DRAFT FINAL

FOCUSED REMEDIAL INVESTIGATION REPORT

UPRIVER DAM PCB SEDIMENTS SITE

Prepared for

Avista Development, Inc.
and
Kaiser Aluminum & Chemical Corporation

For Submittal to

Washington Department of Ecology

Prepared by

Anchor Environmental, L.L.C.
1423 Third Avenue, Suite 300
Seattle, Washington 98101

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μg/kg	micrograms per kilogram
2LAET	second lowest observed effects threshold
ARAR	applicable or relevant and appropriate requirement
Avista	Avista Development, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CLARC	Cleanup Level and Risk Calculation
cm	Centimeters
CPOC	chemicals of potential concern
CSL	Cleanup Screening Level
DOC	dissolved organic carbon
DTW	depth to water
dw	dry weight
EAF	exposure adjustment factors
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
FS	Feasibility Study
Kaiser	Kaiser Aluminum & Chemical Corporation
kHz	kilohertz
L/min	liters per minute
LAET	lowest apparent effects thresholds (s),
MCL	maximum contaminant level
MSL	mean sea level
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity units
PAHs	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
pg/L	picograms per liter
PRC	performance reference compounds
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation

RM	River mile
ROD	record of decision
Rs	sampling rates
SAP	Sampling and Analysis Plan
SC	specific conductance
SMS	Sediment Management Standards
SPMD	semi-permeable membrane device
SQS	Sediment Quality Standards
STP	Sewage Treatment Plant
SVOCs	semi-volatile organic compounds
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSS	total suspended solids
WAC	Washington Administrative Code

EXECUTIVE SUMMARY

Under the terms of a Consent Decree with the Washington Department of Ecology (Ecology), Avista Development, Inc., a subsidiary of Avista Corporation (Avista), and Kaiser Aluminum & Chemical Corporation (Kaiser) conducted a focused Remedial Investigation (RI) of the nature and extent of polychlorinated biphenyls (PCBs) in sediments and waters of the Spokane River between Upriver Dam (Spokane River mile [RM] 80.0) and the Centennial Trail footbridge (RM 85.0). This section of the Spokane River is defined as the Site (Ecology 2003). Previous investigations of the site indicated that sediment PCB contamination in this area was largely limited to relatively fine-grained organic silt accumulations located immediately behind the dam (denoted in this focused RI as Deposit 1). Sediment characterization objectives of the focused RI included detailed sediment mapping to delineate the extent of fine-grained deposits throughout the site and characterization of sediment PCB concentrations in all such deposits.

In addition to verifying the extent of Deposit 1, the sediment mapping survey identified several other relatively fine-grained sediment accumulations within the site, including a localized off-channel area near Donkey Island (Deposit 2) and in small backwater areas immediately downstream of several rock outcrops and inner bends (meanders) of the river channel. Detailed sediment sampling and analysis was performed in each of these fine-grained deposits to characterize the nature and extent of PCB concentrations in these areas.

Surface sediment (0 to 10 centimeters [cm] below the mudline) total PCB concentrations throughout most of the Site are generally well below 60 micrograms per kilogram dry weight (μg/kg dw), the lower range of risk-based sediment screening levels recommended by Ecology. However, bottom sediment surface PCB concentrations exceeding 60 μg/kg dw were identified in two areas of the site:

- Deposit 1 – approximately 3.7 acres in deep water (20 to 25 feet below normal pool level) zones near Upriver Dam (approximately RM 80.1 to 80.6), containing surface sediment PCB concentrations up to 1,430 μg/kg dw
- Deposit 2 – a smaller (0.2 acre) shallow water area on north bank side channels near Donkey Island (RM 83.4), containing surface sediment PCB concentrations up to 330 μg/kg dw

The site characterization data available for the Site also include several high-resolution and radioisotope-dated cores collected within Deposit 1. These coring data define a pronounced vertical profile of PCB concentrations within the sediments. Sediment total PCB concentrations peak at depths approximately 20 to 40 cm below mudline, decreasing steadily in shallower intervals. This vertical profile of PCB concentrations reveals that PCBs deposited historically (prior to 1970) at the site have been overlain and buried with cleaner sediments. The data indicate that this process, referred to as natural recovery, is occurring in sediments located behind Upriver Dam, with net sedimentation rates ranging between approximately 0.4 and 1.0 cm/year. The pronounced stratification or layering apparent in measured PCB concentrations and the radioisotope record suggests that these sediments have, in general, remained stable over time, relative to the more dynamic processes typical of many other parts of the river system. Subsurface sediments at Deposit 1 show no indication of substantial, widespread, deep periodic scouring and remobilization.

In addition to sediment characterization, the focused RI also included detailed sampling and analysis of water column and groundwater PCB concentrations under a range of flow conditions, to assess the potential for transfer of PCBs from the sediment deposits into surface water and groundwater in the vicinity of Upriver Dam. Surface water total PCB concentrations measured at the site during low flow conditions in early September 2003 (500 cubic feet per second [cfs] measured at the Spokane gage) reached a maximum concentration of approximately 120 picograms per liter (pg/L) at Boulder Beach (RM 82.0). All surface water PCB concentrations measured at the Site were below the current surface water quality standard (Chapter 173-201A) of 170 pg/L, though samples collected during September 2003 at Boulder Beach and at the Upriver Dam Forebay (RM 79.8) exceeded EPA's (2002) recommended water quality criterion for total PCBs of 64 pg/L. Surface water total PCB concentrations throughout the Site during flow conditions in mid-December 2003 (4,000 cfs at the Spokane gage) were less than 30 pg/L.

Increases in surface water PCB concentrations in the Site area, relative to more upstream sampling locations, were attributable at least in part to specific congeners (especially PCB 11) apparently associated with treated wastewater from the Inland Empire Paper Company outfall. In addition, increases in bottom water concentrations of certain PCB homologue groups near the Dam Forebay were potentially attributable to sediment-associated releases from Deposit 1, though uncertainties associated with low-level PCB analyses and the degree of water column stratification and mixing in this area precluded more definitive source and mass balance analyses.

Groundwater PCB concentrations were similar to surface water concentrations measured near the dam, and consistent with the site conceptual model verified by local hydrogeologic data of river discharge (exfiltration) to the aquifer in the vicinity of the dam pool. While PCBs were detectable in groundwater, measured concentrations were approximately 3 orders of magnitude below the current drinking water maximum contaminant level.

The data collected during the RI were also used in the accompanying feasibility study (FS) to support identification and evaluation of potential alternatives for cleanup of site sediments. The overall RI/FS evaluation is intended to provide sufficient data and engineering analysis to enable Ecology to select a cleanup action that is protective of human health and the environment.

1 INTRODUCTION

Effective February 6, 2003, the Washington State Department of Ecology (Ecology) entered into a Consent Decree with Avista Development, Inc., a subsidiary of Avista Corporation (Avista), and Kaiser Aluminum & Chemical Corporation (Kaiser). The Consent Decree (Ecology 2003) sets forth requirements for completing a focused Remedial Investigation (RI) and Feasibility Study (FS) of polychlorinated biphenyls (PCBs) in sediments at the Upriver Dam PCB Site (Site). The Site study area begins at approximately river mile (RM) 80.0 near the Upriver Dam and continues to approximately RM 85.0 upstream of the Dam near the Centennial Trail footbridge (Figure 1). The Site is in the County of Spokane, Washington.

The purpose of the RI is to evaluate the nature and extent of PCBs in sediments at the Site in and along the Spokane River upstream of Upriver Dam. Prior to conducting this focused RI, other investigations have shown that PCB contamination at and upstream of Upriver Dam may be limited to fine grained sediments located behind the dam in a narrow strip adjacent to the north bank of the impoundment (denoted Deposit 1; Figure 2; Exponent and Anchor 2001).

This document presents the findings of the focused RI, conducted under the terms of the Consent Decree. Using the site characterization data compiled as part of this RI, the accompanying FS identifies and evaluates potential alternatives for cleanup of PCBs in sediments at the Site.

1.1 Hydrologic Setting

As generally described by the U.S. Environmental Protection Agency (EPA) in its Coeur d'Alene Basin RI/FS (EPA 2001b), sediment within the Spokane River is transported through and deposited in reservoirs along its length, including Upriver Dam. Sediment sources to the upper Spokane River include remobilization of channel bed material, bank erosion, and tributary inputs. Lake Coeur d'Alene provides a low energy environment where much of the sediment derived from the upstream watershed and former mining sources is deposited. However, some silts and clays may remain suspended in the lake and are transported to the Spokane River. Such sediments may subsequently settle in downstream impoundments, including parts of Upriver Dam, where net sedimentation rates between approximately 0.4 and 1.0 centimeters (cm) per year have been measured at Deposit 1 (Hart Crowser 1995, Exponent and Anchor 2001).

The upstream (backwater) end of the Upriver Dam impoundment begins near Plante's Ferry Park (RM 85.0), approximately 17 miles downstream of the Post Falls Dam (RM 101.7). Even under seasonal low flow conditions, stream velocity between Post Falls and Plante's Ferry is generally high enough that sands or finer materials are not deposited in this area beyond small, localized pools (Patmont et al. 1985, EPA 2001a). However, below Plante's Ferry, river velocity slows considerably within the Upriver Dam backwater. During seasonal low flow conditions, average stream velocity through the approximate 170-acre Upriver Dam reservoir drops below 10 cm/sec, particularly within the relatively wide and deep reach of the river immediately upstream of the Dam (RM 79.8). Settling of sediment fines occurs within such lower energy environments. The Coeur d'Alene Basin RI/FS (EPA 2001b) identified sediment deposits contaminated by upstream (Idaho) mining-related metals within approximately 17 acres of the 170-acre Upriver Dam impoundment.

1.2 May 1986 Dam Failure Event

In May 1986 a lightening strike at the Upriver Dam Hydroelectric Development caused a power outage that resulted in failure of portions of the dam structure. The lightning strike knocked out the turbine generators and station power. The backup electric generator system failed which prevented the spillway gates from being raised to release rising water.

The 1986 event caused significant erosion to the intake channel (Figure 3, photos 1-4) leading up to the powerhouse and around the entire powerhouse structure (See Figure 3, photo 2). While water overtopped the spillway gates at the dam itself and caused some erosion south of the dam (Figure 3, photos 5-6), there was no indication that erosion occurred upstream of the spillway gates (i.e., in the vicinity of Deposit 1). Radioisotope profiling of Deposit 1 performed in 1994 and 2001 also suggests that such subsurface sediments were stable throughout the event, with no indication of substantial, widespread scouring and remobilization (see Section 7 and Appendix H).

