-3	438200	Carp	585	2482	S fillet	251	M	14
7/29/02	LWRCARP-4	438201	Carp	570	2189	S fillet	229	M	9
7/29/02	LWRCARP-4	438201	Carp	438	1551	S fillet	169	M	10
7/29/02	LWRCARP-4	438201	Carp	568	2543	S fillet	240	F	13
9/10/02	LWRCARP-4	438201	Carp	705	4322	S fillet	458	F	13
9/10/02	LWRCARP-4	438201	Carp	608	3136	S fillet	360	F	11
9/11/02	LWRNPM-1	438203	NPM	310	237	S fillet	53	F	7
7/31/02	LWRNPM-1	438203	NPM	266	149	S fillet	32	M	5
7/30/02	LWRNPM-1	438203	NPM	203	80	S fillet	24	M	4
9/11/02	LWRNPM-1	438203	NPM	310	269	S fillet	37	F	7
7/29/02	LWRNPM-1	438203	NPM	234	100	S fillet	28	Ind	5
7/29/02	LWRNPM-2	438204	NPM	223	96	S fillet	33	Ind	5
9/11/02	LWRNPM-2	438204	NPM	285	188	S fillet	54	F	6
7/31/02	LWRNPM-2	438204	NPM	235	104	S fillet	37	Ind	6
7/29/02	LWRNPM-2	438204	NPM	229	100	S fillet	35	F	5
9/11/02	LWRNPM-2	438204	NPM	260	153	S fillet	41	M	6
7/29/02	LWRSMBS-1	438205	SMBS	200	97	S fillet	38	Ind	2
7/29/02	LWRSMBS-1	438205	SMBS	197	106	S fillet	36	Ind	2
7/31/02	LWRSMBS-1	438205	SMBS	442	1158	S fillet	204	F	6
7/29/02	LWRSMBS-1	438205	SMBS	183	79	S fillet	28	Ind	2
7/29/02	LWRSMBS-1	438205	SMBS	180	72	S fillet	21	Ind	2
9/11/02	LWRSMBS-2	438206	SMBS	240	182	S fillet	32	M	2
7/31/02	LWRSMBS-2	438206	SMBS	309	399	S fillet	70	Ind	3
9/11/02	LWRSMBS-2	438206	SMBS	370	708	S fillet	107	M	4
7/29/02	LWRSMBS-2	438206	SMBS	313	412	S fillet	75	M	3
7/30/02	LWRSMBS-2	438206	SMBS	382	750	S fillet	114	F	4
9/11/02	LWRSMBS-2C	438209	SMBS	240	182	Carcass	n/a	M	2
7/31/02	LWRSMBS-2C	438209	SMBS	309	399	Carcass	n/a	Ind	3
9/11/02	LWRSMBS-2C	438209	SMBS	370	708	Carcass	n/a	M	4
7/29/02	LWRSMBS-2C	438209	SMBS	313	412	Carcass	n/a	M	3

Collection Date	Sample ID*	Sample No.	Species	Fork** or Total Length (mm)	Total Weight (g)	Tissue Type†	Fillet Weight (g)	Sex	Age
7/30/02	LWRSMBS-2C	438209	SMBS	382	750	Carcass	n/a	F	4
7/31/02	LWRSMBS-3	438207	SMBS	223	132	S fillet	40	M	2
7/29/02	LWRSMBS-3	438207	SMBS	267	278	S fillet	52	M	3
7/31/02	LWRSMBS-3	438207	SMBS	205	109	S fillet	36	Ind	2
9/11/02	LWRSMBS-3	438207	SMBS	220	135	S fillet	47	Ind	2
7/31/02	LWRSMBS-3	438207	SMBS	375	829	S fillet	135	M	5
7/30/02	LWRSMBS-4	438208	SMBS	354	607	S fillet	101	F	4
7/31/02	LWRSMBS-4	438208	SMBS	223	154	S fillet	49	Ind	2
7/31/02	LWRSMBS-4	438208	SMBS	211	122	S fillet	38	Ind	1
7/31/02	LWRSMBS-4	438208	SMBS	358	677	S fillet	125	M	4
7/31/02	LWRSMBS-4	438208	SMBS	204	102	S fillet	37	Ind	2

*UP designates an upper river sample; LWR designates a lower river sample
**Upper river fish are fork length. Total length can be estimated from fork length using the formulas:
Small mouth bass - TL = FK x 1.04
Northern pike minnow - TL = FK x 1.114
Carp - TL = $10^{(0.999 x log FK)+0.053}$
Bridgelip sucker - TL = $10^{(1.022 x log FK)-0.025}$
†S=skin on
NS = no skin

Appendix C

Estimated Water Concentration Calculator from SPMD Data

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Appendix C. Estimated Water Concentration Calculator from SPMD Data (D. Alvarez, USGS, modified).

Enter a temperature value (10, 18, or 26) in °C which most closely approximates the actual exposure water temperature.
Temperature (°C) = 10   Exposure Time (d) = 28.8

Mass of SPMD (g) = 22.5 (NOTE: a standard 81 cm SPMD has a mass of 4.5 g)
Volume of Lipid (L) = 0.005   Volume of Membrane (L) = 0.0185   Volume of SPMD (L) = 0
(NOTE: a standard 81 cm SPMD has lipid volume of 0.001L, membrane volume of 0.0037L, and a total volume of 0.0047L.)

If a PRC was used, the $k_{e\text{-}PRC}$ can be calculated by $k_{e\text{-}PRC} = [\ln(C_{SPMDo}/C_{SPMD})]/t$. $k_{e\text{-}PRC}$ (d^{-1}) = 0.0091
The $k_{e\text{-}cal}$ value is the laboratory calibration value for the native PRC analog. $k_{e\text{-}cal}$ (d^{-1}) = 0.013 (NOTE: the $k_{e\text{-}cal}$ for D_{10}-Phenanthrene is 0.021 d^{-1})

Project Name: Yellowhawk Creek 208089 May-June 02

Compound	Log K_{ow}	K_{SPMD}	Laboratory R_s (L/d)	PRC corrected R_s (L/d)	Theoretical $t_{1/2}$		Total Analyte (ng/SPMD)		Water Conc. (pg/L)	Used
Hexachlorobenzene	5.71	1.45E+05	2.6	1.8	1305.4		30		573.9	linear
Heptachlor	5.19	6.72E+04	3.6	2.5	435.6	<	5	<	69.1	linear
Heptachlor Epoxide	4.51	2.00E+04	2.9	2.0	161.2		14		240.1	linear
p,p'-DDE	6.14	2.50E+05	5.5	3.8	1061.3		392		3546.8	linear
o,p'-DDE	5.56	1.18E+05	3.3	2.3	834.1	<	24	<	361.7	linear
p,p'-DDD	5.75	1.54E+05	3.1	2.2	1155.6		85		1363.8	linear
o,p'-DDD	6.08	2.33E+05	3.3	2.3	1648.3		17		256.2	linear
p,p'-DDT	5.47	1.04E+05	3.2	2.2	754.7		103		1607.2	linear
o,p'-DDT	5.59	1.23E+05	2.2	1.5	1305.8		24		535.8	linear
Dieldrin	4.60	2.38E+04	1.8	1.3	309.0		72		1989.6	linear
Oxychlordane	5.48	1.05E+05	2.9	2.0	845.1		5.2		89.2	linear
trans-Chlordane	5.38	9.05E+04	3.5	2.4	603.1		63		888.2	linear
trans-Nonachlor	6.35	3.16E+05	3.6	2.5	2049.3		36		501.5	linear
cis-Chlordane	5.38	9.05E+04	3.8	2.7	555.5		52		680.6	linear
cis-Nonachlor	6.20	2.68E+05	2.8	2.0	2233.4		15		266.5	linear
Total PCB	6.40	3.33E+05	4.8	3.4	1620.4		110		1139.9	linear

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Appendix D

Pesticide/PCB Data from the Walla Walla Chlorinated Pesticide/PCB TMDL Field Study

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Appendix D-1. Walla Walla SPMD Residues, May-June 2002 (total ng in 5 membranes)

	Field Blank 208087	Upper Mill Cr. 208091	Peppers Bridge 208090	Yellow-hawk Cr. 208089	Garrison Creek 208088	Lower Mill Cr. 208086	Detour Road 208085	Pine Creek 208084	Dry Creek 208083
Hexachlorobenzene	1.0 UJ	6.5 NJ	9.2 NJ	30	67	52	32	61	150
Heptachlor	3.2 J	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0	5.0 U	5.0 U	5.2
Heptachlor Epoxide	1.0 UJ	5.0 UJ	5.0 UJ	14 J	13 J	6.3 J	8.6 J	46 J	87 J
p,p'-DDE	7.8	25	66	400	260	220	240	340	130
o,p'-DDE	1.8 UJ	5.0 UJ	6.9 UJ	24 U	47 U	24 U	14 UJ	55 U	12 UJ
p,p'-DDD	1.0 UJ	5.4	9.4	85	180	57	52	140 NJ	26
o,p'-DDD	1.0 UJ	5.0 UJ	5.0 U	17 NJ	51	17 NJ	13	120 U	7.8 NJ
p,p'-DDT	6.6	24	29	110	36	100	65	180 NJ	56
o,p'-DDT	3.3 J	9.5	11	27	12 NJ	33	20	140 U	19
Dieldrin	1.2 UJ	14 J	5.0 UJ	72 J	55 J	100 J	43 J	59 J	140 J
Oxychlordane	1.0 UJ	5.0 UJ	5.0 U	5.2	16	8.7	5.0 U	11	5.4
trans-Chlordane	2.5 J	33	39	65	120	71	58	55	61
trans-Nonachlor	7.7 NJ	12 NJ	16 NJ	44 NJ	98 NJ	48 NJ	32 NJ	41 NJ	24 NJ
cis-Chlordane	15 NJ	23	30 NJ	67 NJ	160 NJ	73 NJ	52	57 NJ	50
cis-Nonachlor	1.0 U	5.0 U	5.0 U	15	47	20 NJ	10	140 UJ	6.1
Total PCBs	100 U	100 U	100 U	110	890	198	70	100 U	39 J
Toxaphene	100 U	100 U	100 U	100 J	200 U	200 J	200 J	14000 J	180 J
PCB-4	390 U	420	430	350	420	NC	310	340	420
PCB-29	540 U	800	810	770	770	690	790	760	850

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix D-2. Walla Walla SPMD Residues, August-September 2002 (total ng in 5 membranes)

	Field Blank 038086	Upper Mill Cr. 038091	Peppers Bridge 038090	Yellow-hawk Cr. 038088	Yellow-hawk rep. 038089	Garrison Creek 038084	Lower Mill Cr. 038085	Detour Road 038087	Pine Creek 038082	Dry Creek 038083	Touchet River 038081	Lower Walla 038080
Hexachlorobenzene	5.0 U	26	15	23	28	54	27	32	30	140	92	38
Heptachlor	3.0 J	5.6	3.9 J	4.1 J	4.4 J	3.1	4.5 J	3.1 J	3.5 J	4.3 J	8.7	5.4
Heptachlor Epoxide	5.0 U	3.6 J	2.8 J	11	9.2	16	11	20	32	18	16	14
p,p'-DDE	11	46	70	470 J	470	250	65	229	58	58	110	110
o,p'-DDE	2.5 J	4.7 J	5.5	17	20	29	8.2	7.5 NJ	5.0 U	4.5 J	6.8	5.6
p,p'-DDD	2.0 J	14	9.3	100	110	170	35	76	26	14	38	37
o,p'-DDD	5.0 U	5.0 U	<5.0 U	26	30	65	10 NJ	24 NJ	17 NJ	5.0 U	7.2 NJ	11 NJ
p,p'-DDT	9.7	37	22	86	95	22	30	39	25	18	37	23
o,p'-DDT	4.8 J	9.4	8.8	16	18	7.0	10	11	7.6	7.2	11	11
Dieldrin	3.0 J	17	6.1	130	130	130 U	110	72	30 NJ	44	5.0 U	27
Oxychlordane	5.0 U	5.0 U	5.0 U	5.4	5.9	14	3.2 J	7.9	5.0 U	5.0 U	5.0 U	5.0 U
trans-Chlordane	27	43 NJ	37	61	67	96 NJ	51 NJ	50	36	41	47 NJ	40
trans-Nonachlor	9.8	18	17	50	58	89	26	34	14	19	19	17
cis-Chlordane	22	37	31	71	79	130	51	50	31	33	38	33
cis-Nonachlor	1.2 J	3.1 J	2.1 J	15	16	28 U	6.4 NJ	9.0	5.0 U	3.8 J	3.2 J	5.0 U
Total PCBs	100 U	100 U	100 U	230	300	610	100 U	100 U	100 U	100 U	48 NJ	39 NJ
Toxaphene	100 U	100 U	100 U	100 U	100 U	650 J	100 U	220 J	610 J	100 U	260 J	330 J
PCB-4	540	170	330	330	260	310	480	270	410	340	220	340
PCB-29	670	380	680	550	500	600	750	600	710	690	610	670

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix D-3. Walla Walla SPMD Residues, November-December 2002 (total ng in 5 membranes)

	Field Blank 078968	Upper Mill Cr. 078967	Peppers Bridge 078966	Yellow-hawk Cr. 078964	Garrison Creek 078962	Lower Mill Cr. 078963	Detour Road 078965	Pine Creek 078960	Dry Creek 078961	Touchet River 078959	Lower Walla 078958
Hexachlorobenzene	5.0 UJ	14 J	10 J	13 J	29	39 J	30 J	6.2	60 J	11 J	23
Heptachlor	3.4 J	2.8 J	3.4 J	6.6	5.0 U	3.8 J	3.0 J	2.3 J	2.2 J	3.0 J	3.2 J
Heptachlor Epoxide	5.0 UJ	5.0 U	1.2 J	9.8	5.0 U	6.9	5.1	7.2	14	2.9 J	5.3
p,p'-DDE	15	20	37	240	64	75	110	43	31	21	63
o,p'-DDE	3.1 J	2.2 J	2.7 J	24	12	7.2	5.6	1.3 NJ	2.3 J	2.1 J	3.0 NJ
p,p'-DDD	1.3 J	3.4 J	4.5 J	46	33	23	17	21	6.6	3.5 J	15
o,p'-DDD	5.0 UJ	5.0 U	4.5	16 NJ	13 NJ	6.2 NJ	7.4 NJ	15	1.1 NJ	5.0 U	4.2 NJ
p,p'-DDT	12	15	13	130	7.8 NJ	35	24	33	9.8	7.5	18
o,p'-DDT	6.8	5.6	5.0	20	4.1 J	13	7.2	14	3.8 J	3.9 J	7.4
Dieldrin	2.7 J	5.9	3.8 J	1300 E	40 U	70	52	15	25	4.6 J	15
Oxychlordane	5.0 UJ	5.0 U	5.0 U	4.2 J	5.0 U	4.0 J	3.1 J	5.0 U	1.4 J	5.0 U	5.0 U
trans-Chlordane	24 NJ	23 NJ	17	490	36 NJ	34	28	19	22	17	24
trans-Nonachlor	8.9	9.0	7.5	210	27	25	21	5.9 NJ	9.0	7.0	8.5
cis-Chlordane	20	19	14	460	41	37	28	16	17	13	21
cis-Nonachlor	1.1 J	1.2 J	5.0 U	62	12 NJ	5.0 U	5.4	5.0 U	1.7 J	5.0 U	5.0 U
Total PCBs	33 J	22 J	26 J	89 NJ	210	92 NJ	57 J	100 U	25 J	21 J	43 J
Toxaphene	100 UJ	100 U	100 U	200 J	100 U	110 J	100 U	1900 J	100 U	100 U	600 J
PCB-4	660	320	380	360	300	650	480	510	440	360	480
PCB-29	750	580	670	470	480	630	640	630	620	660	500

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.
E = The concentration exceeds the known calibration range.