However, substantial erosion of upland soils within the immediate vicinity of the powerhouse channel material did occur during the 1986 event. The majority of this erosion occurred where the abutments and closure embankments failed (Figures 3 and 4). The power canal banks suffered erosion across approximately 500 feet of length upstream of the powerhouse, removing approximately 200 feet of canal lining. The documented extent of the erosion is depicted in Figure 4. In total, approximately 90,000 cubic yards of soils were eroded during the event and transported downstream. This material partially filled the downstream river channel and caused an abutment for a City of Spokane water supply line to fail. A portion of this material was subsequently removed along approximately 2,000 feet of river channel downstream of Upriver Dam.

The current spillway dam structure was rebuilt in 1989 with additional safety factors (i.e., an erodable fuse plug, centralized control, additional backup systems) to prevent another incident. As part of these safety measures, the powerhouse channel and sediments immediately upstream from the dam were lined with concrete, and armor added to the dam face.

1.3 Phased RI Approach

Under the terms of the Consent Decree, the RI was performed in phases. The studies performed and the general objectives of each work element are outlined below. Further details of the various RI activities and results are provided in Section 5.

1.3.1 Initial Physical Surveys and Seasonal Water Sampling

Work elements in this initial task included assessment of baseline low-flow and peak flow surface water quality and groundwater quality conditions, and initial delineation of fine-grained sediment deposits at the Site. Specific activities associated with this initial RI task were as follows:

- Bathymetric survey, bottom profiling, and structural summary of the Site riverbed to identify relatively soft/fine sediment depositional areas, in preparation for the subsequent sediment sampling efforts described below.
- Seasonal surface water monitoring and semi-permeable membrane device (SPMD) deployment to characterize baseline PCB water concentrations in the Spokane River and possible mass transfer from the riverbed to surface water.
- Sampling of representative monitoring wells in hydraulic connection with the Upriver Dam area to evaluate the potential for PCB mass transfer from the riverbed to regional groundwater.

1.3.2 Focused RI Sediment Sampling

As set forth in the Consent Decree, sediment samples from potential depositional zones located between Upriver Dam (RM 80.0) and RM 81.5 and near Donkey Island (RM 83.25 to 83.75) were collected and analyzed to complete characterization of the nature and extent of PCB sediment contamination at the Site. Potential depositional zones were identified based upon the results of the bathymetric survey, bottom profiling, and structure profiling conducted as outlined above. Sediment samples from a total of 22 locations were collected and analyzed for chemicals of potential concern (COPCs).

1.4 Regulatory Considerations

The Upriver Dam PCB Site is being addressed under the Model Toxics Control Act WAC 173-340 (MTCA), as set forth in the Consent Decree. However, there are two other regulatory actions within the Spokane River that are also relevant to cleanup activities in this area. First, heavy metals contamination in the Coeur d'Alene basin and upper Spokane River from Idaho mining operations is currently being addressed under the federal Superfund, and second, Ecology is currently developing a PCB Total Maximum Daily Load (TMDL) for the Spokane River under the Clean Water Act. These actions are briefly outlined below.

Under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; the federal Superfund), the EPA is concurrently investigating metals contamination in the Coeur d'Alene basin and the upper Spokane River associated with historic mining operations in Idaho (EPA 2001b). The EPA effort has been focused on heavy metals contamination in the river (e.g., zinc, arsenic, cadmium, and lead). Metals-related contamination associated with Idaho's historic mining operations has been determined to be broadly distributed throughout the upper Spokane River including and extending beyond the fine grained sediment areas behind Upriver Dam where PCBs may be located. The EPA Record of Decision (September 2002) selects capping or dredging as the remedial alternatives to reduce metals risks in sediments at and upstream of Upriver Dam, but EPA has not yet selected between these two alternatives. The Site cleanup will be coordinated with EPA's cleanup plans to the greatest extent possible.

Ecology is also currently developing a TMDL assessment consistent with the federal Clean Water Act to address PCBs in the Spokane River. The TMDL addresses PCBs in river water rather than PCBs in sediments. A draft report of the TMDL assessment is expected in 2005. The Upriver Dam PCB Site efforts will be consistent with the TMDL process to the extent possible.

2 ENVIRONMENTAL CONCERNS AND HISTORIC SOURCES

Based on a review of prior sediment sampling data collected within the Upriver Dam impoundment area (Johnson 2000, EPA 2001b, Johnson and Norton 2001, Exponent and Anchor 2001), three different classes of chemicals (metals, PCBs, and wood waste/decomposition products) have been detected in the river sediments at concentrations that may pose a risk to human health and/or the environment. All three chemical classes are frequently co-located in the Upriver Dam impoundment; however, the existing data indicate that metals are much more widely distributed in sediments than PCBs or wood waste. PCBs and wood waste materials are generally associated with deposits of fine-grained, high-organic sediments, whereas elevated metals concentrations are associated with all sediment materials in this area. General environmental concerns and previously identified sources of each chemical class are discussed below.

2.1 General Environmental Concerns in Spokane River Sediments

There have been many previous investigations of the nature, extent, transport dynamics, and risks associated with PCBs and metals in Spokane River sediments. Potential environmental effects associated with wood waste-related chemicals in the Spokane River have not been investigated as thoroughly. The presence of wood-derived material is documented in Appendix E (Table 1). A brief review of general environmental concerns associated with such contaminants, based on prior investigations of the river, is provided below.

2.1.1 Environmental Concerns Relative to PCBs

Potential environmental pathways and receptors of concern identified to date for PCBs present in the Site have included the following:

- Potential for localized toxicity (i.e., in areas exceeding sediment screening level concentrations) to sediment-dwelling (benthic) invertebrate organisms (Johnson 2001).
- Potential mobilization into the water column and possible impacts to water quality (addressed through the conduct of this focused RI).
- Potential risks to wildlife (e.g., birds and mink) and human health due to PCB uptake and bioaccumulation (Johnson 2001). Birds and mink that rely on fish within the Upriver Dam area may be at risk due to elevated PCB concentrations.

- Due to PCB levels detected previously (i.e., 1990s samplings) in certain fish tissues within the Upriver Dam area, the Washington State Department of Heath (1999) has advised against eating trout and mountain whitefish caught from the Site.

With regards to bullets 1 and 3, as noted by Johnson (2001), "there remains, however, insufficient data to establish a quantifiable link between PCB concentrations in the river and impacts to resident invertebrates, fish, and wildlife at the individual or population level." The relevance of these potential pathways is assessed in this RI, and discussed further in Sections 6 and 7.

2.1.2 Environmental Concerns Relative to Metals

Metals, primarily cadmium, lead, and zinc, are widely distributed in the Spokane River sediments. Concerns associated with metals overlap, to some extent, with those of PCBs, and include:

- Population-level toxic effects to benthic organisms (Kadlec 2000, EPA 2001b, Johnson and Norton 2001)
- Human health concerns due to exposure to beach sediments (EPA 2001b)

As a result of a range of EPA and Ecology sponsored studies, the ecological and human health risks associated with metals in Spokane River sediments, including within the Upriver Dam area, have been well documented. For example, sediment toxicity within the Coeur d'Alene basin, including within the fine-grained sediment deposit depicted in Figure 2, is consistent with risk-based models of metals toxicity (EPA 2001b, Johnson and Norton 2001). As discussed above, remedial design and remedial actions are planned under the federal Superfund program to address these risks, beginning with a broad watershed-wide metal source control program in the Idaho mining districts.

2.1.3 Environmental Concerns Relative to Wood Waste

Localized wood-derived waste accumulations, (identified by physical examination of sediments and total organic carbon [TOC] enrichment, along with elevated concentrations of associated degradation products (e.g., phenolics and retene), have been observed in Spokane River sediments, particularly within the fine-grained deposit depicted in Figure 2 (Johnson 2000, Exponent and Anchor 2001, Johnson and Norton

2001). Again, environmental concerns associated with wood wastes overlap, to some extent, with those of PCBs, and include:

- Potential for toxicity to benthic invertebrate organisms (Johnson and Norton 2001)
- Habitat degradation associated with changes to the sediment substrate

2.2 Historic Sources

Documented historic sources of these chemical classes discussed above in Upriver Dam sediments are discussed individually below.

2.2.1 Historic Sources of PCBs

PCBs were produced between 1929 and 1977 in the United States and consist of two benzene rings (biphenyl) linked by a single carbon-carbon bond and have between 1 and 10 chlorine atoms. PCBs were produced as chemical mixtures that had varying degrees of chlorination. The degree of chlorination modifies the chemical properties of the PCB mixture.

PCBs were used in a wide variety of applications which include: capacitors, transformers, hydraulic fluids, plasticizers, adhesives, cutting oils, sealants and caulks, and inks. The Spokane River flows through an urbanized and industrialized basin and is downstream of a large urban area (Coeur d'Alene). Because of this setting, there are a wide variety of potential industrial and non-industrial sources of PCBs to the Spokane River. Known historical sources of PCBs to the Spokane River upstream of Upriver Dam include: Kaiser's Trentwood Facility, Spokane Industrial Park, Liberty Lake Sewage Treatment Plant (STP), and Inland Empire Paper Company (Ecology 1995, Golding 1996, and Golding 2002).

2.2.2 Historic Sources of Metals

Metals contamination in the Spokane River is dominated by historic mining sources that are upstream of Lake Coeur d'Alene in Idaho (EPA 2001b). The mine-derived metal-rich sediments reach the low-energy environment of Lake Coeur d'Alene where much of the material has deposited, and to a lesser extent continues to deposit. A smaller portion of these metals-rich sediments pass through Lake Coeur d'Alene, either dissolved in the water column or as suspended fine materials (i.e., silts and clays). These materials are then transported to, or through, the Spokane River system and some portion has settled in the downstream impoundments, including Upriver Dam. The Coeur d'Alene Basin RI/FS (EPA 2001b) identified an accumulation of mining-related metals in sediments within the 170-acre Upriver Dam impoundment, particularly within an approximately 17-acre area immediately upstream of the dam.

2.2.3 Historic Sources of Wood Waste

Sources of commercially- or industrially-derived wood waste material are not as well documented as sources of the other classes of chemicals. However, industries previously and/or currently located along the Spokane River that could reasonably be expected to produce wood waste material accessible to the river include the Inland Empire Paper Company as well as upstream log yards and lumber mills.