Appendix D-4. Walla Walla SPMD Residues, February-March 2002 (total ng in 5 membranes)

	Field Blank 157506	Upper Mill Cr. 157510	Peppers Bridge 157509	Yellow-hawk Cr. 157507	Garrison Creek 157504	Lower Mill Cr. 157505	Detour Road 157508	Pine Creek 157502	Dry Creek 157503	Touchet River 157501	Lower Walla 157500
Hexachlorobenzene	5.0 U	9.2	9.4 J	63	50	38	27	39	72	43	34
Heptachlor	3.9 J	4.2 J	2.7 J	6.1	5.0 UJ	3.8 J	5.4	2.8 J	2.8 J	2.7 J	2.3 J
Heptachlor Epoxide	5.0 U	1.4 J	5.0 U	7.4	4.9 J	2.9 J	4.3 J	29	12	5.9	7.5
p,p'-DDE	13	29	94 J	660 J	110	120	200	110	94	93	150
o,p'-DDE	2.8 J	2.6 J	3 J	19 NJ	14	8.9	8.6	4.3 J	4.8	4.4 J	6.7
p,p'-DDD	1.6 J	5.0	9.6	38	53	31	31	5.0 U	16	18	28
o,p'-DDD	5.0 U	5 U	2.7 J	9.4 NJ	20	11	8.4	27	4.7 J	5.1	6.9 NJ
p,p'-DDT	11	44	42 J	240	26	100	87	88	33	29	73
o,p'-DDT	6.7	11	10 J	73	9.0	29	17	26 NJ	12	9.5	23
Dieldrin	2.4 J	14	2.5 J	26	31 UJ	32	19	42	28	8.8	17
Oxychlordane	5.0 U	5.0 U	5.0 U	4.2 J	5.5	1.6 J	5.0 U	5.0 U	2.2 J	5.0 U	1.6 J
trans-Chlordane	24	30	14	110	43	28 NJ	44	33	26	27	29
trans-Nonachlor	10	11	6.6	76	43	26	24	12 NJ	14	11	17
cis-Chlordane	21	22	11 J	120	58	29	40	32	22	22	27
cis-Nonachlor	1.2 J	5.0 U	5.0 U	11	13 J	5.1 J	5.9	5.0 U	2.4 J	2.1 J	3.3 J
Total PCBs	29 J	23 J	24 J	100 U	210	120	65 J	100 U	39 NJ	27 J	100 U
Toxaphene	100 U	100 U	100 U	580 J	100 UJ	100 U	300 J	1200 J	160 J	100 U	680 J
PCB-4	590 J	390	190	300 J	470	320 J	450	500 J	410 J	320 J	380 J
PCB-29	840	620	390	570	580	680	770	710	560	440	610

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix D-5. Walla Walla SPMD Residues, May-June 2003 (total ng in 3 membranes)

	Field Blank 244013		Touchet River 244011		Lower Walla 244010	
Hexachlorobenzene	5.0	U	24		49	
Heptachlor	5.0	U	5.0	U	5.0	U
Heptachlor Epoxide	5.0	U	10		26	
p,p'-DDE	5.0	U	58		230	
o,p'-DDE	5.0	U	5.0	U	9.8	
p,p'-DDD	5.0	U	15		78	
o,p'-DDD	5.0	U	5.0	U	19	
p,p'-DDT	5.0	U	12		55	NJ
o,p'-DDT	5.0	U	5.0	U	14	
Dieldrin	5.0	U	8.4	J	41	J
Oxychlordane	5.0	U	5.0	U	5.0	U
trans-Chlordane	18	NJ	17	NJ	55	
trans-Nonachlor	3.2	J	6		34	
cis-Chlordane	13		14		52	
cis-Nonachlor	5.0	U	5.0	U	5.0	U
Total PCBs	25	U	32	NJ	96	NJ
Toxaphene	25	U	50	NJ	2000	NJ
PCB-4	430		130		420	
PCB-29	360		400		880	

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix D-6. Mean Temperatures and Exposure Times for Walla Walla SPMDs

	May-June 2002		Aug.-Sept. 2002		Nov.-Dec. 2002	
	Temp (°C)	Time (days)	Temp (°C)	Time (days)	Temp (°C)	Time (days)
Yellowhawk Creek	13.7	28.8	17.7	25.9	5.8	28.0
Dry Creek	16.4	28.0	14.9	26.0	8.1	27.0
Garrison Creek	16.1	28.8	19.0	25.9	9.4	28.0
Lower Walla Walla	15.8	*	**	26.0	5.5	26.9
Lower Mill Creek	15.1	29.6	18.7	25.1	8.2	27.0
Peppers Bridge	11.0	28.6	17.6	25.9	6.0	28.0
Pine Creek	17.1	29.0	18.0	26.0	5.1	26.9
Touchet River	16.8	*	20.8	26.0	4.6	26.9
Upper Mill Creek	11.1	29.3	16.1	26.0	5.5	28.0
Detour Road	13.4	29.7	18.3	25.1	7.1	27.1

	Feb.-March 2003		May-June 2003	
	Temp (°C)	Time (days)	Temp (°C)	Time (days)
Yellowhawk Creek	5.6	24.8	- -	- -
Dry Creek	5.3	23.2	- -	- -
Garrison Creek	8.6	24.8	- -	- -
Lower Walla Walla	5.7	24.0	- -	- -
Lower Mill Creek	6.3	23.3	- -	- -
Peppers Bridge	5.4	24.8	- -	- -
Pine Creek	5.5	23.0	- -	- -
Touchet River	5.3	23.1	19.5	24.9
Upper Mill Creek	4.8	24.0	- -	- -
Detour Road	6.0	24.0	16.5	24.9

*Sampler silted over and unusable
**Tidbit lost

Appendix D-7. Pesticide/PCB Data for the Final Effluents from the College Place and Walla Walla WWTPs (ng/L).

WWTP Name	Date	Parameter	Result	qualifier	Sample ID
College Place	5/29/02	Total PCBs	2.3		2228031
College Place	5/29/02	2,4'-DDD	0.066	UJ	3258031
College Place	5/29/02	2,4'-DDE	0.066	UJ	3258031
College Place	5/29/02	2,4'-DDT	0.066	UJ	3258031
College Place	5/29/02	4,4'-DDD	0.066	UJ	3258031
College Place	5/29/02	4,4'-DDE	0.11	J	3258031
College Place	5/29/02	4,4'-DDT	0.092	UJ	3258031
College Place	5/29/02	Cis-Chlordane (Alpha-Chlordane)	0.13	J	3258031
College Place	5/29/02	Cis-Nonachlor	0.066	UJ	3258031
College Place	5/29/02	Dieldrin	0.066	NC	3258031
College Place	5/29/02	Heptachlor	0.066	UJ	3258031
College Place	5/29/02	Heptachlor Epoxide	0.066	NC	3258031
College Place	5/29/02	Hexachlorobenzene	0.095	UJ	3258031
College Place	5/29/02	Oxychlordane	0.066	UJ	3258031
College Place	5/29/02	Trans-Chlordane (Gamma)	0.089	NJ	3258031
College Place	5/29/02	Trans-Nonachlor	0.12	NJ	3258031
College Place	5/30/02	Total PCBs	2.67		2228033
College Place	5/30/02	2,4'-DDD	0.066	UJ	3258033
College Place	5/30/02	2,4'-DDE	0.066	UJ	3258033
College Place	5/30/02	2,4'-DDT	0.066	UJ	3258033
College Place	5/30/02	4,4'-DDD	0.066	UJ	3258033
College Place	5/30/02	4,4'-DDE	0.1	J	3258033
College Place	5/30/02	4,4'-DDT	0.093	UJ	3258033
College Place	5/30/02	Cis-Chlordane (Alpha-Chlordane)	0.086	NJ	3258033
College Place	5/30/02	Cis-Nonachlor	0.066	UJ	3258033
College Place	5/30/02	Dieldrin	0.066	NC	3258033
College Place	5/30/02	Heptachlor	0.066	UJ	3258033
College Place	5/30/02	Heptachlor Epoxide	0.066	NC	3258033
College Place	5/30/02	Hexachlorobenzene	0.096	UJ	3258033
College Place	5/30/02	Oxychlordane	0.066	UJ	3258033
College Place	5/30/02	Trans-Chlordane (Gamma)	0.076	J	3258033
College Place	5/30/02	Trans-Nonachlor	0.13	UJ	3258033
College Place	9/11/02	2,4'-DDD	0.069	UJ	2378882
College Place	9/11/02	2,4'-DDE	0.069	UJ	2378882
College Place	9/11/02	2,4'-DDT	0.069	UJ	2378882
College Place	9/11/02	4,4'-DDD	0.069	UJ	2378882
College Place	9/11/02	4,4'-DDE	0.1	J	2378882
College Place	9/11/02	4,4'-DDT	0.069	UJ	2378882
College Place	9/11/02	Cis-Chlordane (Alpha-Chlordane)	0.086	J	2378882
College Place	9/11/02	Cis-Nonachlor	0.069	UJ	2378882
College Place	9/11/02	Dieldrin	0.22	UJ	2378882
College Place	9/11/02	Heptachlor	0.069	UJ	2378882
College Place	9/11/02	Heptachlor Epoxide	0.14	UJ	2378882

WWTP Name	Date	Parameter	Result	qualifier	Sample ID
College Place	9/11/02	Hexachlorobenzene	0.069	UJ	2378882
College Place	9/11/02	Oxychlordane	0.069	UJ	2378882
College Place	9/11/02	Total PCBs	0.925		2378882
College Place	9/11/02	Trans-Chlordane (Gamma)	0.069	UJ	2378882
College Place	9/11/02	Trans-Nonachlor	0.069	UJ	2378882
College Place	12/2/02	2,4'-DDD	0.067	U	2498959
College Place	12/2/02	2,4'-DDE	0.067	U	2498959
College Place	12/2/02	2,4'-DDT	0.067	U	2498959
College Place	12/2/02	4,4'-DDD	0.067	U	2498959
College Place	12/2/02	4,4'-DDE	0.067	U	2498959
College Place	12/2/02	4,4'-DDT	0.073	UJ	2498959
College Place	12/2/02	Cis-Chlordane (Alpha-Chlordane)	0.067	U	2498959
College Place	12/2/02	Cis-Nonachlor	0.067	U	2498959
College Place	12/2/02	Dieldrin	0.54	UJ	2498959
College Place	12/2/02	Heptachlor	0.067	U	2498959
College Place	12/2/02	Heptachlor Epoxide	0.64	UJ	2498959
College Place	12/2/02	Hexachlorobenzene	0.17	UJ	2498959
College Place	12/2/02	Oxychlordane	0.067	U	2498959
College Place	12/2/02	Total PCBs	1.29		2498959
College Place	12/2/02	Trans-Chlordane (Gamma)	0.073		2498959
College Place	12/2/02	Trans-Nonachlor	0.067	U	2498959
College Place	2/24/03	Dieldrin	0.21	J	3098998
College Place	2/24/03	Heptachlor Epoxide	0.066	UJ	3098998
College Place	2/24/03	Total PCBs	0.527		3098998
College Place	3/24/03	2,4'-DDD	0.066	UJ	3138164
College Place	3/24/03	2,4'-DDE	0.066	UJ	3138164
College Place	3/24/03	2,4'-DDT	0.066	UJ	3138164
College Place	3/24/03	4,4'-DDD	0.066	UJ	3138164
College Place	3/24/03	4,4'-DDE	0.066	UJ	3138164
College Place	3/24/03	4,4'-DDT	0.093	UJ	3138164
College Place	3/24/03	Cis-Chlordane (Alpha-Chlordane)	0.066	UJ	3138164
College Place	3/24/03	Cis-Nonachlor	0.066	UJ	3138164
College Place	3/24/03	Dieldrin	0.21	J	3138164
College Place	3/24/03	Heptachlor	0.066	UJ	3138164
College Place	3/24/03	Heptachlor Epoxide	0.066	UJ	3138164
College Place	3/24/03	Hexachlorobenzene	0.15	NJ	3138164
College Place	3/24/03	Oxychlordane	0.066	UJ	3138164
College Place	3/24/03	Trans-Chlordane (Gamma)	0.066	UJ	3138164
College Place	3/24/03	Trans-Nonachlor	0.066	UJ	3138164
Walla Walla	5/29/02	Total PCBs	1.01		2228030
Walla Walla	5/29/02	Total PCBs	0.791		2228034
Walla Walla	5/29/02	2,4'-DDD	0.065	UJ	3258030
Walla Walla	5/29/02	2,4'-DDE	0.065	UJ	3258030
Walla Walla	5/29/02	2,4'-DDT	0.065	UJ	3258030
Walla Walla	5/29/02	4,4'-DDD	0.065	UJ	3258030
Walla Walla	5/29/02	4,4'-DDE	0.11	J	3258030

WWTP Name	Date	Parameter	Result	qualifier	Sample ID
Walla Walla	5/29/02	4,4'-DDT	0.091	UJ	3258030
Walla Walla	5/29/02	Cis-Chlordane (Alpha-Chlordane)	0.2	J	3258030
Walla Walla	5/29/02	Cis-Nonachlor	0.14	UJ	3258030
Walla Walla	5/29/02	Heptachlor	0.065	UJ	3258030
Walla Walla	5/29/02	Hexachlorobenzene	0.094	UJ	3258030
Walla Walla	5/29/02	Oxychlordane	0.065	UJ	3258030
Walla Walla	5/29/02	Trans-Chlordane (Gamma)	0.17	J	3258030
Walla Walla	5/29/02	Trans-Nonachlor	0.065	UJ	3258030
Walla Walla	5/29/02	2,4'-DDD	0.068	UJ	3258034
Walla Walla	5/29/02	2,4'-DDE	0.068	UJ	3258034
Walla Walla	5/29/02	2,4'-DDT	0.068	UJ	3258034
Walla Walla	5/29/02	4,4'-DDD	0.068	UJ	3258034
Walla Walla	5/29/02	4,4'-DDE	0.068	UJ	3258034
Walla Walla	5/29/02	4,4'-DDT	0.095	UJ	3258034
Walla Walla	5/29/02	Cis-Chlordane (Alpha-Chlordane)	0.15	J	3258034
Walla Walla	5/29/02	Cis-Nonachlor	0.068	UJ	3258034
Walla Walla	5/29/02	Dieldrin	0.068	NC	3258034
Walla Walla	5/29/02	Heptachlor	0.068	UJ	3258034
Walla Walla	5/29/02	Heptachlor Epoxide	0.068	NC	3258034
Walla Walla	5/29/02	Hexachlorobenzene	0.098	UJ	3258034
Walla Walla	5/29/02	Oxychlordane	0.068	UJ	3258034
Walla Walla	5/29/02	Trans-Chlordane (Gamma)	0.078	J	3258034
Walla Walla	5/29/02	Trans-Nonachlor	0.16	NJ	3258034
Walla Walla	5/30/02	Total PCBs	0.743		2228032
Walla Walla	5/30/02	2,4'-DDD	0.065	UJ	3258032
Walla Walla	5/30/02	2,4'-DDE	0.065	UJ	3258032
Walla Walla	5/30/02	2,4'-DDT	0.065	UJ	3258032
Walla Walla	5/30/02	4,4'-DDD	0.065	UJ	3258032
Walla Walla	5/30/02	4,4'-DDE	0.075	J	3258032
Walla Walla	5/30/02	4,4'-DDT	0.091	UJ	3258032
Walla Walla	5/30/02	Cis-Chlordane (Alpha-Chlordane)	0.17	J	3258032
Walla Walla	5/30/02	Cis-Nonachlor	0.075	UJ	3258032
Walla Walla	5/30/02	Dieldrin	0.065	NC	3258032
Walla Walla	5/30/02	Heptachlor	0.065	UJ	3258032
Walla Walla	5/30/02	Heptachlor Epoxide	0.065	NC	3258032
Walla Walla	5/30/02	Hexachlorobenzene	0.094	UJ	3258032
Walla Walla	5/30/02	Oxychlordane	0.065	UJ	3258032
Walla Walla	5/30/02	Trans-Chlordane (Gamma)	0.12	J	3258032
Walla Walla	5/30/02	Trans-Nonachlor	0.17	NJ	3258032
Walla Walla	9/11/02	2,4'-DDD	0.067	UJ	2378881
Walla Walla	9/11/02	2,4'-DDE	0.067	UJ	2378881
Walla Walla	9/11/02	2,4'-DDT	0.067	UJ	2378881
Walla Walla	9/11/02	4,4'-DDD	0.067	UJ	2378881
Walla Walla	9/11/02	4,4'-DDE	0.08	J	2378881
Walla Walla	9/11/02	4,4'-DDT	0.067	UJ	2378881
Walla Walla	9/11/02	Cis-Chlordane (Alpha-Chlordane)	0.19	J	2378881

WWTP Name	Date	Parameter	Result	qualifier	Sample ID
Walla Walla	9/11/02	Cis-Nonachlor	0.067	UJ	2378881
Walla Walla	9/11/02	Dibutylchlorendate	0	NC	2378881
Walla Walla	9/11/02	Dieldrin	0.73	UJ	2378881
Walla Walla	9/11/02	Heptachlor	0.067	UJ	2378881
Walla Walla	9/11/02	Heptachlor Epoxide	0.77	UJ	2378881
Walla Walla	9/11/02	Hexachlorobenzene	0.33	J	2378881
Walla Walla	9/11/02	Oxychlordane	0.067	UJ	2378881
Walla Walla	9/11/02	Total PCBs	0.647		2378881
Walla Walla	9/11/02	Trans-Chlordane (Gamma)	0.16	J	2378881
Walla Walla	9/11/02	Trans-Nonachlor	0.087	J	2378881
Walla Walla	12/2/02	2,4'-DDD	0.069	U	2498958
Walla Walla	12/2/02	2,4'-DDE	0.069	U	2498958
Walla Walla	12/2/02	2,4'-DDT	0.069	U	2498958
Walla Walla	12/2/02	4,4'-DDD	0.069	U	2498958
Walla Walla	12/2/02	4,4'-DDE	0.069	U	2498958
Walla Walla	12/2/02	4,4'-DDT	0.11	UJ	2498958
Walla Walla	12/2/02	Cis-Chlordane (Alpha-Chlordane)	0.12		2498958
Walla Walla	12/2/02	Cis-Nonachlor	0.069	U	2498958
Walla Walla	12/2/02	Dieldrin	0.79	UJ	2498958
Walla Walla	12/2/02	Heptachlor	0.069	U	2498958
Walla Walla	12/2/02	Heptachlor Epoxide	0.069	U	2498958
Walla Walla	12/2/02	Hexachlorobenzene	0.085	UJ	2498958
Walla Walla	12/2/02	Oxychlordane	0.069	U	2498958
Walla Walla	12/2/02	Total PCBs	0.748		2498958
Walla Walla	12/2/02	Trans-Chlordane (Gamma)	0.1		2498958
Walla Walla	12/2/02	Trans-Nonachlor	0.069	U	2498958
Walla Walla	2/24/03	2,4'-DDD	0.066	UJ	3098997
Walla Walla	2/24/03	2,4'-DDE	0.066	UJ	3098997
Walla Walla	2/24/03	2,4'-DDT	0.066	UJ	3098997
Walla Walla	2/24/03	4,4'-DDD	0.066	UJ	3098997
Walla Walla	2/24/03	4,4'-DDE	0.073	J	3098997
Walla Walla	2/24/03	4,4'-DDT	0.093	UJ	3098997
Walla Walla	2/24/03	Cis-Chlordane (Alpha-Chlordane)	0.12	J	3098997
Walla Walla	2/24/03	Cis-Nonachlor	0.066	UJ	3098997
Walla Walla	2/24/03	Dieldrin	0.25	J	3098997
Walla Walla	2/24/03	Heptachlor	0.066	UJ	3098997
Walla Walla	2/24/03	Heptachlor Epoxide	0.066	UJ	3098997
Walla Walla	2/24/03	Hexachlorobenzene	0.096	UJ	3098997
Walla Walla	2/24/03	Oxychlordane	0.066	UJ	3098997
Walla Walla	2/24/03	Total PCBs	0.87		3098997
Walla Walla	2/24/03	Trans-Chlordane (Gamma)	0.086	J	3098997
Walla Walla	2/24/03	Trans-Nonachlor	0.066	UJ	3098997

Note: Ecology's Environmental Information System (EIM) contains the complete PCB aroclor and congener data.
U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
NC = Not calculated.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix D-8. Whole Water Pesticide Data for the Walla Walla Drainage.

Site Name	Sample No.	Date	2,4'-DDD	2,4'-DDE	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT	Cis-Chlordane (Alpha-Chlordane)	Cis-Nonachlor	Dieldrin	Heptachlor	Heptachlor Epoxide	Hexachloro-benzene	Oxychlordane	Trans-Chlordane (Gamma)	Trans-Nonachlor
Upper Mill Creek	2228158	5/29/02	--	--	--	0.065 U	0.065 U	0.1 UJ	0.065 U	0.065 U	0.065 UJ	0.065 U	0.16 UJ	0.065 UJ	0.16 U	0.16 U	0.065 U
Upper Mill Creek	2368890	9/4/02	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 UJ	0.069 UJ	0.069 U	0.069 U	0.069 U
Peppers Bridge	2228159	5/29/02	--	--	--	0.066 U	0.14	0.15 NJ	0.066 U	0.066 U	0.069 UJ	0.066 U	0.16 UJ	0.066 UJ	0.16 U	0.16 U	0.066 U
Peppers Bridge	2368885	9/4/02	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 UJ	0.069 UJ	0.069 U	0.069 U	0.069 U
Peppers Bridge	3058975	1/30/03	0.067 UJ	0.067 UJ	0.1 UJ	0.12 J	1.2	0.55	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.18 NJ	0.067 UJ	0.067 UJ	0.067 UJ
Peppers Bridge	3098985	2/25/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.093 J	0.093 UJ	0.067 UJ	0.067 UJ	0.38	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Peppers Bridge	3138155	3/24/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.33	0.21 J	0.067 UJ	0.067 UJ	0.11 UJ	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Peppers Bridge	3208155	5/15/03	0.061 UJ	0.061 UJ	0.061 UJ	0.061 UJ	0.098 J	0.085 UJ	0.061 UJ	0.061 UJ	0.061 UJ	0.061 UJ	0.061 UJ	0.089 UJ	0.061 UJ	0.061 UJ	0.061 UJ
Yellowhawk Creek	2228165	5/29/02	--	--	--	0.14 NJ	0.59	0.26 NJ	0.067 U	0.067 U	0.12 UJ	0.067 U	0.17 UJ	0.067 UJ	0.17 U	0.17 U	0.067 U
Yellowhawk Creek	2348856	8/22/02	0.063 U	0.063 U	0.063 U	0.24	0.85	0.22	0.12	0.063 U	0.17 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 U	0.089	0.063 U
Yellowhawk Creek	2368887	9/4/02	0.068 U	0.068 U	0.068 U	0.12	0.41	0.085	0.068 U	0.068 U	0.12 UJ	0.068 U	0.068 UJ	0.068 UJ	0.068 U	0.068 U	0.068 U
Yellowhawk Creek	2478949	11/19/02	0.064 U	0.064 U	0.064 U	0.09	0.37	0.16 UJ	0.064 U	0.064 U	0.12	0.064 U	0.064 U	0.064 U	0.064 U	0.064 U	0.064 U
Yellowhawk Creek	2518966	12/17/02	0.069 U	0.069 U	0.069 U	0.087	0.39	0.12 UJ	0.069 U	0.069 U	0.19	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U
Yellowhawk Creek	3058976	1/30/03	0.077 J	0.097 NJ	0.4	0.33 J	3.8	1.6	0.97	0.16 NJ	4.4	0.067 UJ	0.23 J	0.28 NJ	0.067 UJ	0.81	0.69 NJ
Yellowhawk Creek	3098987	2/25/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.58	0.28 J	0.14 J	0.069 UJ	0.13 J	0.069 UJ	0.072 NJ	0.1 UJ	0.069 UJ	0.093 J	0.072 NJ
Yellowhawk Creek	3138156	3/24/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.46	0.29 J	0.3 J	0.067 UJ	0.087 J	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.25 J	0.1 NJ
Yellowhawk Creek	3208156	5/15/03	0.063 UJ	0.063 UJ	0.063 UJ	0.069 J	0.49	0.2 J	0.1 NJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.091 UJ	0.063 UJ	0.069 J	0.063 UJ
Garrison Creek	2228160	5/29/02	--	--	--	0.19 NJ	0.37	0.065 UJ	0.26 NJ	0.065 UJ	--	0.065 UJ	--	0.065 UJ	0.065 UJ	0.13 NJ	0.11 NJ
Garrison Creek	2368888	9/4/02	0.068 U	0.068 U	0.068 U	0.14	0.23	0.068 U	0.12	0.068 U	0.33	0.068 U	0.37 UJ	0.068 UJ	0.068 U	0.081	0.071
Garrison Creek	3058977	1/30/03	0.066 UJ	0.066 UJ	0.066 UJ	0.086 J	0.24 J	0.093 UJ	0.093 NJ	0.066 UJ	0.12 UJ	0.066 UJ	0.066 UJ	0.096 UJ	0.066 UJ	0.066 UJ	0.16 UJ
Garrison Creek	3098988	2/25/03	0.067 UJ	0.067 UJ	0.067 UJ	0.11 J	0.31 J	0.093 UJ	0.1 NJ	0.067 UJ	0.11 J	0.067 UJ	0.067 UJ	0.093 UJ	0.067 UJ	0.083 J	0.067 UJ
Garrison Creek	3138157	3/24/03	0.067 UJ	0.067 UJ	0.067 UJ	0.15 J	0.4	0.13 J	0.15 NJ	0.067 UJ	0.09 J	0.067 UJ	0.067 UJ	0.1 NJ	0.067 UJ	0.093 J	0.13 NJ
Lower Mill Creek	2228157	5/29/02	--	--	--	0.067 U	0.13	0.15 NJ	0.067 U	0.067 U	0.16 UJ	0.067 U	0.17 UJ	0.067 UJ	0.17 U	0.17 U	0.067 U
Lower Mill Creek	2368889	9/3/02	0.067 U	0.067 U	0.067 U	0.07 UJ	0.13	0.067 U	0.067 U	0.067 U	0.26	0.067 U	0.067 UJ	0.067 UJ	0.067 U	0.067 U	0.067 U
Lower Mill Creek	3058978	1/30/03	0.066 UJ	0.066 UJ	0.12 UJ	0.19 J	0.79	0.68	0.089 NJ	0.066 UJ	0.22 J	0.066 UJ	0.066 UJ	0.11 NJ	0.066 UJ	0.079 J	0.096 UJ
Lower Mill Creek	3098989	2/25/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.09 J	0.093 UJ	0.067 UJ	0.067 UJ	0.1 NJ	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Lower Mill Creek	3138158	3/25/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.077 J	0.093 J	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Lower Mill Creek	3208158	5/14/03	0.061 UJ	0.061 UJ	0.061 UJ	0.085 NJ	0.097 J	0.12 J	0.061 UJ	0.061 UJ	0.097 J	0.061 UJ	0.061 UJ	0.088 UJ	0.061 UJ	0.064 J	0.061 UJ
Detour Road	2228156	5/30/02	--	--	--	0.067 U	0.22	0.11 NJ	0.067 U	0.067 U	0.1 UJ	0.067 U	0.17 UJ	0.067 UJ	0.17 U	0.17 U	0.067 U
Detour Road	2368891	9/4/02	0.068 U	0.068 U	0.068 U	0.11	0.27	0.092	0.068 U	0.068 U	0.1 UJ	0.068 U	0.068 UJ	0.068 UJ	0.068 U	0.068 U	0.068 U
Detour Road	3058980	1/30/03	0.066 J	0.093 J	0.21 UJ	0.33	2.1	1.5	0.15 NJ	0.066 J	0.3 J	0.066 UJ	0.083 J	0.22 NJ	0.066 UJ	0.13 J	0.14 UJ
Detour Road	3098991	2/26/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.19 J	0.093 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Detour Road	3138159	3/25/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.25 J	0.17 J	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.1 UJ	0.069 UJ	0.069 UJ	0.069 UJ
Detour Road	3208160	5/14/03	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.15 J	0.097 J	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.091 UJ	0.063 UJ	0.063 UJ	0.063 UJ
Dry Creek	2228161	5/29/02	--	--	--	0.26 NJ	1.7 J	1.8 J	0.067 UJ	0.067 UJ	0.93 NJ	0.067 UJ	0.75 J	0.067 UJ	0.17 UJ	0.17 UJ	0.067 UJ
Dry Creek	2348861	8/21/02	0.068 U	0.068 U	0.068 U	0.068 U	0.081	0.068 U	0.068 U	0.068 U	0.14 UJ	0.068 UJ	0.068 UJ	0.068 UJ	0.068 U	0.068 U	0.068 U
Dry Creek	2368892	9/3/02	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.075 UJ	0.071 U	0.071 UJ	0.083 UJ	0.071 U	0.071 U	0.071 U
Dry Creek	2478954	11/19/02	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.088	0.065 U	0.065 U	0.065 U
Dry Creek	2518971	12/16/02	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.071 U	0.2	0.071 U	0.11 UJ	0.071 U	0.071 U	0.071 U	0.071 U
Dry Creek	3058981	1/30/03	0.067 UJ	0.083 J	0.083 UJ	0.12 J	0.77	0.26 J	0.067 UJ	0.067 UJ	0.28 J	0.067 UJ	0.26 J	0.54 NJ	0.067 UJ	0.067 UJ	0.077 UJ
Dry Creek	3098992	2/26/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.18 J	0.097 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.1 UJ	0.069 UJ	0.069 UJ	0.069 UJ
Dry Creek	3138160	3/25/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.29 J	0.14 J	0.069 UJ	0.069 UJ	0.13 J	0.069 UJ	0.12 J	0.23 NJ	0.069 UJ	0.069 UJ	0.069 UJ
Dry Creek	3208161	5/14/03	0.063 UJ	0.063 UJ	0.063 UJ	0.072 NJ	0.12 J	0.13 UJ	0.063 UJ	0.063 UJ	0.12 J	0.063 UJ	0.12 J	0.094 J	0.063 UJ	0.063 UJ	0.063 UJ
Pine Creek	2228155	5/30/02	--	--	--	0.2 J	0.26	0.17 NJ	0.067 U	0.067 U	0.11 UJ	0.067 U	0.22 J	0.067 UJ	0.17 U	0.17 U	0.067 U
Pine Creek	2348862	8/21/02	0.067 U	0.067 U	0.067 U	0.073 UJ	0.15 NJ	0.067 U	0.067 U	0.067 U	0.17 UJ	0.067 UJ	0.19 J	0.067 UJ	0.067 U	0.067 U	0.067 U
Pine Creek	2368893	9/3/02	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.13 J	0.067 UJ	0.067 UJ	0.067 UJ	0.47 UJ	0.067 UJ	0.53 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Pine Creek	2478955	11/19/02	0.1 UJ	0.067 U	0.067 U	0.12	0.3	0.25 UJ	0.067 U	0.067 U	0.14	0.067 U	0.093 UJ	0.067 U	0.067 U	0.067 U	0.067 U
Pine Creek	2498955	12/2/02	0.18 UJ	0.063 U	0.14 UJ	0.19	0.3	0.35 UJ	0.063 U	0.063 U	0.13 UJ	0.063 U	0.063 U	0.12 UJ	0.063 U	0.063 U	0.063 U
Pine Creek	2518972	12/16/02	0.1	0.069 U	0.076	0.17	0.39	0.27	0.069 U	0.069 U	0.2 UJ	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U
Pine Creek	3058982	1/30/03	0.45	0.21 NJ	0.61	0.75	4.1	10	0.32 J	0.15 NJ	1.4	0.067 UJ	1.5 J	1.8 J	0.083 NJ	0.43	0.35