3 SUMMARY OF PREVIOUS INVESTIGATIONS

Numerous physical and chemical analyses have previously been performed on sediments located in the Upriver Dam impoundment area. Studies relevant to this focused RI Report are summarized in Table 1. These investigations include:

- **Ecology's 1993-94 Investigations (Ecology 1995).** This survey assessed PCB concentrations in fish, assessed hazards to aquatic life, and identified sources of PCBs to the Spokane River. Samples of fish, sediment, and effluent from various dischargers to the river were collected and analyzed for PCBs. This report concluded that elevated concentrations of PCBs in sediments were present immediately upstream of Upriver Dam and recommended further investigations of PCBs in sediments and sources between Post Falls and Upriver Dam.

- **Kaiser's 1994 Investigations (Hart Crowser 1995).** This study filled data gaps not addressed by Ecology's 1993-94 Investigations. Specifically, PCB sources in the vicinity of Kaiser were assessed by collecting fish samples and deploying SPMDs. In addition, sediment core samples were collected and analyzed for PCBs and radioisotope dating parameters (Appendix H). The sediment data demonstrated that PCB releases to the Upriver Dam Site peaked in the early 1960s and have declined steadily since that time.

- **Ecology's 1999 Survey (Johnson 2000).** Metals, semi-volatile compounds, and PCBs were analyzed as part of this survey. Zinc, lead, cadmium, PCBs, PAHs, phenols, retene, benzyl alcohol, and benzoic acid were identified as COPCs within the Upriver Dam Site. Of more than 30 locations sampled, only the two locations sampled within Deposit 1 (Figure 2) contained PCBs at levels exceeding Ecology's recommended screening criteria.

- **Ecology's 2000 Sediment Toxicity Tests (Johnson and Norton 2001).** Seven sediment samples were analyzed for metals, semi-volatile compounds, and PCBs, and were also submitted for confirmatory biological testing using a suite of acute and chronic sediment toxicity bioassays. The two samples collected in the vicinity of Upriver Dam (Deposit 1; Figure 2) exhibited sediment toxicity significantly greater than the reference samples.

Zinc, lead, cadmium, phenol, retene, and PCBs were all identified as potential sediment toxicants.

- **Avista's and Kaiser's 2001 Investigation (Exponent and Anchor 2001).** Ten surface samples and three subsurface cores were collected by Avista and Kaiser to further characterize the primary sediment deposit (Deposit 1) identified in Ecology's 1999 and 2000 samplings. This study delineated the horizontal and vertical extent of elevated metal, PCB, and wood waste concentrations in Deposit 1 (Figure 2). Radioisotope cores were also collected during this investigation to further characterize sediment deposition rates and evaluate sediment stability (Appendix H).

All of these prior investigations utilized sampling and analysis methodologies that conformed to RI Project Plans, and the quality of the analytical data obtained was subsequently validated by qualified environmental chemists. Accordingly, data developed from these prior investigations was incorporated into the overall RI database (Table 1).

The sediment sampling locations from these prior investigations are presented in Figure 2 and the analytical results for several indicator hazardous substances (i.e., zinc, PCBs, and TOC) are summarized in Table 1. The majority of these prior data are for surface and subsurface core samples collected within the largest and most fine-grained sediment deposits (cross-hatched area in Figure 2), located immediately upstream of the Upriver Dam apron (Exponent and Anchor 2001). PCB concentrations in this deposit have consistently been significantly higher than sediments collected in other locations (Table 1).

4 PURPOSE AND OBJECTIVES OF THE FOCUSED RI

The purpose of the focused RI was to evaluate the extent of PCBs in sediments at the Site. The RI also evaluated potential effects of sediment contaminants on groundwater and surface water quality, potential effects on drinking water wells, and potential sediment-related risks to aquatic life, wildlife, and human health. In accordance with WAC 173-340-350, the overall approach involves focused sampling efforts followed by data compilation, development, evaluation, and report preparation. The work scope is intended to generate data for further development of the site conceptual model by requiring targeted field sampling. To achieve this objective, the work performed was both focused and phased.

The first phases of work are described below in Sections 4.1 (Bathymetric Survey and Sediment Classification), Section 4.2 (Groundwater PCB Measurements), and Section 4.3 (Spokane River Water Measurements for PCBs). The bathymetric survey and sediment classification results were then used to focus the subsequent sediment sampling effort described in Section 4.4.

4.1 Bathymetric Survey and Sediment Classification

A Single Beam Acoustic Depth Measurement bathymetric survey was conducted between the Upriver Dam structure and RM 81.5, and between RM 83.25 and RM 83.75 to develop a detailed description of the bathymetry in the study area near known PCB-containing sediments behind Upriver Dam (Figure 2). In addition, a concurrent sediment classification survey was conducted in these areas to distinguish hard-bottom substrates (i.e., cobble and gravel) from softer, finer-grained silts that could retain PCBs. The sediment classification survey was performed in the same areas as the bathymetric survey.

4.2 Groundwater PCB Measurements

To evaluate the potential for PCB mass transfer from the riverbed (i.e., existing sediment deposits) to regional groundwater, water samples were collected from representative wells located downgradient of the fine-grained sediment deposit (i.e., Deposit 1, see Figure 2). Three wells were selected for monitoring based upon their proximity to the known PCB deposit behind Upriver Dam (Figure 5).

Consistent with the Ecology-approved RI Sampling and Analysis Plan (Anchor and Hart Crowser 2003), the first groundwater sampling event occurred during spring runoff conditions in 2003. The purpose of this sampling was to assess the potential for PCB mass transfer from the riverbed to groundwater under this higher flow condition (Figure 6). The second sampling event took place in early September 2003 and represented potential groundwater impacts during seasonal low flow conditions.

4.3 Spokane River Water Measurements for PCBs

Two different types of river sample collections were performed during the RI to characterize water column concentrations of PCBs. These included direct measurements of water concentrations via collection and analysis of water samples, and indirect measurement of PCBs in Spokane River waters using SPMDs. These sampling locations are shown on Figure 7. SPMD technology is based on rate-controlled chemical partitioning from the water column to enclosed neutral lipid materials, and can be used to mathematically extrapolate modeled steady-state water concentrations of dissolved organic chemicals such as PCBs (Huckins et al. 1993 and 2002). These procedures are discussed in detail in Section 5 below.

As described in Section 1.3, water column PCB concentration data also may assist Ecology in developing a PCB TMDL for the broader Spokane River. Because the TMDL process will assess the entire river system and Kaiser is a National Pollutant Discharge Elimination System (NPDES) discharger at their Trentwood facility, Kaiser elected to concurrently conduct additional water sampling and analysis upstream and downstream from the Site independently of this investigation. Sampling locations were selected to provide further information about the presence of PCB loadings along a broader geographic extent of the river system. These sampling locations and the associated information are provided in Appendices C and D. Both bulk water samples and SPMDs were collected at these locations.

4.3.1 Direct Measurement of PCBs in Spokane River Waters

The first river water sampling event took place in early September of 2003 and represented typical seasonal low flow conditions. The second event occurred in mid-December 2003 and was designed to coincide with a fall precipitation event (Anchor 2003). However, a significant, local precipitation event did not occur from late November to December. Thus, water samples collected in mid-December are representative of higher seasonal flows associated with regional precipitation, snowmelt, and release of water from Lake Coeur d'Alene, but do not necessarily reflect local event-based runoff inputs. The sampling locations for direct water measurements are identified in Figure 7.

4.3.2 Indirect Measurement of PCBs in Spokane River Waters

Indirect measurements of PCBs in Spokane River waters using SPMDs were also performed during seasonal low-flow conditions in August 2003 and during higher seasonal flows in late November and December 2003. The locations selected were identical to those for the direct water sampling (Figure 7).

SPMDs were deployed at the locations shown on Figure 7 for a period of between 22 and 32 days. The number of deployed days was shorter (22 days) in December due to concerns about the ability to retrieve the sampling devices as the river flows increased in late December.

4.4 Sediment Sampling and Analyses

Sediment sampling locations were selected based upon the sediment classification survey and the bathymetric survey. As discussed in the Consent Decree, the objective of the sediment sampling activities was to investigate other depositional areas (i.e., beyond the largest and most fine-grained of the sediment deposits located immediately upstream of the Upriver Dam apron [Deposit 1]; Figure 8), to determine if sediments in such depositional areas contain concentrations of PCBs that may trigger potential remedial actions. In order to meet or exceed the sampling density already achieved within Deposit 1, surface sediment sample spacing within each of the other potential depositional areas was no greater than approximately 300 to 400 feet, with at least one sample collected in each of the delineated areas. Using this general guideline, a total of 23 additional surface samples (Stations 10 to 15, 20 to 32, and 40 to 42) were designated for sampling, with station locations depicted on Figure 8. As further described below (Section 5.5), a second round of sediment grab sampling was conducted in October 2004 to address data gaps remaining from the 2003 sampling event (Stations 51 to 61; Figure 8).

5 FOCUSED RI ACTIVITIES AND RESULTS

The text and tables below present the results for each of the focused RI activities.

5.1 Bathymetric Survey and Sediment Profiling

In late May 2003, Bluewater Engineering performed a combined bathymetric and sediment texture profiling survey within target depositional areas of the Site (between Upriver Dam [RM 80.0] and RM 81.5 and near Donkey Island [RM 83.25 to 83.75]), following the Ecology-approved Phase 1 – Task 1 SAP/QAPP (Anchor and Hart Crowser 2003). The results of the bathymetric and sediment classification surveys, summarized in this section, were used to determine sediment sampling locations (Section 5.5 and Figure 8).

5.1.1 Bathymetric Survey

The bathymetric survey conformed to U.S. Army Corps of Engineers Single Beam Acoustic Depth Measurement survey requirements (EM 1110-2-1003; USACE 2002). Depths were recorded using an Odom Hydrotrac single-frequency, survey-grade depth sounder, with a transducer operating at 200 kilohertz (kHz). Depths were acquired and stored digitally at 5 to 7 foot intervals, along transects spaced approximately 50 feet apart. Transect surveys were performed along track lines oriented both perpendicular and parallel to the channel. The bathymetric data were managed using Coastal Oceanographics HYPACK MAX survey software version 2.12. Following completion of upland benchmark surveys in June 2003, the depth data were converted to elevation contours, which are shown on Figure 2.