Site Name	Sample No.	Date	2,4'-DDD	2,4'-DDE	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT	Cis-Chlordane (Alpha-Chlordane)	Cis-Nonachlor	Dieldrin	Heptachlor	Heptachlor Epoxide	Hexachloro-benzene	Oxychlordane	Trans-Chlordane (Gamma)	Trans-Nonachlor
Pine Creek	3098993	2/24/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.15 J	0.093 UJ	0.067 UJ	0.067 UJ	0.083 J	0.067 UJ	0.11 J	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Pine Creek	3098994	2/24/03	0.066 UJ	0.066 UJ	0.066 UJ	0.066 UJ	0.14 J	0.093 UJ	0.066 UJ	0.066 UJ	0.066 UJ	0.066 UJ	0.09 J	0.096 UJ	0.066 UJ	0.066 UJ	0.066 UJ
Pine Creek	3138161	3/25/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.2 J	0.13 J	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.097 J	0.1 UJ	0.069 UJ	0.069 UJ	0.069 UJ
Pine Creek	3208162	5/14/03	0.11 UJ	0.063 UJ	0.078 UJ	0.078 J	0.29 J	0.12 J	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.072 NJ	0.091 UJ	0.063 UJ	0.063 UJ	0.063 UJ
Touchet River	2228163	5/30/02	--	--	--	0.067 U	0.14	0.067 U	0.067 U	0.067 U	0.07 UJ	0.067 U	0.033 J	0.067 UJ	0.17 U	0.17 U	0.067 U
Touchet River	2248088	6/12/02	--	--	--	0.092 UJ	0.066 UJ	0.066 UJ	0.066 UJ	0.066 UJ	0.16 UJ	0.066 UJ	0.039 J	0.066 UJ	0.16 UJ	0.16 UJ	0.066 UJ
Touchet River	2348863	8/21/02	0.064 U	0.064 U	0.064 U	0.064 U	0.077	0.064 U	0.064 U	0.064 U	0.1 UJ	0.064 UJ	0.064 UJ	0.064 UJ	0.064 U	0.064 U	0.064 U
Touchet River	2368894	9/3/02	0.067 U	0.067 U	0.067 U	0.067 U	0.11	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U	0.07 UJ	0.067 UJ	0.067 U	0.067 U	0.067 U
Touchet River	2478956	11/19/02	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U	0.073 UJ	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U
Touchet River	2518973	12/16/02	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.091 UJ	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U	0.069 U
Touchet River	3058983	1/30/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.12 J	0.093 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Touchet River	3098995	2/24/03	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.21 J	0.093 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.067 UJ	0.097 UJ	0.067 UJ	0.067 UJ	0.067 UJ
Touchet River	3138162	3/24/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.41	0.12 J	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.16 NJ	0.069 UJ	0.069 UJ	0.069 UJ
Touchet River	3208163	5/14/03	0.062 UJ	0.062 UJ	0.062 UJ	0.062 UJ	0.071 J	0.087 UJ	0.062 UJ	0.062 UJ	0.062 UJ	0.062 UJ	0.062 UJ	0.09 UJ	0.062 UJ	0.062 UJ	0.062 UJ
Lower Walla Walla	2228167	5/30/02	--	--	--	0.063 U	0.28	0.16 UJ	0.063 U	0.063 U	0.063 UJ	0.063 U	0.038 J	0.063 UJ	0.16 U	0.16 U	0.063 U
Lower Walla Walla	2228168	5/30/02	--	--	--	0.063 UJ	0.28 J	0.13 NJ	0.063 UJ	0.063 UJ	0.12 UJ	0.063 UJ	0.041 J	0.063 UJ	0.16 UJ	0.16 UJ	0.063 UJ
Lower Walla Walla	2248090	6/12/02	--	--	--	0.069 NJ	0.18	0.079 UJ	0.063 UJ	0.063 UJ	0.16 UJ	0.063 UJ	0.044 J	0.063 UJ	0.16 UJ	0.16 UJ	0.063 U
Lower Walla Walla	2348864	8/21/02	0.065 U	0.065 U	0.065 U	0.075 UJ	0.19	0.065 U	0.065 U	0.065 U	0.13 UJ	0.065 UJ	0.068 UJ	0.065 UJ	0.065 U	0.065 U	0.065 U
Lower Walla Walla	2368895	9/3/02	0.067 U	0.067 U	0.067 U	0.13	0.31	0.067 U	0.067 U	0.067 U	0.08	0.067 U	0.11 UJ	0.067 UJ	0.067 U	0.067 U	0.067 U
Lower Walla Walla	2478957	11/19/02	0.066 U	0.066 U	0.066 U	0.066 U	0.15	0.1 UJ	0.066 U	0.066 U	0.069 UJ	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U
Lower Walla Walla	2518974	12/16/02	0.067 U	0.067 U	0.067 U	0.067	0.21	0.097 UJ	0.067 U	0.067 U	0.11	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U	0.067 U
Lower Walla Walla	3058984	1/30/03	0.066 UJ	0.066 UJ	0.11 UJ	0.13 J	1.2	0.65	0.066 UJ	0.066 UJ	0.3 J	0.066 UJ	0.12 J	0.18 NJ	0.066 UJ	0.066 UJ	0.066 UJ
Lower Walla Walla	3098996	2/24/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.28 J	0.1 J	0.069 UJ	0.069 UJ	0.076 J	0.069 UJ	0.069 UJ	0.1 UJ	0.069 UJ	0.069 UJ	0.069 UJ
Lower Walla Walla	3138163	3/24/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.41	0.18 J	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.11 NJ	0.069 UJ	0.069 UJ	0.069 UJ
Lower Walla Walla	3208164	5/14/03	0.065 UJ	0.065 UJ	0.065 UJ	0.077 UJ	0.24 J	0.097 UJ	0.065 UJ	0.065 UJ	0.065 UJ	0.065 UJ	0.065 UJ	0.094 UJ	0.065 UJ	0.065 UJ	0.065 UJ
E. Little Walla Walla	3099001	2/25/03	0.11 J	0.069 UJ	0.069 UJ	0.66	1.5	0.29 J	0.069 UJ	0.069 UJ	0.21 J	0.069 UJ	0.13 J	0.1 UJ	0.069 UJ	0.086 J	0.069 UJ
E. Little Walla Walla	3208157	5/15/03	0.11 NJ	0.063 UJ	0.063 UJ	0.38	1.2	0.48	0.069 J	0.063 UJ	0.19 J	0.063 UJ	0.11 J	0.091 UJ	0.063 UJ	0.12 J	0.063 UJ
E. Little Walla Walla	3208167	5/15/03	0.095 J	0.063 UJ	0.063 UJ	0.38	1.1	0.18 J	0.063 UJ	0.063 UJ	0.18 J	0.063 UJ	0.11 J	0.092 UJ	0.063 UJ	0.098 J	0.063 UJ
E. Little Walla Walla	3248276	6/9/03	0.066 J	0.063 UJ	0.063 UJ	0.34 J	0.88	0.17 J	0.063 UJ	0.063 UJ	0.23 J	0.063 UJ	0.17 J	0.091 UJ	0.063 UJ	0.063 UJ	0.063 UJ
E. Little Walla Walla	3368757	9/3/03	0.064 UJ	0.064 UJ	0.064 UJ	0.31 J	0.6	0.09 UJ	0.064 UJ	0.064 UJ	0.16 J	0.064 UJ	0.064 UJ	0.093 UJ	0.064 UJ	0.064 UJ	0.064 UJ
Stone Creek	3099000	2/25/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.097 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.1 UJ	0.069 UJ	0.069 UJ	0.069 UJ
Stone Creek	3208159	5/15/03	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.088 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.091 UJ	0.063 UJ	0.063 UJ	0.063 UJ
W. Little Walla Walla	3099002	2/25/03	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.36	0.11 J	0.069 UJ	0.069 UJ	0.069 UJ	0.069 UJ	0.11 J	0.1 UJ	0.069 UJ	0.069 UJ	0.069 UJ
W. Little Walla Walla	3208168	5/15/03	0.062 UJ	0.062 UJ	0.062 UJ	0.062 UJ	0.36	0.087 UJ	0.062 UJ	0.062 UJ	0.062 UJ	0.062 UJ	0.16 NJ	0.09 UJ	0.062 UJ	0.062 UJ	0.062 UJ
W. Little Walla Walla	3248277	6/9/03	0.063 UJ	0.063 UJ	0.063 UJ	0.11 J	0.29 J	0.088 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.069 NJ	0.091 UJ	0.063 UJ	0.063 UJ	0.063 UJ
Mud Creek	3098999	2/26/03	0.079 NJ	0.071 UJ	0.071 UJ	0.071 UJ	0.71	0.1 UJ	0.071 UJ	0.071 UJ	0.071 UJ	0.071 UJ	0.071 UJ	0.1 UJ	0.071 UJ	0.071 UJ	0.071 UJ
Mud Creek	3208165	5/14/03	0.077 UJ	0.065 UJ	0.065 UJ	0.13 J	0.34	0.09 UJ	0.065 UJ	0.065 UJ	0.081 NJ	0.065 UJ	0.065 UJ	0.094 UJ	0.065 UJ	0.065 UJ	0.065 UJ
Mud Creek	3248274	6/9/03	0.063 UJ	0.063 UJ	0.063 UJ	0.097 J	0.18 J	0.088 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.063 UJ	0.091 UJ	0.063 UJ	0.063 UJ	0.063 UJ
Mud Creek	3368755	9/3/03	0.061 UJ	0.061 UJ	0.061 UJ	0.11 J	0.21 J	0.085 UJ	0.061 UJ	0.061 UJ	0.061 UJ	0.061 UJ	0.061 UJ	0.089 UJ	0.061 UJ	0.061 UJ	0.061 UJ
Gardena Creek	3208166	5/14/03	0.21 UJ	0.063 UJ	0.19 NJ	0.34 J	1.3	0.51 NJ	0.063 UJ	0.063 UJ	0.084 J	0.063 UJ	0.063 UJ	0.094 J	0.063 UJ	0.063 UJ	0.063 UJ
Gardena Creek	3248275	6/9/03	0.31 UJ	0.063 UJ	0.063 UJ	0.27 J	0.49 J	0.23 J	0.063 UJ	0.063 UJ	0.14 J	0.063 UJ	0.094 NJ	0.091 UJ	0.063 UJ	0.063 UJ	0.063 UJ

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix D-9. Pesticide/PCB Data on Walla Walla River Fish Samples Collected in 2002
[ug/Kg, weight wet; detection limit used to calculate total concentrations]

Upper Walla Walla River Samples Collected July 17-18, 2002

Sample ID	UPCARP-1		UPSMBS-1		UPBLS-1		UPBLS-2		UPBLS-3		UPBLS-4	
Sample No.	438181		438182		438183		438184		438185		438186	
Species	Common Carp		Smallmouth Bass		Bridgelip Sucker		Bridgelip Sucker		Bridgelip Sucker		Bridgelip Sucker	
Tissue	fillet		fillet		fillet		fillet		fillet		fillet	
Lipids (%)	2.0		2.1		3.1		1.9		2.6		2.6	
4,4'-DDT	**0.79**	J	**1.4**	J	**6.5**	J	**6.6**	J	**3.7**	J	**5.6**	J
4,4'-DDE	**35**		**48**		**110**		**100**		**56**		**100**	
4,4'-DDD	**10**		**4.8**		**16**		**5.8**		**5.3**		**4.8**	
Total DDT	**46**		**54**		**133**		**112**		**65**		**110**	
2,4'-DDT	0.54	U	0.55	U	**0.48**	NJ	**0.68**		0.51	U	0.43	U
2,4'-DDE	0.54	UJ	0.55	UJ	**0.91**	J	0.51	UJ	0.51	UJ	**0.57**	NJ
2,4'-DDD	**1.3**		0.55	U	**2.4**		**0.73**		**0.71**		**0.59**	
Dieldrin	**1.1**		**0.99**		**0.80**		**0.51**		**0.74**		**0.75**	
Heptachlor	0.54	UJ	0.55	UJ	0.46	UJ	0.51	UJ	0.51	UJ	0.43	UJ
Heptachlor Epoxide	0.54	U	0.55	U	0.46	U	0.51	U	0.51	U	0.43	U
Hexachlorobenzene	**1.1**	J	**0.79**	J	**0.65**		0.51	U	0.51	U	0.43	U
cis-Chlordane	**1.5**		**0.86**		**1.2**		**0.76**		**0.77**	NJ	**0.83**	NJ
trans-Chlordane	**0.85**		0.55	U	**0.58**	NJ	0.51	U	0.51	U	0.43	U
cis-Nonachlor	**1.1**	J	**0.91**	J	**1.2**	J	**0.58**	J	**0.62**	J	**0.80**	J
trans-Nonachlor	**1.7**		**2.4**		**2.6**	NJ	**2.0**		**1.5**		**2.5**	
Oxychlordane	0.54	U	**0.77**		**0.61**		0.51	U	0.51	U	**0.47**	
Total Chlordane	**5.7**		**5.5**		**6.2**		**4.4**		**3.9**		**5.0**	
Toxaphene	**17**	J	**26**	J	**20**	J	**12**	J	**19**	J	**12**	J
PCB-1254	**18**	NJ	**12**		**18**		**15**		**10**		**31**	
PCB-1260	**17**		**4.6**	J	**12**		**5.7**		**4.9**		**8.8**	
Total PCBs	**35**		**17**		**30**		**21**		**15**		**40**	

Upper Walla Walla River Samples Collected July 17-18, 2002

Sample ID	UPBLS-5	UPNPM-1	UPNPM-2	UPNPM-3	UPNPM-4F	UPNPM-4C
Sample No.	438187	438188	438189	438190	438191	438210
Species	Bridgelip Sucker	N. Pike Minnow	N. Pike Minnow	N. Pike Minnow	N. Pike Minnow	N. Pike Minnow
Tissue	whole	fillet	fillet	fillet	fillet	carcass
Lipids (%)	5.5	1.5	1.7	1.7	1.5	5.0
4,4'-DDT	**6.6** J	0.54 UJ	**0.57** J	0.47 UJ	0.55 U	0.51 UJ
4,4'-DDE	**160**	**340** J	**260**	**410**	**250**	**830**
4,4'-DDD	**11**	**12**	**18**	**28**	**11**	**34**
Total DDT	**178**	**353**	**279**	**438**	**262**	**865**
2,4'-DDT	**0.65** NJ	**0.67** NJ	**0.99** NJ	**0.74** NJ	0.55 U	**3.1**
2,4'-DDE	**0.87** NJ	**1.0** NJ	**1.4** NJ	**1.8** NJ	**0.86** NJ	**7.2** NJ
2,4'-DDD	**1.5**	**1.1** NJ	**1.4**	**2.2**	**1.0**	**3.4**
Dieldrin	**1.5**	**1.3**	**1.6**	**1.0**	**0.80**	**2.1** J
Heptachlor	0.54 UJ	0.54 UJ	0.55 UJ	0.47 UJ	0.55 UJ	0.52 UJ
Heptachlor Epoxide	0.54 U	**0.67** NJ	0.55 U	0.47 U	0.55 U	**0.88**
Hexachlorobenzene	**1.4** J	0.54 UJ	**0.63** J	**0.87** J	0.55 U	**2.7**
cis-Chlordane	**1.7**	**2.9** NJ	**2.7** NJ	**2.6** NJ	**1.9** NJ	**5.8** NJ
trans-Chlordane	**1.0**	**1.6**	**1.5**	**1.4** NJ	**0.96** NJ	**2.5**
cis-Nonachlor	**1.1** J	**3.4** J	**3.3** J	**3.1** J	**2.1** J	**6.0** J
trans-Nonachlor	**4.2**	**11** J	**9.4**	**9.6**	**7.6**	**30**
Oxychlordane	**0.92**	**0.61**	**0.76**	**0.72**	**0.57**	**1.7**
Total Chlordane	**8.9**	**20**	**18**	**17**	**13**	**46**
Toxaphene	**27** J	**26** J	**20** J	**17** J	**18** J	**39** J
PCB-1254	**19** NJ	**50** NJ	**26** NJ	**38** NJ	**20** J	**120** NJ
PCB-1260	**11**	**15**	**15**	**19**	**9.5** J	**34** NJ
Total PCBs	**30**	**65**	**41**	**57**	**30**	**154**

Lower Walla Walla River Samples Collected July 29-31 and Sept. 10-11, 2002

Sample ID	LWRCAT-1	LWRCAT-1	LWBLS-1	LWBLS-2	LWBLS-3	LWBLS-4
Sample No.	438192	duplicate	438193	438194	438195	438196
Species	Channel Catfish	Channel Catfish	Bridgelip Sucker	Bridgelip Sucker	Bridgelip Sucker	Bridgelip Sucker
Tissue	fillet	fillet	fillet	fillet	fillet	fillet
Lipids (%)	4.2	3.5	2.5	3.5	1.5	1.4
4,4'-DDT	**8.3** J	**5.5** J	**1.7** J	**4.4** J	**1.5** J	**2.1** J
4,4'-DDE	**220**	**280**	**47**	**110**	**42**	**68**
4,4'-DDD	**23**	**17**	**4.5**	**6.7**	**4.2**	**6.6**
Total DDT	**251**	**303**	**53**	**121**	**48**	**77**
2,4'-DDT	0.55 U	0.54 U	0.55 U	0.40 U	0.49 U	0.52 U
2,4'-DDE	**0.82** NJ	**1.4** NJ	0.55 UJ	**0.55** NJ	0.49 UJ	**0.62** J
2,4'-DDD	**1.2**	**0.82**	**0.58**	**0.94**	**0.62**	**0.81**
Dieldrin	**2.0**	**2.2**	0.55 U	**0.78**	0.49 U	**0.55**
Heptachlor	0.55 UJ	0.54 UJ	0.55 UJ	0.40 UJ	0.49 UJ	0.52 UJ
Heptachlor Epoxide	**0.68** NJ	0.54 U	0.55 U	**0.65** NJ	0.49 U	0.52 U
Hexachlorobenzene	**2.5**	**1.9**	**1.1** J	**1.7**	**1.1 J**	**1.8** J
cis-Chlordane	**2.4**	**1.3**	0.55 U	**0.80** NJ	0.49 U	**0.68**
trans-Chlordane	**1.9**	**1.1**	0.55 U	**0.44** NJ	0.49 U	0.52 U
cis-Nonachlor	**1.7** J	**0.96** NJ	0.55 UJ	**0.69** J	0.49 U	**0.60** J
trans-Nonachlor	**3.9**	**4.5**	**1.1** J	**2.5**	0.98 UJ	**1.7** J
Oxychlordane	**1.1**	0.54 U	0.55 U	**0.62**	0.49 U	0.52 U
Total Chlordane	**11**	**8.4**	**3.3**	**5.1**	**2.9**	**4.0**
Toxaphene	**72** J	**44** J	**13** J	**27** J	**16 J**	**23** J
PCB-1254	**29** NJ	**30** NJ	**7.7**	**13** NJ	**5.4**	**9.9**
PCB-1260	**24**	**30**	**3.6 J**	**9.5**	**3.1 J**	**5.6**
Total PCBs	**53**	**60**	**11**	**23**	**8.5**	**16**

Lower Walla Walla River Samples Collected July 29-31 and Sept. 10-11, 2002

Sample ID	LWBLS-5		LWBLS-5		LWRCARP-1		LWRCARP-1		LWRCARP-2		LWRCARP-3	
Sample No.	438197		duplicate		438198		duplicate		438199		438200	
Species	Bridgelip Sucker		Bridgelip Sucker		Common Carp		Common Carp		Common Carp		Common Carp	
Tissue	whole		whole		fillet		fillet		fillet		fillet	
Lipids (%)	4.4		4.5		3.3		3.4		2.4		7.0	
4,4'-DDT	**2.1**	J	**4.8**	J	**1.0**	J	**1.1**	J	**0.74**	J	**0.81**	J
4,4'-DDE	**170**		**190**		**420**		**760**		**300**		**930**	
4,4'-DDD	**5.4**		**11**		**40**		**100**		**21**		**91**	
Total DDT	**178**		**206**		**461**		**861**		**322**		**1022**	
2,4'-DDT	**0.80**	NJ	**0.86**	NJ	**1.1**	NJ	**1.4**	NJ	**1.1**	NJ	**3.3**	NJ
2,4'-DDE	**1.4**	J	**1.5**	J	**5.4**	J	**7.5**	J	**1.8**	NJ	**12**	NJ
2,4'-DDD	**0.66**		**1.5**		**3.8**		**4.8**		**2.9**		**0.94**	
Dieldrin	**1.0**	J	**0.94**	J	**1.2**		**1.4**		**1.1**		**2.9**	
Heptachlor	0.44	UJ	0.48	UJ	0.54	UJ	0.55	UJ	0.55	UJ	0.49	UJ
Heptachlor Epoxide	0.44	UJ	**1.1**	NJ	**1.1**	NJ	**1.4**	NJ	**0.86**	NJ	**2.1**	
Hexachlorobenzene	**3.4**	J	**4.2**		**5.3**	J	**6.4**		**5.4**	J	**9.5**	
cis-Chlordane	**0.52**		**1.2**		**2.4**		**3.2**		**1.8**		**4.8**	
trans-Chlordane	0.44	UJ	**0.76**		**1.5**		**2.1**		**1.5**		**3.9**	
cis-Nonachlor	**0.46**	J	**1.2**	J	**2.3**	J	**3.2**	J	**1.8**	J	**4.5**	J
trans-Nonachlor	**3.7**	J	**4.2**		**0.73**		**11**		**4.9**		**16**	
Oxychlordane	0.44	UJ	**0.88**		**0.77**		**1.0**		**0.70**		**1.5**	
Total Chlordane	**5.6**		**8.2**		**7.7**		**21**		**11**		**31**	
Toxaphene	**26**	J	**47**	J	**49**	J	**53**	J	**46**	J	**65**	J
PCB-1254	**16**	NJ	**18**	NJ	**74**	NJ	**130**		**29**		**140**	J
PCB-1260	**11**		**11**		**120**		**220**		**39**		**270**	
Total PCBs	**27**		**29**		**194**		**350**		**68**		**410**	

Lower Walla Walla River Samples Collected July 29-31 and Sept. 10-11, 2002

Sample ID	WRCARP-4	LWRNPM-1	LWRNPM-2	LWRSMB-1	LWRSMB-2F	LWRSMB-2F
Sample No.	438201	438203	438204	438205	438206	duplicate
Species	Common Carp	N. Pike Minnow	N. Pike Minnow	Smallmouth Bass	Smallmouth Bass	Smallmouth Bass
Tissue	fillet	fillet	fillet	fillet	fillet	fillet
Lipids (%)	5.6	1.3	1.0	0.89	0.78	0.92
4,4'-DDT	**1.4** J	0.54 U	0.55 U	0.55 U	**0.53** J	**0.58** J
4,4'-DDE	**530**	**48**	**64**	**26**	**31**	**31**
4,4'-DDD	**50**	**2.1**	**2.5**	**1.6**	**2.0**	**2.8**
Total DDT	**581**	**51**	**67**	**28**	**34**	**34**
2,4'-DDT	**3.2** NJ	0.54 UJ	1.1 UJ	0.55 U	0.50 U	0.51 U
2,4'-DDE	**6.6** J	0.54 UJ	0.55 UJ	0.55 UJ	0.50 UJ	0.51 UJ
2,4'-DDD	**6.8**	0.54 U	0.55 U	0.55 U	0.50 U	0.51 U
Dieldrin	**1.9**	0.54 U	0.55 U	0.55 U	0.50 U	0.51 U
Heptachlor	0.51 UJ	0.54 UJ	0.55 UJ	0.55 UJ	0.50 UJ	0.51 UJ
Heptachlor Epoxide	**1.3** NJ	0.54 U	0.55 U	0.55 U	0.50 U	0.51 U
Hexachlorobenzene	**5.7**	**1.2**	**1.3** J	**0.92**	**0.90**	**0.90**
cis-Chlordane	**3.5**	0.54 U	0.55 U	0.55 U	0.50 U	0.51 U
trans-Chlordane	**2.4**	0.54 U	0.55 U	0.55 U	0.50 U	0.51 U
cis-Nonachlor	**3.2** J	0.54 U	0.55 U	0.55 U	0.50 U	0.51 U
trans-Nonachlor	**8.7**	**1.4**	**1.8**	**0.69**	**0.79**	**0.78**
Oxychlordane	**0.95**	0.54 U	0.55 U	0.55 U	0.50 U	0.51 U
Total Chlordane	**19**	**3.6**	**4.0**	**2.9**	**2.8**	**2.8**
Toxaphene	**60** J	**15** J	**39** J	**9.9** J	**7.7** J	**8.6** J
PCB-1254	**80**	**7.4**	**6.2** NJ	**3.4** J	**5.7**	**5.7**
PCB-1260	**120**	**6.5** NJ	**44** NJ	5.5 U	**2.8** J	**2.8** J
Total PCBs	**200**	**14**	**50**	**8.9**	**8.5**	**8.5**