5.1.2 Sediment Classification

Concurrent with the bathymetric survey, a sediment classification survey was conducted to distinguish hard-bottom substrates (e.g., cobble and gravel) from softer, finer-grained silts that could retain PCBs. The sediment classification survey consisted of three interrelated components:

1. An acoustic reflection survey was performed using the Quester Tangent shallow water system (Preston and Collins 2001), with data collected at 50-foot transect intervals (oriented both perpendicular and parallel to the channel), to provide an initial screening and delineation of relatively soft sediments throughout the area between Upriver Dam (RM 80.0) and RM 81.5, and near Donkey Island (RM

83.25 to 83.75). The Quester Tangent sediment classification, based on detailed analysis of acoustic response characteristics of the sediment bed, identified seven discrete acoustic regimes along transect lines. Although the acoustic classification successfully delineated many of the coarser-grained sediment types (e.g., boulders and cobbles), ground truth data (i.e., video surveys and grab sampling, see below) was required to validate the classification in relatively uniform benches of gravel and sand or silt, where the acoustic response was more difficult to interpret. The Quester Tangent Report is Appendix A to this report.

2. A video survey was performed along six track lines oriented parallel to the channel, to provide visual characterization and corresponding video footage documentation of potential fine-grained deposits at the Site. Due to construction activities at the Argonne Street Bridge, the Donkey Island reach was not accessible with the video camera at the time of the survey.
3. Van Veen grab samples were collected at various locations indicated by the bathymetric, Quester Tangent, and video surveys to verify grain size determinations at the Site. Each sediment sample was inspected on board the sampling vessel to provide a definitive visual characterization of sediment grain size. (Ecology analyzed many of these split samples for separate metal screening.)

The sediment classification survey identified a total of four potentially fine-grained sediment deposits within the Site having a continuous dimension in any direction of 50 feet or greater, or a minimum surface area of 250 square feet. These four areas, depicted on Figure 8, are located along inner bends of the Spokane River channel or in off-channel embayments (e.g., near Donkey Island) where sediment deposition may be focused in such a fluvial system.

5.2 Groundwater Well Monitoring

To evaluate the potential for PCB mass transfer from the riverbed to regional groundwater, water samples were collected from representative wells located downgradient of the fine-grained sediment deposit, and compared with upgradient surface water data collected at RM 82.0.

5.2.1 Conceptual Hydrogeologic Model

The Site is located within the Spokane Valley Aquifer, a major regional water supply source. The aquifer is unconfined and composed of coarse-grained glacial outwash deposits. Typical deposits include sand, gravel, and boulders, with minor amounts of silt and clay. Regional groundwater flow is generally to the west, following the river basin.

Groundwater flow directions in the vicinity of Upriver Dam are influenced by water impounded behind the dam. The pool behind the dam has an approximate elevation of 1,910 feet (mean sea level; MSL) while the river elevation below the dam is approximately 1,880 feet MSL. This results in localized surface water exfiltration from the reservoir to the aquifer. Regional groundwater flow patterns resume downstream from the dam, with groundwater flow generally following the river basin. Groundwater elevation data collected by Spokane County from nearby monitoring wells confirms this finding (Stan Miller personal communication 2003). The most complete data sets covering the spring runoff and fall low flow periods were used to develop the groundwater contours shown on Figures 9 and 10.

Figure 9 provides groundwater and surface water elevation measurements and interpreted groundwater elevation contours during a representative spring runoff event occurring on April 30, 1999 (18,700 cfs discharge at Spokane). (Note that the applied contouring is regional in nature and may not reflect localized conditions immediately in the vicinity of the Dam operations and the water supply wells.) The influence of the impoundment is seen, with strong gradients from the impoundment to nearby wells (i.e., 5312C01 and 5311H01) indicating exfiltration from the Upriver Dam impoundment to the aquifer. Much flatter gradients are observed a short distance from the dam (e.g., between wells 5311J07 and 5311H01 on the south side of the dam, and wells 5311D03 and 5311E03 on the north side of the dam) indicating the area of influence of the dam on groundwater flow directions is relatively limited.

Figure 10 provides groundwater and surface water elevation measurements and interpreted groundwater elevation contours during a representative seasonal low flow event on October 26, 2000. Although there are fewer data points available from this time period for contouring groundwater elevations, the data indicate a similar groundwater flow pattern is established during the fall low flow period as occurs during the spring runoff. This is a reasonable conclusion, as the primary control on groundwater flow patterns near the dam is the pool elevation behind the impoundment, which varies little throughout the year, maintaining an elevation of approximately 1,910 feet MSL.

Lower gradients and the regional westward flow with discharge to the river appear to be restored within approximately ½ to 1 mile west of the dam. The presence of visible seepage discharges on both sides of the river within ½ mile of the dam, particularly at locations immediately below the dam and Powerhouse, provides additional evidence of localized return flows.

5.2.2 Well Inventory

A well inventory was performed for the Upriver Dam area to determine the location of domestic or public water supply wells that may be on flow paths from the Upriver Dam impoundment, and to assist in selecting appropriate wells for groundwater quality monitoring in this focused RI. Well logs were obtained from Ecology for the four sections surrounding the dam (R43E, T25N, Sections 1, 2, 11, and 12). The Ecology well logs and locations of monitoring, domestic, industrial, and irrigation water wells are presented in the SAP (Anchor and Hart Crowser 2003).

5.2.3 Sampling Stations

As discussed above, the objective of the groundwater sampling tasks was to evaluate the potential for PCBs detected in fine-grained riverbed deposits present upstream of Upriver Dam (Figures 2 and 5) to be transferred into regional groundwater. Since MTCA defines drinking water use as the reasonable maximum exposure condition for all groundwater in the area, regardless of the location of existing supply wells, sampling stations for this RI were located at positions likely to reflect the potential maximum impact of mass transfer from the Site. Given the conceptual hydrogeologic model outlined above, such wells were located as close as possible to the Upriver Dam area, at locations immediately adjacent to the dam and Powerhouse where dilution and other attenuation processes are minimized.

The City of Spokane has installed more than 40 monitoring wells within the immediate vicinity of the Upriver Dam and Powerhouse to evaluate seepage flows around these structures. Most of the City wells in this area are 1 to 1.5-inch diameter polyvinyl chloride (PVC) piezometers screened in relatively permeable sand and gravel materials near the surface of the water table. Because of their proximity to the fine-grained sediment deposits, this well network includes locations likely to reflect the potential maximum impact of PCB mass transfer from the Site, particularly at the following locations:

- Monitoring well D14, located approximately 100 feet west (downgradient) of the Upriver Dam abutment, immediately north of the Spokane River channel, and within the vicinity of a primary seepage zone visible along this part of the shoreline. As discussed in the SAP, depth to water at this location periodically exceeded the limits of a peristaltic pump required for low-level PCB sampling (see below).
- Monitoring well D16, located on the opposite side of the spillway from D14, approximately 100 feet west (downgradient) of Upriver Dam, and immediately south of the Spokane River channel, and within the vicinity of a primary seepage zone visible along this part of the shoreline.
- The City of Spokane's "Electric Well" (5311G05; Figure 5) was also included in the sampling program.

The selected wells are located immediately north and south of the reservoir, respectively; the approximate locations of these wells are indicated on Figure 5. Due to their proximity to the reservoir and PCB-bearing sediments, these sample locations provided a worst-case indication of PCB migration into groundwater and potentially to downgradient water supply wells.

5.2.4 Sample Analysis and Frequency

Wells were sampled during two representative river flow conditions to evaluate mass transfer potential from the riverbed to the wells. The first sampling event occurred in early May 2003 (for wells D14 and D16) and June 2003 for the Electric Well. The Electric Well could not be sampled in May since it was not in operation at that time. The May/June sampling event represents general spring runoff conditions. For both sampling events, groundwater samples were collected for analysis of PCBs by EPA Method 1668A.

The second sampling event occurred in early September 2003 and represents seasonal low flow conditions. During September a sample was collected from well D-16 and from the Electric Well, but it was not possible to collect a sample at well D-14 on the north side of Upriver Dam. The depth to water (DTW) at this well was over 25 feet and it was not possible to pump water to the surface using a peristaltic pump. The water levels in the surrounding wells were at similar depths: well D-13 DTW was 27 feet, well D-1 DTW was 27 feet, and well D-19 DTW was 24 feet. This is similar to the depth to the impoundment surface from the dam face at this time which was measured at 20 to 25 feet by the Hart Crowser field crew. Based upon this information, and following discussions with Ecology, it was decided that it would not be possible to collect a representative groundwater sample in this area during the low flow (September 2003) period.

5.2.5 Sampling Procedures

Field personnel measured and recorded depth of water to the nearest 0.01 foot noting the date, time, and the reference point from which the measurement was taken. This value, along with the well depth information from the well log, was used to calculate the volume of water within the well casing. In addition, for monitoring wells D14 and D16, the bottom of the well casings were tagged for total depth and well completion information, and elevations were recorded.

After the static water level in the well was recorded, the peristaltic pump and tubing were set up. Protective plastic sheeting was placed around the well to minimize potential for contamination of sampling equipment from soil. Sample tubing was placed in the well within the upper 1 foot of the screened interval. Tubing was placed at such a depth as to avoid the bottom of the screen and associated sediment at the bottom of the well. To minimize the potential for cross contamination of samples, new tubing was used for each well and disposed of after use. Water samples from the City's "Electric Well" (5311G05; Figure 5) were collected directly from the sampling pump at the wellhead.

5.2.6 Well Purging Procedures

As discussed in Section 5.2.4, groundwater samples were collected when water levels were low enough (less than 20 feet below ground surface) to allow for the use of a peristaltic pump. To minimize turbidity, low-flow purging methods were employed using a peristaltic pump system. Typical flow rates range from 0.1 to 0.5 liters per minute (L/min); however, the flow rates utilized to purge the monitoring wells were determined in the field by monitoring the water levels in each well during sampling so that drawdown in the well was minimized. If at any point the purge water became turbid (turbidity measurement greater than 20 NTU) or drawdown exceeded the recommended 4 inches, the purge rate was reduced.

Temperature, pH, specific conductance (SC), and turbidity were measured in the field. Field parameters were considered stabilized after all parameters were unchanged for three consecutive readings. Three consecutive readings were within 0.1 pH units for pH, 10 percent for turbidity, and 3 percent for SC (EPA 2002). Once this was accomplished, the well was sampled.

5.2.7 Groundwater Sampling Procedures

Groundwater samples were collected by filling the lab-provided bottles directly from the pump discharge line (maintaining the same flow rate as purging). In this way, only dedicated materials were used in sampling, and there was no need for equipment decontamination (other than the well sounder). In order to reduce the potential for cross-contamination, "clean hands/dirty hands" sampling procedures were followed.