Lower Walla Walla River Samples Collected July 29-31 and Sept. 10-11, 2002

Sample ID	LWRSMB-3		LWRSMB-4		LWRSMB-2C	
Sample No.	438207		438208		438209	
Species	Smallmouth Bass		Smallmouth Bass		Smallmouth Bass	
Tissue	fillet		fillet		carcass	
Lipids (%)	0.97		0.83		6.2	
4,4'-DDT	**0.55**	J	0.51	U	**2.0**	J
4,4'-DDE	**25**		**26**		**340**	
4,4'-DDD	**1.7**		**2.6**		**24**	
Total DDT	**27**		**29**		**366**	
2,4'-DDT	0.46	U	0.51	U	**1.9**	NJ
2,4'-DDE	0.46	UJ	**0.54**	J	**4.1**	NJ
2,4'-DDD	0.46	U	0.51	U	**3.3**	
Dieldrin	0.46	U	0.51	U	**1.8**	NJ
Heptachlor	0.46	UJ	0.51	UJ	0.51	UJ
Heptachlor Epoxide	0.46	U	0.51	U	**1.8**	
Hexachlorobenzene	**0.84**		**0.70**		**6.8**	J
cis-Chlordane	0.46	U	0.51	U	**1.4**	NJ
trans-Chlordane	0.46	U	0.51	U	**0.64**	
cis-Nonachlor	0.46	U	0.51	U	**2.2**	J
trans-Nonachlor	**0.66**		**0.64**		**8.5**	
Oxychlordane	0.46	U	0.51	U	**1.9**	
Total Chlordane	**2.5**		**2.7**		**15**	
Toxaphene	**13**	J	**9.5**	J	**58**	J
PCB-1254	**3.2**	J	**7.8**		**68**	NJ
PCB-1260	4.6	U	**2.6**	J	**36**	
Total PCBs	**7.8**		**10**		**104**	

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix E

Results on Replicate and Split Samples Analyzed for the Walla Walla Chlorinated Pesticide/PCB Field Study

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Appendix E-1. Variability of Replicate SPMD Deployments in Yellowhawk Creek, August - September 2002

	Concentration in SPMD Extract (total ng)		Calculated Water Column Concentration (ng/L; parts per trillion)		
Sample No.:	038088	038089	038088	038089	RPD
p,p'-DDE	459	459	1.4	1.2	15%
p,p'-DDD	98	108	0.56	0.53	5%
p,p'-DDT	76	85	0.30	0.29	4%
trans-Chlordane	34	40	0.24	0.24	1%
trans-Nonachlor	40	48	0.31	0.32	3%
cis-Chlordane	49	57	0.38	0.38	0%
cis-Nonachlor	14	15	0.10	0.09	8%
Oxychlordane	5.4	5.9	0.05	0.05	6%
Dieldrin	127	127	0.69	0.60	15%
Hexachlorobenzene	23	28	0.14	0.15	5%
Heptachlor Epoxide	11	9.2	0.07	0.05	32%
Toxaphene	<100	<100	<0.3	<0.3	nd
Total PCBs	230	300	1.0	1.2	12%

RPD = relative percent difference (range/mean x 100)
nd = not detected

Appendix E-2. Variability of Replicate Water Samples

Location/Date/Parameter	Sample Number / Result		RPD
Lower Walla Walla R. 5/30/02	228167	228168	
4,4'-DDE (ng/L)	0.28	0.28	0%
4,4'-DDT (ng/L)	<0.16	0.13	>21%
Heptachlor epoxide (ng/L)	0.038	0.041	8%
TSS (mg/L)	66	66	0%
Turbidity (NTU)	18	20	11%
TOC (mg/L)	2.4	2.2	9%
DOC (mg/L)	1.9	2.3	19%
Conductivity (umhos/cm)	87.7	87.5	0%
Pine Creek 2/24/03	098993	098994	
4,4'-DDE (ng/L)	0.15	0.14	7%
Dieldrin (ng/L)	0.083	<0.066	>23%
Heptachlor epoxide (ng/L)	0.11	0.09	20%
TSS (mg/L)	41	34	19%
Turbidity (NTU)	21	20	5%
TOC (mg/L)	3.6	3.7	3%
DOC (mg/L)	3.9	3.8	3%
Conductivity (umhos/cm)	164	163	1%
East Little Walla Walla R. 5/15/03	208167	208157	
4,4'-DDE (ng/L)	1.1	1.2	9%
4,4'-DDD (ng/L)	0.38	0.38	0%
4,4'-DDT (ng/L)	0.18	0.48	91%
Dieldrin (ng/L)	0.18	0.19	5%
Heptachlor epoxide (ng/L)	0.11	0.11	0%
Trans-chlordane (ng/L)	0.098	0.12	20%
Cis-chlordane (ng/L)	<0.063	0.069	>9%
TSS (mg/L)	29	29	0%
Turbidity (NTU)	13	11	17%
TOC (mg/L)	1.4	1.3	7%
DOC (mg/L)	<1.0	<1.0	nd
Conductivity (umhos/cm)	97.2	97.3	0%

nd = not detected

Appendix E-3. Variability of Pesticide/PCB Concentrations in Replicate Effluent Samples (ng/L; parts per trillion)

Facility:	Walla Walla WWTP			College Place WWTP		
Date:	5/28-29/02	5/29-30/02		5/28-29/02	5/29-30/02	
Sample No.:	228030	228032/34*	RPD	228031	228033	RPD
4,4'-DDT	<0.091	<0.095	nd	<0.092	0.093	>1%
4,4'-DDE	0.11	0.072	42%	0.11	0.10	10%
4,4'-DDD	0.065	<0.068	>5%	<0.066	<0.066	nd
Dieldrin	<1.6	<1.7	nd	<1.6	<1.7	nd
Heptachlor epoxide	<1.6	<1.7	nd	<1.6	<1.7	nd
Hexachlorobenzene	<0.094	<0.098	nd	<0.095	0.093	>2%
cis-Chlordane	0.20	0.16	22%	0.13	<0.066	>65%
trans-Chlordane	0.17	0.099	53%	<0.066	0.076	nd
cis-Nonachlor	<0.14	<0.068	nd	<0.066	<0.066	nd
trans-Nonachlor	<0.065	<0.068	nd	<0.066	<0.066	nd
Oxychlordane	<0.065	<0.068	nd	<0.066	<0.066	nd
Total PCBs	1.0	0.76	27%	2.3	2.7	16%

Note: Pesticide reporting limits and concentrations are estimated values (see Data Quality)
*Mean of duplicate (split) samples
RPD = relative percent difference (range/mean x 100)
nd = not detected

Appendix E-4. Precision of Pesticide/PCB Analyses on Duplicate (Split) Effluent Samples (ng/L; parts per trillion)

Facility:	Walla Walla WWTP		
Date:	5/29-30/02	5/29-30/02	
Sample No:	228032	228034	RPD
4,4'-DDT	<0.091	<0.095	nd
4,4'-DDE	0.075	<0.068	>10%
4,4'-DDD	<0.065	<0.068	nd
Dieldrin	<1.6	<1.7	nd
Heptachlor epoxide	<1.6	<1.7	nd
Hexachlorobenzene	<0.094	<0.098	nd
cis-Chlordane	0.17	0.15	13%
trans-Chlordane	0.12	0.078	42%
cis-Nonachlor	<0.065	<0.068	nd
trans-Nonachlor	<0.065	<0.068	nd
Oxychlordane	<0.065	<0.068	nd
Total PCBs	0.74	0.79	7%

Note: Pesticide reporting limits and concentrations are estimated values (see Data Quality)
RPD = relative percent difference (range/mean x 100)
nd = not detected

Appendix E-5. Precision of Pesticide/PCB Analyses on Duplicate (Split) Fish Tissue Samples (ug/Kg wet weight; parts per billion)

Species / Tissue:	Channel Catfish / Fillet			Smallmouth Bass / Fillet		
Sample No.:	438192	duplicate	RPD	438206	duplicate	RPD
Lipids (%)	4.2	3.5	19%	0.78	0.92	16%
4,4'-DDT	8.3	5.5	41%	0.53	0.58	9%
4,4'-DDE	220	280	24%	31	31	0%
4,4'-DDD	23	17	30%	2.0	2.8	33%
Dieldrin	2.0	2.2	10%	<0.50	<0.51	nd
Heptachlor Epoxide	0.68	<0.54	>23%	0.50	<0.51	>2%
Hexachlorobenzene	2.5	1.9	27%	0.90	0.90	0%
cis-Chlordane	2.4	1.3	59%	<0.50	<0.51	nd
trans-Chlordane	1.9	1.1	53%	<0.50	<0.51	nd
cis-Nonachlor	1.7	0.96	56%	<0.50	<0.51	nd
trans-Nonachlor	3.9	4.5	14%	0.79	0.78	1%
Oxychlordane	1.1	<0.54	>68%	<0.50	<0.51	nd
Toxaphene	72	44	48%	7.7	8.6	11%
Total PCBs	53	60	12%	8.5	8.5	0%

Species / Tissue:	Bridgelip Sucker / Whole			Common Carp / Fillet		
Sample No.:	438197	duplicate	RPD	438198	duplicate	RPD
Lipids (%)	4.4	4.5	2%	3.3	3.4	1%
4,4'-DDT	2.1	4.8	78%	1.0	1.1	10%
4,4'-DDE	170	190	11%	420	760	58%
4,4'-DDD	5.4	11	68%	40	100	86%
Dieldrin	1.0	0.94	6%	1.2	1.4	15%
Heptachlor Epoxide	<0.44	1.1	>86%	1.1	1.4	24%
Hexachlorobenzene	3.4	4.2	21%	5.3	6.4	19%
cis-Chlordane	0.52	1.2	79%	2.4	3.2	29%
trans-Chlordane	<0.44	0.76	>53%	1.5	2.1	33%
cis-Nonachlor	0.46	1.2	89%	2.3	3.2	33%
trans-Nonachlor	3.7	4.2	13%	0.73	11	175%
Oxychlordane	<0.44	0.88	67%	0.77	1.0	26%
Toxaphene	26	47	58%	49	53	8%
Total PCBs	27	29	7%	194	350	57%

RPD = relative percent difference (range/mean x 100)
nd = not detected

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Appendix F

Flow and Conventional Water Quality Data for the Walla Walla Drainage

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Appendix F. Flow and Conventional Water Quality Data for the Walla Walla Drainage.

Site Name	Sample No.	Date	Time	Conductivity (umhos/cm)	DOC (mg/L)	Flow* (cfs)	Temperature (C°)	TOC (mg/L)	TSS (mg/L)	Turbidity (NTU)
Upper Mill Creek	2208108	5/14/02	8:30	58.8	1.5	--	7.8	1.6	1	1.6 J
Upper Mill Creek	2228158	5/29/02	8:50	52.5	1.6	--	9.8	2	5	2.7
Upper Mill Creek	2248080	6/11/02	18:10	66.1	1.5	--	15.8	1.7	2	1.4
Upper Mill Creek	2348859	8/22/02	8:30	88.1	1 U	--	14.4	1 U	1	1.2
Upper Mill Creek	2368890	9/4/02	9:30	87.3	1 U	--	13.6	1 U	2	0.9
Upper Mill Creek	2388907	9/17/02	7:15	87.5	1 U	--	13	1.3	4	1.5 J
Upper Mill Creek	2478952	11/19/02	8:30	84.6	1.1	--	7.5	1.4	2	0.7 J
Upper Mill Creek	2498952	12/2/02	12:15	84.4	1.3	--	2.8	1.3	1	0.5
Upper Mill Creek	2518969	12/17/02	7:50	79.6	2.8	--	3.5	3.4	3	2.2
Upper Mill Creek	3078989	2/11/03	8:20	67.5	2.4	--	2	2.8	2	3.5
Upper Mill Creek	3098990	2/25/03	15:05	62.5	2.3	--	3.8	2.2	3	5
Upper Mill Creek	3108989	3/7/03	8:05	67.7	1.6	--	4.3	1.7	3	3.2 J
Peppers Bridge	2208109	5/14/02	10:30	51.3	1.7	--	8.9	1.9	2	2.1 J
Peppers Bridge	2228159	5/29/02	11:00	44.3	1.9	--	12.2	2.4	29	6.2
Peppers Bridge	2248081	6/11/02	16:10	61.2	1.6	--	16.6	1.9	4	1.4
Peppers Bridge	2348854	8/22/02	9:25	109	1 U	--	16.3	1 U	2	1.5
Peppers Bridge	2368885	9/4/02	10:20	111	1 U	--	15.7	1 U	4	1.3
Peppers Bridge	2388902	9/17/02	7:30	106	1.3	--	14.7	1.5	4	1.8
Peppers Bridge	2478947	11/19/02	9:30	104	1.2	15	9	1.3	2	0.8 J
Peppers Bridge	2498947	12/2/02	8:30	88.3	1.7	48	3	1.5	3	1.3
Peppers Bridge	2518964	12/17/02	8:30	81.2	2.5	82	4	2.4	4	1.7
Peppers Bridge	3058975	1/30/03	14:15	52.4	--	1127	7.2	--	585	290 J
Peppers Bridge	3078985	2/10/03	15:00	69.8	2.3	297	6.5	2.6	9	4.3
Peppers Bridge	3098985	2/25/03	8:04	68.4	2.1	276	1.2	2.1	4	3.3
Peppers Bridge	3108985	3/7/03	8:45	72.9	1.3	186	5	1.4	4	1.8 J
Peppers Bridge	3138155	3/24/03	16:15	53.7	--	530	8.2	--	32	13
Peppers Bridge	3208155	5/15/03	8:15	60	1.2	205	9.6	1.1	5	2.8