5.2.8 Groundwater Results

Groundwater results for the May and September samples are presented in Figures 11 and 12. Both summary and raw data for the groundwater results are presented in Appendix B. All results indicate that the total PCBs in groundwater were extremely low (more than 4,000 times below the state and federal drinking water maximum contaminant level [MCL] of 500,000 pg/L), and were in the same total PCBs range as the associated blank results. Average and maximum results were 23 and 70 pg/L, respectively, in the May samples. In September, average and maximum results were 63 and 116 pg/L, respectively. The associated blanks ranged from 10 to 226 pg/L.

5.2.8.1 Laboratory Analyses and Data Quality

The samples collected were analyzed for PCB congeners by EPA Method 1668A at Axys Analytical in Sydney, British Columbia. Results were blank qualified per EPA Region 10 guidance for validation of Method 1668 PCB data (EPA 1995). The following items were noted during data review:

- Sample analyses were completed within method-specified holding times
- Method criteria for instrument performance, initial calibration, calibration verification, and sensitivity were met.
- Recoveries of labeled standards were slightly below method criteria in some cases; however, the associated data are believed to be unaffected as evidenced by acceptable matrix spike recovery.
- Sample results were low and frequently in the same range as the associated blanks for total PCBs. PCB congener results within five times the level for the same congener in an associated blank were qualified as not-detected.

As mentioned above, low levels of some PCB congeners were observed in the trip blanks, laboratory method blanks and equipment blanks (May 5, 2003 rinsate blank and August 28, 2003 tubing proof; Appendix B). The highest levels of PCB congeners in blanks were observed in the rinsate blank and tubing proof; these samples were collected by pumping laboratory PCB-free water through the Teflon/silicone tubing in the same manner as a sample. This indicates that there was some contribution of PCB congeners due to the sample collection procedures used. Di-, tri-, and tetra-chlorinated biphenyls represented the majority of the congeners detected in the rinsate (tubing) blank and were, in many cases, the same congeners found in the pumped samples. For the groundwater whole water samples blank contamination was accounted for by qualifying results according to EPA Region 10 guidance (EPA 1995). These guidelines qualify detected results as "not detected" if the sample result is less than a factor of five higher than the associated blank. All qualifications were performed on a congener-specific basis.

5.2.8.2 Summary of Total PCB Data

Downgradient groundwater total PCB concentrations (range of 9 to 116 pg/L; overall average of 40 pg/L) measured during the focused RI sampling were similar to area background surface water PCB concentrations measured near the dam (see discussion below). Thus the PCB groundwater results are consistent with the site conceptual model, verified by local hydrogeologic data (Figures 9 and 10), of river discharge (exfiltration) to the aquifer in the vicinity of the dam. While PCBs are detectable in groundwater, the concentrations are approximately 3 orders of magnitude below the current drinking water MCL.

5.3 Seasonal Direct PCB Measurement in Surface Water

Water column PCB concentrations at the Site were characterized by direct collection of surface water samples, as well as SPMD deployments. The results of the direct sampling are summarized in this section; SPMD data are presented below in Section 5.4.

5.3.1 Sampling Stations

One sampling station was located within the Powerhouse intake channel (i.e., the Dam Forebay). This station provided downstream water quality data to characterize surface water conditions downstream of the Upriver Dam sediments. Three co-located samples immediately upstream of the Upriver Dam reservoir at RM 82.0 (Boulder Beach; Figure 7) provided water quality data immediately upstream/upgradient of the delineated fine-grained sediments in the Upriver Dam impoundment. The sampling station at Plante's Ferry Park, at the Centennial Trail footbridge (approximately RM 84.6), provided water quality data at the upstream end of the Site, immediately below groundwater inflows (seeps) and point source discharges into this reach of the Spokane River.

5.3.2 Sample Analysis and Frequency

During the summer low flow and fall precipitation event sampling, surface water samples were collected in duplicate from Plante's Ferry (RM 84.6) and the Dam Forebay (RM 79.8) for analysis of PCB congeners by EPA Method 1668A and total suspended solids (TSS) by EPA Method 160.2. One shallow sample and two deep samples were collected at Boulder Beach (RM 82.0; see Figure 7) for PCBs and TSS. In addition, samples from each station were collected for analysis of dissolved organic carbon (DOC) and TOC.

For the summer low flow event, water samples were collected in early September 2003. For the fall precipitation event, water samples were targeted to be collected during or immediately following a rainfall episode (as practicable), in mid-December 2003. However, because a predicted precipitation event did not occur from late November to December, it was not possible to sample a distinct localized precipitation event (Figure 13). Two likely events were targeted, staff mobilized, and the forecast storm failed to occur. The samples collected on December 17, 2003 are therefore representative of higher seasonal flows associated with regional precipitation, snowmelt, and release of water from Lake Coeur d'Alene.

5.3.3 Site Access

Surface water samples were collected from a small boat, which was launched from the boat launch at Upriver Dam. At locations too shallow for boat access, samples were collected by wading.

5.3.4 Surface Water Sampling Procedures – September

The SAP initially envisioned collection of all surface water samples at approximately 1 meter above the mudline with the same general Teflon/silicone tubing and peristaltic pump apparatus used for the groundwater sampling. Because the results of the May groundwater results rinsate/tubing blank sample indicated that the Teflon and silicone tubing was adding low, but measurable, levels of PCB congeners to the groundwater samples (Section 5.2.8.1), alternative procedures were applied in September. It was determined that the best procedure was to collect grab samples (i.e., collect water directly into the sample containers) and to modify the initial sampling regime slightly, as discussed below. The deep grab samples were collected using divers.

5.3.4.1 Surface Sample Collection Procedures

In order to reduce the potential for cross-contamination, modified "clean hands/dirty hands" sampling procedures were followed. The only equipment used was the sample bottle, which was sealed inside two Ziploc bags. After donning new gloves, the sample container was removed from the Ziploc bags, opened, submerged as deeply as possible, and sealed immediately after it was filled. The sample bottle was then placed back into both Ziploc bags and stored on ice. Surface samples at Boulder

Beach and the Dam Forebay were collected by moving the boat slowly upstream and upwind. At Plante's Ferry, samples were collected by wading upstream and submerging the sample bottle while facing upstream.

5.3.4.2 Deep Sample Collection Procedures

Since it is impossible to truly use "clean hands/dirty hands" procedures while diving, these procedures were not used, but the same philosophy was applied. Both divers wore new gloves, identical to those used for collection of surface samples. One diver managed the sample containers, while the other diver collected the samples. Pre-labeled and sealed bottles were taken to the desired depth in a mesh bag. Containers were filled consecutively by opening each container at arms length in front of the diver while swimming slowly upstream at approximately 1 meter above the bottom. By swimming upstream, potential contamination from disturbed sediments and the divers themselves was minimized.

5.3.5 Surface Water Sampling Procedures – December

Due to the higher flows in December 2003 and the danger of diving proximate to a hydroelectric facility, it was deemed unsafe to use divers during this period. Therefore, shallow samples were collected using the same grab samples procedures discussed above (Section 5.3.4.1) and deep samples were collected using the Teflon/silicone tubing system used for the groundwater sampling, recognizing the limitations of this apparatus. The same "clean hands/dirty hands" sampling procedures discussed above were followed.

5.3.6 Surface Water Sampling Results

The PCB results for the water samples are presented in Figures 14, 15, 16, and 17 and additional figures and analytical data are presented in Appendix C. The water results were calculated in two different ways to reflect the range of approaches used by EPA and others to address low-level blank contamination issues: 1) blank corrected (Figures 14 and 15); and 2) blank qualified (Figures 16 and 17). The results designated as "blank corrected" were corrected on a congener-specific basis for the average of the same congener in applicable blanks, whereby the congener-specific average from the associated blanks was subtracted from the sample result. Thus, the average of each congener measured in the laboratory blank, trip blank, and equipment blank was subtracted from that congener in the sample results. Negative values generated were omitted from further calculations (e.g., sums). Results presented as blank qualified results were calculated as per EPA Region 10 guidance for validation of Method 1668 PCB data (EPA 1995). This guidance indicates that congener results that are less than 5 times the maximum value in the relevant blanks should be qualified as "not detected." These results are qualified with a "UB" and are presented in Appendix C. All qualification was performed on a congener-specific basis. PCB data were evaluated using both the "qualified" and "corrected" blank qualifying methods, because of the low-level analytical methods applied, site-specific contaminant fate and transport considerations, and the dual application of whole-water and the SPMD technology. Surface water results from the September 2003 low flow sampling and higher flow December 2003 sampling are discussed below.

5.3.6.1 Laboratory Analyses and Data Quality

The samples collected were analyzed for PCB congeners by EPA Method 1668A at Axys Analytical in Sydney, British Columbia. The following items were noted during data review:

- Sample analyses were completed within method-specified holding times.
- Method criteria for instrument performance, initial calibration, calibration verification, and sensitivity were met.
- Recoveries of labeled standards were slightly below method criteria in some cases; however, the associated data are believed to be unaffected, as evidenced by acceptable matrix spike recovery.
- Sample results were low and frequently in the same range as the associated blanks. PCB congener results within five times the level for the same congener in an associated blank were qualified as not-detected when interpreting data as blank "qualified."

The highest levels of PCB congeners in blanks were observed in the equipment blank (Appendix C; 140 pg/L total PCBs) and the other laboratory and trip blanks range from 9 to 80 pg/L. In this instance, the equipment blank was collected by pumping laboratory water through pre-cleaned Teflon-lined tubing and into a sample container in approximately the same manner as the December pumped samples were collected. This indicates that there is some contribution of PCB congeners due to the sample collection procedures used (i.e., likely from the tubing). Assuming that the PCB congeners measured in the blanks were added to the samples, this was accounted for by qualifying these results according to EPA Region 10 guidance (EPA 1995). Because of the increased uncertainty associated with the pumped samples, due to the contamination caused by the tubing, these results are not discussed or presented in the text, but are presented in Appendix C.

5.3.6.2 Summary of Total PCB Data

For discussion purposes, the following summary primarily presents results based on blank "qualified" results. The validated surface water sampling data (i.e., EPA qualified results) indicate compliance throughout the Upriver Dam Site with the proposed MTCA Method B surface water screening level of 170 pg/L, but above the screening level of 64 pg/L (Figures 16 and 17). Blank "corrected" results indicate that in some instances total PCBs were above both screening levels (Figure 14 and 15, and Appendix C). The 170 pg/L screening level is based on the promulgated Chapter 173-201A WAC surface water quality standard for combined aquatic life, wildlife, drinking water, and bioaccumulation protection, and is thus protective of a wide range of surface water beneficial uses. Under MTCA, the National Recommended Water Quality Criterion for PCBs of 64 pg/L also is to be applied (EPA-822-R-02-047). A narrative discussion of the nature and extent of water column total PCB concentrations at the Site, which ranged from 14 to roughly 120 pg/L using blank qualified results is provided below.