Site Name	Sample No.	Date	Time	Conductivity (umhos/cm)	DOC (mg/L)	Flow* (cfs)	Temperature (C°)	TOC (mg/L)	TSS (mg/L)	Turbidity (NTU)
Yellowhawk Creek	2208110	5/14/02	11:30	113	1.8	54.4	10.4	2	6	4.8
Yellowhawk Creek	2228164	5/29/02	13:15	109	2	50.7	16	2.2	19	8.2
Yellowhawk Creek	2228165	5/29/02	14:30	112	1.8	--	15.2	2.2	18	8.3
Yellowhawk Creek	2248082	6/11/02	15:40	126	2.1	45.3	15.2	2.6	19	7.2
Yellowhawk Creek	2348855	8/22/02	10:10	130	1.1	18.5	16.7	1.3	8	4.7
Yellowhawk Creek	2348856	8/22/02	10:45	132	1.2	--	16.8	1.1	7	4.1
Yellowhawk Creek	2368886	9/4/02	11:00	127	1.2	17.03	15.2	1.2	5	3
Yellowhawk Creek	2368887	9/4/02	12:00	129	1.2	--	15.4	1.3	5	3
Yellowhawk Creek	2388903	9/17/02	8:45	129	2.3	13.1	15.1	2.7	21	7.8
Yellowhawk Creek	2478948	11/19/02	10:00	125	1.6	21.9	8.8	1.7	5	1.5 J
Yellowhawk Creek	2478949	11/19/02	10:30	126	1.6	--	9	1.6	2	1.4 J
Yellowhawk Creek	2498948	12/2/02	9:00	128	1.7	--	2.6	2	5	2.2
Yellowhawk Creek	2518965	12/17/02	9:00	126	3.2	--	4.2	3.5	6	2.9
Yellowhawk Creek	2518966	12/17/02	9:20	128	3.1	--	4.3	3.7	5	2.8
Yellowhawk Creek	3058976	1/30/03	14:30	78.3	--	--	8.3	--	777	400
Yellowhawk Creek	3078986	2/10/03	15:30	144	3.1	--	6.8	3.9	66	25
Yellowhawk Creek	3098986	2/25/03	8:45	124	2.6	--	0.6	3.1	29	13
Yellowhawk Creek	3098987	2/25/03	9:15	128	2.8	--	0.7	3.1	25	15
Yellowhawk Creek	3108986	3/7/03	9:10	152	1.8	--	5.5	2.7	23	9.6 J
Yellowhawk Creek	3138156	3/24/03	16:30	101	--	--	9.7	--	33	17
Yellowhawk Creek	3208156	5/15/03	8:30	103	1.7	--	10.5	2.3	29	14
Garrison Creek	2208111	5/14/02	12:45	190	3.1	3.4	14.4	3.7	9	5
Garrison Creek	2228160	5/29/02	16:15	248	4	3.9	21.5	4.3	25	8.6
Garrison Creek	2248084	6/11/02	16:45	210	2.9	2.8	19.9	3.5	18	6.7
Garrison Creek	2348857	8/22/02	11:25	524	4.9	0.1	18.7	4.9	1	1.5
Garrison Creek	2368888	9/4/02	12:20	508	5.4	0.27	18	5.1	1	1.7
Garrison Creek	2388905	9/17/02	9:20	524	6.7	0.06	17.1	7.2	1 U	1.5
Garrison Creek	2478950	11/19/02	10:45	375	5.8	1.62	11.9	5.5	6	3.5 J
Garrison Creek	2498950	12/2/02	9:30	281	3.9	2.5	5.9	4.2	13	5.1

Site Name	Sample No.	Date	Time	Conductivity (umhos/cm)	DOC (mg/L)	Flow* (cfs)	Temperature (C°)	TOC (mg/L)	TSS (mg/L)	Turbidity (NTU)
Garrison Creek	2518967	12/17/02	9:35	291	5.7	1.83	9	8.6	28	11
Garrison Creek	3058977	1/30/03	14:50	194	--	--	10.2	--	18	10 J
Garrison Creek	3078987	2/10/03	16:10	263	2.9	7.16	10	3.4	13	4.9
Garrison Creek	3098988	2/25/03	10:15	258	2.3	5.44	5.5	2.4	30	14
Garrison Creek	3108987	3/7/03	9:35	257	2.1	5.56	8.6	2.6	24 J	9.1 J
Garrison Creek	3138157	3/24/03	17:00	264	--	8.14	13	--	23	8.8
Lower Mill Creek	2208107	5/13/02	17:30	116	1.9	99.6	15.3	2.5	3	1.8 J
Lower Mill Creek	2228157	5/29/02	17:30	89.1	1.9	--	18.1	2	7	3.2
Lower Mill Creek	2248085	6/11/02	17:20	136	1.8	--	19.6	1.8	2	1.2
Lower Mill Creek	2348858	8/22/02	13:15	434	2.1	0.11	19.2	2	1	1.1
Lower Mill Creek	2368889	9/3/02	18:30	423	2.1	0.5	20.1	2	1 U	0.5 U
Lower Mill Creek	2388906	9/16/02	16:35	425	1.6	0.82	18	2.1	1 U	0.5 U
Lower Mill Creek	2478951	11/19/02	11:40	306	2.1	15.56	10.8	2.1	1 U	0.5 U
Lower Mill Creek	2498951	12/2/02	10:45	325	2.3	13.49	5.6	2.6	1 U	0.5 U
Lower Mill Creek	2518968	12/16/02	15:40	170	3.6	--	9.1	4.1	3	1.8
Lower Mill Creek	3058978	1/30/03	15:10	61.3	--	--	8	--	465	230 J
Lower Mill Creek	3078988	2/11/03	9:35	130	2.6	--	3.7	3.1	4	4.4
Lower Mill Creek	3098989	2/25/03	17:00	102	2.4	--	4.9	2.3	4	5.4
Lower Mill Creek	3108988	3/6/03	16:45	131	1.9	--	7.3	2	2	2.4 J
Lower Mill Creek	3138158	3/25/03	7:50	83.3	--	--	6.9	--	7	5.8
Lower Mill Creek	3208158	5/14/03	16:45	94.3	1.9	--	16.4	1.8	7	3.3
Detour Road	2208106	5/13/02	15:45	93.2	1.8	--	13.8	2.1	4	4.2 J
Detour Road	2228156	5/30/02	7:30	70.4	1.6	--	12.1	2.1	32	9.7
Detour Road	2248083	6/12/02	9:20	122	1.6	--	15.3	1.9	6	2
Detour Road	2348860	8/22/02	14:20	138	1.3	--	20.3	1.2	3	2.1
Detour Road	2368891	9/4/02	13:15	144	1.3	34.52	17.5	1.5	3	1.9
Detour Road	2388908	9/16/02	16:10	133	1	--	17.2	1.4	4	1.8
Detour Road	2478953	11/19/02	12:30	221	2.4	--	10.2	2.3	1	0.7
Detour Road	2498953	12/2/02	11:30	210	2.5	--	4.2	2	1	0.9

Site Name	Sample No.	Date	Time	Conductivity (umhos/cm)	DOC (mg/L)	Flow* (cfs)	Temperature (C°)	TOC (mg/L)	TSS (mg/L)	Turbidity (NTU)
Detour Road	2518970	12/16/02	13:07	150	3	--	8.6	3.2	9	3.4
Detour Road	3058980	1/30/03	15:20	64.6	--	--	7.8	--	785	350 J
Detour Road	3078990	2/10/03	16:55	121	3	--	6.8	3.3	17	7.6
Detour Road	3098991	2/26/03	11:15	107	2	--	3.6	2.1	6	5.7
Detour Road	3108990	3/6/03	16:10	123	1.5	--	7.3	1.8	18	4.5 J
Detour Road	3138159	3/25/03	8:30	80.2	--	--	6.9	--	28	13
Detour Road	3208160	5/14/03	17:30	97.5	1.6	--	16.2	2.4	11	5.3
Detour Road	3228271	5/30/03	12:24	140	1.2	--	16.9	1.3	6	2 J
Detour Road	3248271	6/9/03	13:15	189	1.7	--	22.4	1.9	4	2.2
Dry Creek	2208112	5/14/02	14:30	271	3.2	14.9	15.8	3.3	5	4.6
Dry Creek	2228161	5/29/02	19:15	265	4.3	11.6	20.2	19	250	550
Dry Creek	2248086	6/12/02	11:15	377	2.5	7.2	17.3	2.8	18	14
Dry Creek	2348861	8/21/02	16:15	637	1.8	0.29	15.9	1.7	1	2.1
Dry Creek	2368892	9/3/02	17:15	621	1.7	0.26	15.6	1.9	1	1.3
Dry Creek	2388909	9/16/02	15:20	650	1.8	0.98	14.8	2	2	1.7
Dry Creek	2478954	11/19/02	13:10	614	2.8	0.71	12	2.7	1 U	1.4
Dry Creek	2498954	12/2/02	16:00	612	4	1.29	--	2.9	2	1.9
Dry Creek	2518971	12/16/02	14:34	423	4.8	--	9.2	5.1	4 J	4.4
Dry Creek	3058981	1/30/03	16:55	135	--	--	--	--	583	310 J
Dry Creek	3078991	2/11/03	10:30	255	3.9	31.59 E	2.9	3.8	41	25
Dry Creek	3098992	2/26/03	9:10	197	2.8	--	0.9	2.7	50	28
Dry Creek	3108991	3/6/03	15:45	254	2.4	--	7	2.6	28	18 J
Dry Creek	3138160	3/25/03	9:10	161	--	--	8.4	--	84	37
Dry Creek	3208161	5/14/03	16:05	231	2.5	--	17	3	18	10
Pine Creek	2208105	5/13/02	14:00	201	2.6	15.1	15.7	2.6	6	7.2 J
Pine Creek	2228155	5/30/02	10:00	330	3.4	5	19.7	4.2	12	11
Pine Creek	2248087	6/12/02	11:45	224	2.3	15.5	18.4	2.6	12	9.2
Pine Creek	2348862	8/21/02	15:00	1770	4.8	0.1	21.7	4.9	6	5.4
Pine Creek	2368893	9/3/02	16:15	1840	5.5	0.02	21.3	6	11	3.1

Site Name	Sample No.	Date	Time	Conductivity (umhos/cm)	DOC (mg/L)	Flow* (cfs)	Temperature (C°)	TOC (mg/L)	TSS (mg/L)	Turbidity (NTU)
Pine Creek	2388910	9/16/02	14:15	1800	5.1	--	17.9	5.6	9	9.2
Pine Creek	2478955	11/19/02	16:20	256	2.9	3.02	8.4	2.9	2	2.9
Pine Creek	2498955	12/2/02	14:45	266	4.7	13.8	--	4	26	14
Pine Creek	2518972	12/16/02	13:30	174	3.9	20.37	8.6	7	145 J	140
Pine Creek	3058982	1/30/03	16:35	130	--	--	--	--	3700	2400 J
Pine Creek	3078992	2/11/03	11:20	236	4.6	37.02	4.3	4.2	27	17
Pine Creek	3098993	2/24/03	16:20	164	3.9	57.54	2.8	3.6	41	21 J
Pine Creek	3098994	2/24/03	16:20	163	3.8	--	--	3.7	34	20 J
Pine Creek	3108992	3/6/03	14:50	243	3.5	31.22	7.1	4.4	419 J	160 J
Pine Creek	3138161	3/25/03	9:50	135	--	97.89 E	8.1	--	55	27
Pine Creek	3208162	5/14/03	15:15	179	2.6	26.9 E	17.7	4.3	14	11
Touchet River	2208113	5/14/02	16:00	85	3	--	16.7	3.3	27	6.6
Touchet River	2228162	5/30/02	13:00	68.6	2.5	--	17.8	2.6	28	10
Touchet River	2228163	5/30/02	14:05	69.9	2.4	--	18.9	2.8	42	12
Touchet River	2248088	6/12/02	12:25	88.6	2	--	19.6	2.2	11	5.1
Touchet River	2348863	8/21/02	14:15	179	2.6	--	19.9	2.5	4	2.8
Touchet River	2368894	9/3/02	15:00	174	2.7	--	20.5	2.9	8	3.3
Touchet River	2388911	9/16/02	14:05	169	2.2	--	17.2	2.4	1	1.3
Touchet River	2478956	11/19/02	15:45	119	2.2	86	8.6	2.2	2	1.7
Touchet River	2498956	12/2/02	14:00	118	1.9	58	--	1.9	2	1.3
Touchet River	2518973	12/16/02	13:00	106	2.6	116	8.5	3.7	9 J	5.2
Touchet River	3058983	1/30/03	16:15	78.7	--	546	6.8	--	102	32 J
Touchet River	3078993	2/11/03	12:40	105	3.2	286	4.1	3.4	84	29
Touchet River	3098995	2/24/03	15:15	85.1	2.9	500	3.8	3.3	99	33 J
Touchet River	3108993	3/6/03	14:10	107	2.1	247	7	2.2	33	15 J
Touchet River	3138162	3/24/03	14:40	77.1	--	813	8.9	--	187	72
Touchet River	3208163	5/14/03	13:50	98.1	1.8	216	17.7	3.1	15	6.3
Touchet River	3228272	5/30/03	11:30	106	1.6	133	20.5	1.8	13	3.2 J
Touchet River	3248272	6/9/03	12:45	128	2.4	49	23.5	2.2	28	7.7