In September 2003, the highest validated and blank qualified total PCB concentration (approximately 120 pg/L) was detected in the surface water sample collected from Boulder Beach (Station AN-02S), located upstream of Deposit 1 (Figure 7). The surface water sample collected further downstream in the Upriver Dam Forebay (Station AN-03S) also contained a similar total PCB concentration (approximately 110 pg/L). Conversely, water samples collected at and above the upstream Site boundary at Plante's Ferry (Station AN-01) and Barker Road, respectively, both contained lower total PCB concentrations (14 to 17 pg/L; Figure 16). Most of the apparent increase in total PCB concentrations between Stations AN-01 and AN-02 (i.e., between Plante's Ferry and Boulder Beach, and upstream of any fine-grained sediment deposits) was attributable to a single dichlorobiphenyl congener (PCB-11). In addition, increases in bottom water concentrations of certain PCB homologue groups (e.g., tetrachlorobiphenyls) near the Dam Forebay were potentially attributable to sediment-associated releases from deposits near the dam (primarily between RM 80.1 and 80.6), though uncertainties associated with low-level PCB analyses and the degree of water column stratification and mixing in this area precluded more definitive source and mass balance analyses.

In December 2003, all validated and blank qualified PCB results were relatively low, compared with those during the September 2003 sampling (Figures 16 and 17). Total PCB concentrations in surface water samples collected during December ranged from 15 to 29 pg/L and there were no noticeable trends in the data. The highest measured concentration was observed at Plante's Ferry (29 pg/L), but the measured concentrations covered a narrow range and were generally in the same range as the associated blanks.

Based on the available data, the apparent increase in total PCB concentrations observed during September 2003 between Stations AN-01 and AN-02 is indicative of surface water releases of predominantly PCB-11 to the river system between Plante's Ferry and Boulder Beach. Increases in surface water PCB concentrations in the site area, relative to more upstream sampling locations, were attributable at least in part to specific congeners (especially PCB 11) apparently from treated wastewater discharged from the Inland Empire Paper Company outfall. A rough mass balance comparing PCB-11 measured at Boulder Beach during the September 2003 sampling event (79 pg/L) to measurements of Inland Empire's effluent indicates that between 45 and 76 percent of the PCB-11 measured in the river could be accounted for based upon the mass discharged in Inland Empire's effluent. (The mass balance was based on the following assumptions: 493 cfs flow at Upriver Dam; a 3-foot surface stratification layer (Appendix C.5); 4.3 million gallons per day discharge from Inland Empire; and 393 to 670 pg/L PCB-11 measured in Inland Empire effluent during

Ecology's 2002 Survey and 2004 TMDL sampling.) A mass balance could not be calculated for the December 2003 event because PCB-11 was not measurable.

As discussed above, the apparent increase in certain PCB homologue groups in deep water samples collected between Boulder Beach and the Dam Forebay may potentially be a result of a release of PCBs from Deposit 1. However, uncertainties associated with low-level PCB analyses and the degree of water column stratification and mixing in this area precluded more definitive source and mass balance analyses.

5.4 Seasonal Indirect PCB Measurements in Water

To further characterize the nature and extent of dissolved PCBs in the Spokane River, particularly in bottom waters closest to sediment deposits, passive in situ SPMD measurements were performed during the 2003 summer low flow period and also during a fall 2003 regional runoff event. As discussed in the SAP (Anchor and Hart Crowser 2003), SPMD technology is based on rate-controlled chemical partitioning from the water column to enclosed neutral lipid materials, and can be used to mathematically extrapolate steady-state water concentrations of dissolved organic chemicals such as PCBs (Huckins et al. 1993 and 2002). This approach has the benefit of obtaining time-averaged results over several days, versus instantaneous samples gathered by the whole-water grab methods. However, because of the extrapolations required, SPMD-based estimates of dissolved PCB concentrations were expected to only provide qualitative or semi-quantitative data for the purpose of this RI.

A standard "commercial" SPMD configuration consisting of a thin film of triolein (approximately 95 percent pure) sealed in a low-density polyethylene layflat tube (70 to 90 μm wall thickness) manufactured without additives was used. The standard SPMD contains 1 milliliter of triolein, has dimensions of 2.5 cm wide by 91 cm long, with a membrane surface area of approximately 450 cm^2. The SPMDs are heat-sealed at each end, and protected within a galvanized steel cage.

As discussed in Huckins et al. (2002), a number of different environmental factors control uptake of PCBs within a SPMD, including the congener-specific SPMD sampling rate (liters of water extracted per day), the SPMD capacity for the specific congener, the average water concentration during deployment, exposure conditions (primarily temperature, flow velocity, turbulence, and biofouling), and deployment duration. Of the environmental conditions affecting sampling rates, flow velocity and turbulence appear to have the greatest impact. Turbulence-induced changes in the SPMD sampling rates of chemicals such as PCBs with diffusion layer control can be as high as tenfold. For this reason, Huckins et al. (2002) recommend that the flow regime of deployment stations be as similar as possible to facilitate inter-station comparisons. Permeability/performance reference compounds (PRCs) are also recommended to improve comparability between stations, as discussed below.

For PCBs, extended exposure periods (greater than 30 days) will typically result in a greater mass of PCB congeners sequestered, but increased biofouling may gradually reduce the daily amount of residues sequestered. As discussed in Huckins et al. (2002), fouling impedance is generally insignificant for the first two weeks of an exposure but becomes increasingly important during extended deployments. For these reasons, and also to ensure that sampling rates for the lesser chlorinated PCB congeners (e.g., di- and trichlorobiphenyls) remain in the linear range, an SPMD deployment duration of 30 days is typically recommended.

The SPMDs were provided by Environmental Sampling Technologies (St. Joseph, Missouri). The triolein included appropriate PRCs, that were used to correct sampling rates affected by turbulence and/or biofouling. A PRC is an analytically non-interfering compound added to the SPMD lipid before field deployment. Measured values of PRC loss rates can be used to account for differences in sampling rates between different locations, and to improve the accuracy of SPMD-based estimates. This approach to in situ SPMD calibration is based on the principle that the rate of residue loss is proportional to the rate of uptake. Thus, PRC loss rate data can be used to adjust SPMD-derived estimates of ambient concentrations to reflect site-specific environmental conditions of an exposure. However, this assumes that the compound used as a PRC has a similar partitioning rate as the compounds of interest. As discussed in Huckins et al. (2002) and as further described below, using the PRC method, SPMD-based estimates of ambient water concentrations can obtain an accuracy within approximately twofold.

5.4.1 Sampling Stations

SPMDs were deployed at the three focused RI surface water sampling stations identified in Figure 7, and also, independently, at additional regional reference locations shown in Appendix D. The regional results are not discussed in the text, but results are presented in Appendix D. At each station, the SPMDs were deployed no more than 1 meter above the sediment bed. Because the Plante's Ferry Park area (Station AN-LP-01) is subject to relatively high recreational use, SPMD deployments at this station could have been at risk of vandalism or removal, particularly during the summer low flow period. To protect against this possibility, a second set of upstream "backup" SPMDs was deployed near the Trent Road Bridge. The backup SPMDs proved to be unnecessary since no vandalism occurred.

5.4.2 Sample Analysis and Frequency

PRC-spiked SPMDs were deployed in duplicate at each of the three sampling stations during the summer low flow and fall precipitation sampling intervals. For the summer low flow interval, SPMDs were deployed on August 1 and retrieved on September 2, 2003. For the fall precipitation interval, SPMDs were deployed on November 25 and retrieved on December 17, 2003. The fall SPMDs were retrieved after 22 days because of concerns that increasing river levels might prevent retrieval if they remained deployed.

The SPMD lipids were analyzed for PCB congeners and the PCB PRC (carbon-13 labeled PCB congener 8) by EPA Method 1668A. However, because of analytical (e.g., co-elution) and/or availability issues, Axys Analytical determined that it was not possible to use the three additional PCB PRCs (PCB congeners 21, 53, and 153) listed in the Phase 1, Task 1 SAP (Anchor and Hart Crowser 2003). Thus, in order to maintain data quality objectives set forth in the SAP, three deuterated PAHs (fluorene, anthracene, and pyrene) were substituted as PRCs for this effort, and were analyzed by EPA Method 8270.

5.4.3 Site Access

SPMDs were deployed and retrieved using snorkel or diving equipment, or by wading, as appropriate for each location.

5.4.4 SPMD Deployment and Retrieval Procedures

The SPMDs were deployed at each of the three stations identified in Figure 7 (i.e., Plante's Ferry, Boulder Beach, and in the Dam Forebay). The SPMDs at Boulder Beach and in the Dam Forebay were deployed using floats and weights to keep them suspended approximately 1 meter from the sediment.

Upon retrieval, the SPMDs were placed in pre-cleaned containers, and transported on ice in a cooler to the laboratory. SPMD samples were then held frozen (-20°C) until extraction.

5.4.5 SPMD Calculations

The basic theory of SPMD sampling is described in Huckins et al. publications (1993 and 2002). SPMD results can be used to qualitatively (and potentially semi-quantitatively) estimate dissolved PCB concentrations over the period of deployment (Huckins et al. 2002). This can be done by using two sets of interrelated calculations: 1) using an empirical model based upon published uptake rates for each chemical; and 2) adjusting the empirical model using exposure adjustment factors (EAFs) based upon measured depuration of chemicals (i.e., PRCs) spiked into the SPMD prior to deployment.

As discussed above, several different PRCs were spiked into the SPMDs, and the results were incorporated into the estimation model. However, because the model developed using the PCB PRC resulted in predicted water column concentrations that were in relatively poor agreement with the direct analyses of water samples (Section 5.3), an average of the three PAH PRCs was used for these calculations. In addition, it was confirmed with Jim Huckins (personal communication) that PCB-8, for currently unknown reasons, has not performed well as a PRC in other similar deployments. This information was not known when the focused RI sampling effort was planned.

Average dissolved water concentrations of PCBs during the period of SPMD deployment (C_{wd}) were estimated using the following semi-quantitative correlation model (Huckins et al. 2002):

$$C_{wd} = (C_{spmd} / M_s) / ((R_s / M_s) * EAF * t)$$

where:

C_{spmd} = PCB concentration in SPMD at the end of the deployment period

R_s = SPMD sampling rate (from API 2002; largely empirically-based)

M_s = mass of SPMD (layflat tube and triolein)

EAF = site-specific exposure adjustment factor

t = deployment duration

Equations from API publication #4690 (Huckins et al. 2002) were used to calculate EAFs for each SPMD deployment location. The EAF provides an estimate of the observed sampling efficiency relative to the sampling efficiency, under calibration conditions based upon the recovery of the PAH PRCs. Additional details of the semi-quantitative SPMD calculation procedures are provided in Appendix D.

5.4.6 SPMD Results

Semi-quantitative dissolved PCB concentration estimates derived from the August SPMD deployments and correlation models are presented in Figures 18, 19, 20 and 21. The original analytical data and estimation models applied for this focused RI are presented in Appendix D. The SPMD-based estimates of dissolved water column PCB concentrations over the period of deployment are presented in a similar fashion to the direct water sampling results (i.e., both blank corrected and blank qualified). Figures 18 and Figure 19 present blank corrected results for the August and December 2003 sampling events. Figures 20 and 21 present EPA-qualified results for August and December. The following items were noted following modeling and evaluation of the SPMD results:

- Modeling results, utilizing PRCs with known laboratory-determined sampling rates (Rs), are consistent with modeling efforts performed on other PCB-contaminated river systems.
- The SPMD model using blank corrected data and EAF provides the most accurate estimate of PCB concentrations across all the sample sites included in this study.

5.4.6.1 Laboratory Analyses and Data Quality

The SPMD extracts were analyzed for PCB congeners by EPA Method 1668A and for deuterated PAHs by EPA Method 8270 at Axys Analytical in Sydney, British Columbia. Results were both blank qualified per EPA Region 10 guidance for validation of Method 1668 PCB data (EPA 1995) and blank corrected on a congener-specific basis. The following items were noted during data review:

- Sample analyses were completed within method-specified holding times.
- Method criteria for instrument performance, initial calibration, calibration verification, and sensitivity were met.
- Recoveries of labeled standards were slightly below method criteria in some cases; however, the associated data are believed to be unaffected as evidenced by acceptable matrix spike recovery.
- Sample results were low and frequently in the same range as the associated SPMD blanks (trip blank and day zero SPMD).

As mentioned above, low levels of PCB congeners were observed in the associated SPMD blanks in both the August and December 2003 samplings. The two SPMD blanks analyzed were the trip blank SPMD and the “day zero” SPMD sample, which is essentially a laboratory blank SPMD that is prepared, extracted, and analyzed along with the other SPMDs, but is not shipped to the field. This indicates that there may be some contribution of PCB congeners due to the sample collection procedures used. Assuming that the PCB congeners measured in the blanks were added to the samples, this was accounted for by qualifying these results according to EPA Region 10 guidance (EPA 1995).

5.4.6.2 Comparison of SPMD Estimates with Direct Water Sample Data

A comparison of SPMD-based semi-quantitative dissolved PCB concentration estimates with corresponding total PCB concentrations from direct water sampling at the same stations and over the same time frame are presented in Figures 22 to 25. Both blank qualified results (Figures 22 and 23) and blank corrected (Figures 24 and 25) results are presented for all sampling events. Figure 22 presents blank qualified results for August to early September; whereas blank corrected results are presented in Figure 24. These results suggest that between 20 and 60 pg/L of PCBs are entering the site at Plante's Ferry. In addition, about 70-80 percent of the congeners present are tri- and tetrachlorinated PCBs (see Figures 14 to 21). As discussed in Section 5.3.6.2, apparent increases in water column total PCB concentrations under low-flow conditions (September-August 2003) as the Spokane River flows through the Site area appears to be attributable to a combination of local treated wastewater releases of PCB-11 between Plante's Ferry and Boulder Beach and apparent sediment-related increases in other PCB homologue concentrations from Boulder Beach to the Dam Forebay. The SPMD data further suggest that such PCB concentration increases from Boulder Beach to the Dam Forebay occurs predominantly in the dissolved fraction, which comprises most of the total PCBs discharged through the Dam Forebay (Figures 22 and 24). There were no discernable spatial differences in PCB concentrations measured during the December sampling (Figures 23 and 25).

The SPMD data corroborate that concentrations of both dissolved and total PCBs at the Site based on blank qualified results were below the 170 pg/L water quality standard but above the National Recommended Criteria of 64 pg/L under the seasonal low flow conditions sampled (Figure 22). The SPMD also corroborated a number of other PCB fate and transport characteristics at the Site, including:

- A common shift in predominant dissolved PCB congener homologue groups or individual congeners between AN-02 (Boulder Beach) and AN-03 (Upriver Dam).
- An apparent increase in dissolved PCB concentrations at depth below Boulder Beach, likely due to a combination of wastewater sources and potential sediment releases. However, uncertainties associated with the SPMD analyses and the degree of water column stratification and mixing in this area precluded more definitive source and mass balance analyses.

The SPMD data, along with the low concentrations of total suspended solids in Site surface water (all results were not detected [less than 5 mg/L]), also support equilibrium partitioning model-based predictions that PCBs present in surface water at the Site are predominantly in the dissolved form.

5.5 Sediment Sampling and Results

As discussed in the Consent Decree, the objective of the focused sediment sampling activities was to investigate other depositional areas (i.e., beyond the largest and most fine-grained of the sediment Deposit 1 previously delineated by Exponent and Anchor [2001] immediately upstream of the Upriver Dam apron; see Figure 8), to determine if surface sediments in such depositional areas contain concentrations of PCBs that may trigger remedial action. During the first round of sampling, a total of 23 additional surface samples were designated for sampling, with station locations depicted on Figure 8.

- Three surface sediment sampling stations located within the roughly 1-acre depositional area on the south bank near RM 80.8 (Stations 10 through 12)
- One station located within the roughly ½-acre area off the north bank at RM 81.3 (Station 13)
- Five surface samples south of the previously defined fine-grained sediment deposit (Stations 20-24)
- Two surface samples immediately upstream of the previously defined fine-grained sediment deposit (Stations 25 and 26)
- Three additional samples further downstream of the possible fine-grained deposit on the south bank (Station 27-29)
- Three zones of interest upstream of the possible fine-grained deposit on the south bank (Stations (30-32)
- Two stations located within the roughly ½-acre Donkey Island embayment (RM 83.4; Stations 14 and 15)
- Three surface samples in the flood channels near Donkey Island (Stations 40-42).
- One surface grab in the known PCB deposit at Station BWE-9 for PCB congener analysis

In addition to the 23 surface (0 to 10 cm) sediment samples, subsurface sediment samples were designated for collection from nine of these locations to delineate the vertical extent of PCB concentrations to a maximum thickness of 100 cm (3 feet). Core locations are depicted on Figure 8, and include one core at RM 80.8 (Station 11) and another at RM 83.4 (Donkey Island; Station 14). Cores were also designated for collection at Stations 21, 23, 29, 30, 31, 32 and 42.

To fill data gaps identified from the first round of sampling, a second sampling effort was conducted in October 2004. This sampling effort focused on two areas:

- The area near BWE-10 was previously identified as a potential fine-grained deposit, but was not confirmed as a location with elevated PCB concentrations (above 60 μg/kg dw) during the first round of focused RI sampling. Nevertheless, Ecology's split sample of surface sediment collected during the sediment classification survey at Station BWE-10 contained apparently elevated levels of PCBs (440 μg/kg dw). Supplemental sediment sampling at four stations clustered in the BWE-10 area (Stations 51 to 54) was designed to provide a more definitive characterization of this area.
- The Donkey Island side channel area was previously identified as a fine-grained deposit with elevated PCB concentrations (above 60 μg/kg dw). Supplemental sediment sampling at seven stations clustered in this area (Stations 55-61) was designed to provide a more detailed delineation of this area of potential concern.

5.5.1 Station Positioning and Location Control

Station positioning was determined by differential global positioning system (DGPS). The accuracy of measured and recorded horizontal coordinates were within 1 meter and electrical interference near the Upriver Dam did not interfere with DGPS positioning during this event. This is likely due to the low flow and low hydroelectric generation during this time. Vertical elevation of each sediment sampling station was measured using a fathometer.

5.5.2 Field Documentation

Field procedures, sample information, and custody records were maintained in a variety of log sheets and forms. Procedures used to document station locations, sample collection, and sample custody are described in the Task 1, Phase 2 SAP (Anchor and Hart Crowser 2003).

5.5.3 Equipment Decontamination

The van Veen grab sampler, diver grab sampler, piston head of the piston corer, and polycarbonate core tubes were decontaminated prior to sampling at each location. Decontamination of this equipment consisted of scrubbing and rinsing the equipment down with site water, followed by a non-phosphate detergent wash (consisting of a diluted mixture of Alconox and tap water), and site water rinse. Care was taken during sampling to avoid contact of the clean sampling equipment with potentially contaminated surfaces.

5.5.4 Surface Sediment Sampling

Surface sediment samples (0 to 10 cm below the mudline) were collected using a stainless steel van Veen or similar grab sampler in accordance with standard methods described in EPA (1986 as updated in 1989, 1991, 1995, and 1997). In many instances, it was not possible to collect grab samples using the van Veen grab sampler due to the large grain sizes (gravel, cobble, and woody debris) present. In this event, divers using a stainless steel diver-grab sampling device collected surface samples at these locations. The details of the sampling procedures applied at each station are found in Appendix E, Table 1. All of the samples collected in October 2004 (Stations 51 to 61) were collected using a diver-grab sampling device. The samples near Donkey Island did not require diving, but were collected using this device while wading.

Upon retrieval, material collected in the grab sampler was evaluated for acceptability according to the SAP. After a sediment grab was accepted, the overlying water was siphoned off and the upper 10 cm of sediment collected in accordance with EPA (1986 as updated in 1989, 1991, 1995, and 1997) guidelines. Sediment touching the sides of the grab sampler was not collected. Subsamples of the homogenized sediment were transferred to pre-cleaned glass containers with Teflon-lined lids and immediately placed on ice in a cooler.

5.5.5 Surface Sediment Sample Analysis

All surface sediment samples collected were analyzed for PCB Aroclors using EPA Method 8082, TOC, and grain size. (Note: The Consent Decree specifies PCB analysis using EPA Method 8080, but EPA Method 8082 has replaced this procedure.) At stations 10-15, 25, 30, 40, 41, and BWE-9, sediments were also analyzed for total petroleum hydrocarbons (TPH) and semi-volatile organic compounds (SVOCs). At least one sample from each location was frozen at -20°C and archived for potential future analyses. Based upon the Aroclor and grain size results, surface samples from stations

10, 15, 25, 40, and BWE-9 were selected for PCB congener analysis. These analyses were designated in consultation with Ecology.