Site Name	Sample No.	Date	Time	Conductivity (umhos/cm)	DOC (mg/L)	Flow* (cfs)	Temperature (C°)	TOC (mg/L)	TSS (mg/L)	Turbidity (NTU)
Lower Walla Walla	2208114	5/14/02	17:15	117	2.8	--	14.4	2.9	29	8.8
Lower Walla Walla	2228166	5/30/02	15:25	88.1	2.2	--	17	2.7	87	22
Lower Walla Walla	2228167	5/30/02	16:25	87.7	1.9	--	17.3	2.4	66	18
Lower Walla Walla	2228168	5/30/02	16:25	87.5	2.3	--		2.2	66	20
Lower Walla Walla	2248089	6/11/02	12:15	140	2.5	--	18.1	2.8	19	7.6
Lower Walla Walla	2248090	6/12/02	13:00	146	1.8	--	20.9	1.9	7	4.7
Lower Walla Walla	2348864	8/21/02	13:30	608	2.8	--	21.1	2.9	2	2
Lower Walla Walla	2368895	9/3/02	14:00	498	3.1	--	20.2	3.5	12	5.7
Lower Walla Walla	2388912	9/16/02	13:30	358	2.6	--	17.5	3	2	2.4
Lower Walla Walla	2478957	11/19/02	14:20	257	2.8	--	9	2.9	9	4.6
Lower Walla Walla	2498957	12/3/02	9:15	252	2.5	--	--	2.3	3	2.5
Lower Walla Walla	2518974	12/16/02	12:30	170	3.2	--	8.9	3.7	17 J	11 J
Lower Walla Walla	3058984	1/30/03	16:00	93.1	--	--	7.5	--	405	210 J
Lower Walla Walla	3078994	2/10/03	13:15	144	3.1	--	5.2	3.1	93	27
Lower Walla Walla	3098996	2/24/03	14:15	109	3.8	--	3.8	2.9	82	28 J
Lower Walla Walla	3108994	3/6/03	13:40	155	1.9	--	7	2	46	14 J
Lower Walla Walla	3138163	3/24/03	13:50	86.2	--	--	7.8	--	190 J	63
Lower Walla Walla	3208164	5/14/03	13:10	126	2.2	--	16	5	36	10
Lower Walla Walla	3228273	5/30/03	11:20	173	1.6	--	21.3	1.9	21	7.1 J
Lower Walla Walla	3248273	6/9/03	12:15	303	2.2	--	21.3	2.5	18	7.6
E. Little Walla Walla	3099001	2/25/03	12:15	108	1.2	15.41	7.3	1 U	38	15
E. Little Walla Walla	3208167	5/15/03	9:50	97.2	1 U	12.3 E	10.7	1.4	29	13
E. Little Walla Walla	3208157	5/15/03	9:50	97.3	1 U	--	--	1.3	29	11
E. Little Walla Walla	3228276	5/30/03	13:00	94.9	1 U	2.1 E	13.3	1.2	40 J	13 J
E. Little Walla Walla	3248276	6/9/03	14:55	93	1.3	1.8 E	19.3	1.8	24	9
E. Little Walla Walla	3368757	9/3/03	13:25	98.5	1.9	10 E	16.1	1.5	6	2.2
Stone Creek	3099000	2/25/03	11:05	406	3.4	2.74	4.9	3.6	1	0.9
Stone Creek	3208159	5/15/03	9:20	387	2.6	2 E	13.8	2.6	2	1.2
Stone Creek	3228278	5/30/03	12:50	416	2.6	0.8 E	16.5	3.2	4	1.4 J

Site Name	Sample No.	Date	Time	Conductivity (umhos/cm)	DOC (mg/L)	Flow* (cfs)	Temperature (C°)	TOC (mg/L)	TSS (mg/L)	Turbidity (NTU)
W. Little Walla Walla	3099002	2/25/03	15:40	261	1.8	5.48	6.7	1.7	15	9.1
W. Little Walla Walla	3208168	5/15/03	10:00	203	1.7	5 E	13.7	2.1	8	5.6
W. Little Walla Walla	3228277	5/30/03	12:35	261	2.5	1.25 E	17.8	3.1	7	3.5 J
W. Little Walla Walla	3248277	6/9/03	15:20	265	3.4	1.15 E	23.4	3.6	7	4.2
Mud Creek	3098999	2/26/03	10:00	695	3.6	0.65	0.9	3.9	88	45
Mud Creek	3208165	5/14/03	15:45	379	5	1.2 E	22.2	5.3	9	6.2
Mud Creek	3228274	5/30/03	13:30	356	3.7	2 E	19.8	4.3	5	4.1 J
Mud Creek	3248274	6/9/03	15:40	346	5.4	0.8 E	27.2	5.5	3	2.4
Mud Creek	3368755	9/3/03	12:30	270	3.6	0.91	19.2	3.2	5	4
Gardena Creek	3208166	5/14/03	14:45	85.2	1.7	9.6 E	20.5	2.2	80	32
Gardena Creek	3228275	5/30/03	11:55	92	1.1	4 E	18.2	1.7	77 J	28 J
Gardena Creek	3248275	6/9/03	16:10	136	2.4	0.7 E	27.3	2.7	13	11

* = Flow data from present study and Ecology's Stream Hydrology Unit
E = The reported result is an estimate.
J = The analyte was positively identified. The associated numerical result is an estimate.
U = The analyte was not detected at or above the reported result.

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Appendix G

Conventional Data for Final Effluent from the College Place and Walla Walla WWTPs

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Appendix G. Conventional Data for Final Effluent from the College Place and Walla Walla WWTPs.

Facility	Date	Parameter	Result	qualifier	Unit	Sample ID
College Place	5/29/02	Flow*	1.096		MGD	–
College Place	5/29/02	Conductivity	404		umhos/cm	2228031
College Place	5/29/02	Total Suspended Solids	17		mg/L	2228031
College Place	5/30/02	Conductivity	423		umhos/cm	2228033
College Place	5/30/02	Total Suspended Solids	20		mg/L	2228033
College Place	9/10/02	Flow	0.80		MGD	–
College Place	9/11/02	Conductivity	516		umhos/cm	2378882
College Place	9/11/02	Total Organic Carbon	6.1		mg/L	2378882
College Place	9/11/02	Total Suspended Solids	8	J	mg/L	2378882
College Place	12/2/02	Flow	0.893		MGD	–
College Place	12/2/02	Conductivity	370		umhos/cm	2498959
College Place	12/2/02	Total Suspended Solids	6		mg/L	2498959
College Place	2/24/03	Flow	1.269		MGD	–
College Place	2/24/03	Conductivity	397		umhos/cm	3098998
College Place	2/24/03	Total Suspended Solids	1		mg/L	3098998
College Place	3/24/03	Conductivity	409		umhos/cm	3138164
College Place	3/24/03	Total Suspended Solids	1		mg/L	3138164
College Place	3/24/03	Turbidity	2.9		NTU	3138164
Walla Walla	5/29/02	Flow	4.989		MGD	–
Walla Walla	5/29/02	Conductivity	372		umhos/cm	2228030
Walla Walla	5/29/02	Conductivity	366		umhos/cm	2228034
Walla Walla	5/29/02	Total Suspended Solids	1	U	mg/L	2228030
Walla Walla	5/29/02	Total Suspended Solids	1	U	mg/L	2228034
Walla Walla	5/30/02	Conductivity	384		umhos/cm	2228032
Walla Walla	5/30/02	Total Suspended Solids	1	U	mg/L	2228032
Walla Walla	9/10/02	Flow	3.95		MGD	–
Walla Walla	9/11/02	Conductivity	393		umhos/cm	2378881
Walla Walla	9/11/02	Total Organic Carbon	4.3		mg/L	2378881
Walla Walla	9/11/02	Total Suspended Solids	1	U	mg/L	2378881
Walla Walla	12/2/02	Flow	4.661		MGD	–
Walla Walla	12/2/02	Conductivity	305		umhos/cm	2498958
Walla Walla	12/2/02	Total Suspended Solids	1	U	mg/L	2498958
Walla Walla	2/24/03	Flow	6.362		MGD	–
Walla Walla	2/24/03	Conductivity	302		umhos/cm	3098997
Walla Walla	2/24/03	Total Suspended Solids	1	U	mg/L	3098997

* = Daily averages as reported by the WWTPs.
U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.

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Appendix H

DDE, TSS, and Turbidity Data on Whole Water Samples Collected in the Walla Walla Drainage May 2002 - September 2003

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Appendix H. DDE, TSS, and Turbidity Data on Whole Water Samples Collected in the Walla Walla Drainage, May 2002 - September 2003.

Location	Date	Sample No.	4,4'-DDE (ng/L)	TSS (mg/L)	Turbidity (NTU)
Upper Walla Walla R. @ Peppers Bridge	5/29/2002	2228159	0.14	29	6.2
Upper Walla Walla R. @ Peppers Bridge	9/4/2002	2368885	<0.069	4	1.3
Upper Walla Walla R. @ Peppers Bridge	1/30/2003	3058975	1.2	585	290
Upper Walla Walla R. @ Peppers Bridge	2/25/2003	3098985	0.093	4	3.3
Upper Walla Walla R. @ Peppers Bridge	3/24/2003	3138155	0.33	32	13
Upper Walla Walla R. @ Peppers Bridge	5/15/2003	3208155	0.098	5	2.8
Yellowhawk Creek	5/15/2003	2208110	0.49	29	4.8
Yellowhawk Creek	5/29/2002	2228164	0.59	18	8.2
Yellowhawk Creek	8/22/2002	2348855	0.85	7	4.7
Yellowhawk Creek	9/4/2002	2368886	0.41	5	3
Yellowhawk Creek	11/19/2002	2478948	0.37	2	1.5
Yellowhawk Creek	12/17/2002	2518965	0.39	5	2.9
Yellowhawk Creek	1/30/2003	3058976	3.8	777	400
Yellowhawk Creek	2/25/2003	3098987	0.58	25	15
Yellowhawk Creek	3/24/2003	3138156	0.46	33	17
East Little Walla Walla River	2/25/2003	3099001	1.5	38	15
East Little Walla Walla River	5/15/2003	3208157	1.2	29	12
East Little Walla Walla River	6/9/2003	3248276	0.88	24	9
East Little Walla Walla River	9/3/2003	3368757	0.6	6	2.2
Stone Creek	2/25/2003	3099000	<0.069	<1	0.9
Stone Creek	5/15/2003	3208159	<0.063	<2	1.2
Garrison Creek	5/29/2002	2228160	0.37	25	8.6
Garrison Creek	9/4/2002	2368888	0.23	1	1.7
Garrison Creek	1/30/2003	3058977	0.24	18	10
Garrison Creek	2/25/2003	3098988	0.31	30	14
Garrison Creek	3/24/2003	3138157	0.4	23	8.8
West Little Walla Walla River	2/25/2003	3099002	0.36	15	9.1
West Little Walla Walla River	5/15/2003	3208168	0.36	8	5.6
West Little Walla Walla River	6/9/2003	3248277	0.29	7	4.2
Upper Mill Creek	5/29/2002	2228158	<0.065	5	2.7
Upper Mill Creek	9/4/2002	2368890	<0.069	2	0.9
Mill Creek @ Mouth	5/29/2002	2228157	0.13	7	3.2
Mill Creek @ Mouth	9/3/2002	2368889	0.13	<1	<0.5
Mill Creek @ Mouth	1/30/2003	3058978	0.79	465	230
Mill Creek @ Mouth	2/25/2003	3098989	0.09	4	5.4
Mill Creek @ Mouth	3/25/2003	3138158	0.077	7	5.8
Mill Creek @ Mouth	5/14/2003	3208158	0.097	7	3.3
Middle Walla Walla R. @ Detour Rd	5/30/2002	2228156	0.22	32	9.7
Middle Walla Walla R. @ Detour Rd	9/4/2002	2368891	0.27	3	1.9
Middle Walla Walla R. @ Detour Rd	1/30/2003	3058980	2.1	785	350
Middle Walla Walla R. @ Detour Rd	2/26/2003	3098991	0.19	6	5.7
Middle Walla Walla R. @ Detour Rd	3/25/2003	3138159	0.25	28	13
Middle Walla Walla R. @ Detour Rd	5/14/2003	3208160	0.15	11	5.3

Location	Date	Sample No.	4,4'-DDE (ng/L)	TSS (mg/L)	Turbidity (NTU)
Dry Creek	5/29/2002	2228161	1.7	250	550
Dry Creek	8/21/2002	2348861	0.081	1	2.1
Dry Creek	9/3/2002	2368892	<0.071	1	1.3
Dry Creek	11/19/2002	2478954	<0.065	<1	1.4
Dry Creek	12/16/2002	2518971	<0.071	4	4.4
Dry Creek	1/30/2003	3058981	0.74	583	310
Dry Creek	2/26/2003	3098992	0.18	50	28
Dry Creek	3/25/2003	3138160	0.29	84	37
Dry Creek	5/14/2003	3208161	0.12	18	10
Mud Creek	2/26/2003	3098999	0.71	88	45
Mud Creek	5/14/2003	3208165	0.34	9	6.2
Mud Creek	6/9/2003	3248274	0.18	3	2.4
Mud Creek	9/3/2003	3368755	0.21	5	4
Pine Creek	5/30/2002	2228155	0.26	12	11
Pine Creek	8/21/2002	2348862	0.15	6	5.4
Pine Creek	9/3/2002	2368893	0.13	11	3.1
Pine Creek	11/19/2002	2478955	0.3	2	2.9
Pine Creek	12/2/2002	2498955	0.3	26	14
Pine Creek	12/16/2002	2518972	0.39	145	140
Pine Creek	1/30/2003	3058982	4.1	3700	2400
Pine Creek	2/24/2003	3098993	0.15	38	21
Pine Creek	3/25/2003	3138161	0.2	55	27
Pine Creek	5/14/2003	3208162	0.29	14	11
Touchet River	5/30/2002	2228162	0.14	42	11
Touchet River	6/12/2002	2248088	<0.066	11	5.1
Touchet River	8/21/2002	2348863	0.077	4	2.8
Touchet River	9/3/2002	2368894	0.11	8	3.3
Touchet River	11/19/2002	2478956	<0.067	2	1.7
Touchet River	12/16/2002	2518973	<0.069	9	5.2
Touchet River	1/30/2003	3058983	<0.13	102	32
Touchet River	2/24/2003	3098995	0.21	99	33
Touchet River	3/24/2003	3138162	0.41	187	72
Touchet River	5/14/2003	3208163	0.071	15	6.3
Gardena Creek	5/14/2003	3208166	1.3	80	32
Gardena Creek	6/9/2003	3248275	0.49	13	11
Lower Walla Walla River	5/30/2002	2228167	0.28	66	19
Lower Walla Walla River	6/12/2002	2248090	0.18	7	4.7
Lower Walla Walla River	1/30/2003	3058984	1.2	405	210
Lower Walla Walla River	8/21/2002	2348864	0.19	2	2
Lower Walla Walla River	9/3/2002	2368895	0.31	12	5.7
Lower Walla Walla River	11/19/2002	2478957	0.15	9	4.6
Lower Walla Walla River	12/16/2002	2518974	0.21	17	11
Lower Walla Walla River	2/24/2003	3098996	0.28	82	28
Lower Walla Walla River	3/24/2003	3138163	0.41	190	63
Lower Walla Walla River	5/14/2003	3208164	0.24	36	10