5.5.6 Subsurface Sediment Sampling Procedures

Subsurface sediment samples were collected using a piston coring device fitted with 2.87-inch inner diameter polycarbonate tubing. The sampling procedures used are described in more detail in the SAP. However, it was not possible to collect core samples at many of the designated stations because the coarse substrates present (i.e., gravels or sands) could not be retained in the piston core device. Of the nine locations designated for core collection, it was only possible to collect core samples at Stations 11 and 40. However, because of the coarse-grained nature of these sediments and thus their limited potential to retain sediment contaminants, core refusal at these locations does not represent a data gap for the purpose of the RI. Further details on sediment core collection are presented in Appendix E, Table 2.

5.5.7 Subsurface Sediment Sample Analysis

All core segments collected were analyzed for PCB Aroclors using EPA Method 8082, TOC, and grain size. The 20 to 30 cm and 40 to 51.5 cm intervals from station AN-11 were analyzed for TPH and SVOCs, and the 40 to 51.5 cm interval from station AN-11 was also analyzed for PCB congeners. These analyses were designated in consultation with Ecology. Archive samples from all sediment core intervals collected from each location were frozen at -20°C and archived for potential future analyses.

5.5.8 Sediment Analytical Results

All sediment analytical results are presented in Tables 2 to 4. Results for PCB congeners are presented in Appendix H and corroborate the Aroclor results presented in Tables 2 and 3 (i.e., there was no significant difference in total PCB concentrations between the congener and the Aroclor results). Total PCB concentrations outside of the primary fine-grained Deposit 1 and the Donkey Island side channel area (denoted Deposit 2) were relatively low (at or below 33 μg/kg dw). The single surface sediment sample collected during this focused RI investigation from the primary fine-grained deposit (Station BWE-9; located immediately upstream of the Upriver Dam apron; Figure 8) contained a total PCB concentration of 260 μg/kg dw, within the general range of values collected previously in this area (Table 2). Results for the surface samples collected around Donkey Island, particularly within back-channel areas, were more variable, ranging from at or below 50 μg/kg dw at Stations AN-14, 15, 42, 55, 56, 57, 58, 59, 60, and 61, to 79 μg/kg at AN-41, to 330 μg/kg dw at Station AN-40.

Sediment quality data collected during the focused RI corroborated earlier site characterization efforts (e.g., as described in Exponent and Anchor 2001) suggesting that elevated sediment PCB concentrations are primarily confined to Deposit 1, previously delineated immediately above Upriver Dam (Figure 8). A relatively small sediment deposit in a back-channel area near Donkey Island (Deposit 2) also contained locally elevated PCB concentrations. Results for all other analyses (TPH, SVOCs) were also generally low (Table 2) in areas outside Deposit 1. Consistent with the results of EPA's (2001b) RI/FS, elevated sediment metal concentrations were present throughout a relatively large area of the Upriver Dam impoundment (Table 4).

5.5.9 Results from Ecology's Split Samples

Ecology collected split samples during two sampling efforts conducted as part of this RI. During the sediment classification survey (Section 5.1.2), samples collected were analyzed for PCBs. These locations are designated BWE-1 to 20 on Figure 2; results are presented in Appendix E, Table 3. Three of these samples (BWE-1, BWE-6, and BWE-7) were collected from Deposit 1 and, as expected, contained elevated levels of PCBs. Ecology's split sample collected at BWE-10 also contained elevated PCB concentrations (460 μg/kg dw). However, as discussed in Section 5.5.8, focused RI samples collected at Stations 10, 11, 12, 51, 52, 53, and 54 in this immediate area did not corroborate the presence of elevated PCB concentrations at this location (see Figure 8 for station locations). Because subsequent focused RI sampling Stations 51 to 54 were positioned at BWE-10 (Station 53) and immediately adjacent to this location (Stations 51, 52, and 54) and contained low levels of PCB (i.e., less than 50 μg/kg dw), the original split sample result at location BWE-10 was identified as anomalous.

The split-samples provided to Ecology from the September RI sediment sampling event were analyzed for metals. The metals results are presented in Appendix E, Table 4. As expected, metals were elevated in most samples.

6 CHEMICALS OF POTENTIAL CONCERN

The purpose of this discussion is to present a summary of identified COPCs within Upriver Dam sediments in delineated Deposits 1 and 2, based on the site characterization data collected to date at the Site. As discussed in Section 2, a considerable amount of prior data are available for the Site; validated chemical determinations have been included in the RI database.

Consistent with the cleanup standard approach described in the Sediment Management Standards (SMS; Chapter 173-204 WAC; promulgated to date only for marine sediments), freshwater sediment screening levels used for COPC identification were based on the lowest apparent effects thresholds (LAETs), as updated in Ecology's Draft Freshwater Sediment Quality Value Document (Michelson 2003). The screening levels are presented in Table 5, and include sediment criteria for a wide range of metal and organic chemicals. For comparison, the second-lowest draft LAET, as well as the example sediment quality standard and cleanup screening level values using a floating percentile approach, are also listed in Table 5.

Based on the cumulative RI data collected at the Site, an initial identification of COPCs in Upriver Dam sediment Deposits 1 and 2 is summarized below:

- PCBs:
  - Total PCBs (Aroclor basis)
- Metals:
  - Cadmium
  - Lead
  - Zinc
- Wood Waste and Degradation Products:
  - TOC
  - Retene

Consistent with the requirements of the Consent Decree, subsequent sections of this focused RI are directed towards PCBs. However, in the context of developing appropriate cleanup levels and response actions that address PCBs in this setting, it is also important to consider the potential risks and cleanup remedies applicable to the other co-occurring hazardous substances. These considerations are evaluated in greater detail in the accompanying FS.

7 CONCEPTUAL SITE MODEL

Based upon the site characterization data available for the Site, a conceptual site model was developed for use in determining appropriate cleanup requirements to address PCBs in water and sediment media. A summary of the site conceptual model and initial cleanup level considerations is provided below.

7.1 Chemical Fate and Transport Considerations

The results of the focused RI sampling summarized above corroborate the findings of earlier investigations at the Site that sediment PCB concentrations exceeding the draft LAET screening level (62 µg/kg dw; Table 5) are limited to a narrow deposit of fine-grained sediment immediately upstream of Upriver Dam (Deposit 1), along with a relatively small backwater deposit near Donkey Island (Deposit 2; Figure 8). These sediment PCB deposits represent less than 4 acres within the 17-acre metal remediation area identified by EPA within the Upriver Dam impoundment.

PCBs are lipophilic, and tend to exhibit a strong affinity for organic carbon. The occurrence of elevated bulk sediment PCB concentrations in the fine-grained sediment deposit is consistent with such fate and transport processes.

As discussed in Section 5.3.6.2, the available site characterization data reveal an increase in surface water total PCB concentrations between Stations AN-01 (Plante’s Ferry) and AN-02 (Boulder Beach), particularly during low flow conditions. This observed increase was attributable at least in part to specific congeners (especially PCB-11) apparently from treated wastewater discharged from the Inland Empire Paper Company outfall. A rough mass balance indicated that between 45 and 76 percent of the PCB-11 measured in surface water at AN-02 could be accounted for by the mass of this congener discharged in Inland Empire's effluent.

Vertical stratification of the water column is typical of the lower reaches of the Upriver Dam reservoir (i.e., between AN-02 and AN-02), particularly during the low flow summer months. The apparent increase in certain PCB homologue groups in deep water samples collected between AN-02 (Boulder Beach) and AN-03 (Upriver Dam Forebay) may potentially be a result of a sediment release of PCBs from Deposit 1. The observed shift in homologue patterns is consistent with homologues observed in Deposit 1, however, uncertainties associated with low-level PCB analyses and the degree of water column stratification and mixing in this area precluded more definitive source and mass balance analyses.

As discussed in Section 5.2.8.2, downgradient groundwater total PCB concentrations measured during the focused RI sampling were similar to area background surface water PCB concentrations measured upstream of fine-grained sediment deposits at Boulder Beach. Based on the hydrogeologic data available for the Site, groundwater near Upriver Dam (i.e., in the piezometers sampled during this focused RI) could reasonably be expected to be influenced by exfiltration of river water from the Upriver Dam pool. The similarity of groundwater PCB concentrations measured in the piezometers with surface water values is consistent with this conceptual site model. By comparison, the City's "Electric Well" creates a prominent radius of influence resulting in the capture of flow lines not limited to river water. Nevertheless, maximum groundwater PCB concentrations in all piezometers and wells sampled were substantially (more than 4,000-fold) lower than drinking water-based groundwater criteria.

Biodegradation of PCBs is a complex process that involves different mechanisms under aerobic and anaerobic conditions, and preferences for different microbes to attack certain PCB homologues (i.e., degree of chlorine substitution) and congeners (i.e., location of chlorine substitution on the biphenyl molecule). Although studies of PCB biodegradation in similar freshwater systems have reported limited evidence for anaerobic dechlorination or aerobic decomposition, PCB degradation processes and half-lives on the order of years to decades have been reported in laboratory and field studies (ATSDR 2000).

The site characterization data available for the Upriver Dam PCB Site include several high-resolution and radioisotope-dated cores collected within Deposit 1 (Figure 24; Hart Crowser 1995, Exponent and Anchor 2001). The coring data was consistent between sampling stations located within the deposit, and defined a pronounced vertical profile of PCB concentrations within the sediments (Figure 25). Sediment total PCB concentrations peaked at depths approximately 20 cm (8 inches) below the sediment surface, and decreased steadily in shallower intervals (Hart Crowser 1995; Exponent and Anchor 2001). This vertical profile of PCB concentrations is typical for many aquatic sites in the United States. Following the restriction and eventual ban on the manufacture and use of PCBs in 1970s, PCB levels in surface water discharges decreased. As a result, sediments containing elevated PCBs have been overlain and buried with cleaner sediments (ATSDR 2000). The RI data indicate that this process, referred to as natural recovery, is occurring in sediments located behind Upriver Dam, with net sedimentation rates measured in this area of approximately 0.4 to 1.0 cm/year (Hart Crowser 1995, Exponent and Anchor 2001). Moreover, the pronounced stratification/layering apparent in PCB concentrations and the radioisotope record suggests that such subsurface sediments have been generally stable over time, with no indication of substantial, deep, widespread periodic scouring and remobilization.

Recent suspended particulate measurements performed within the Upriver Dam area reveal that sediment input concentrations of PCBs to the study area are now well below draft LAET screening criteria. Present-day sediment PCB inputs to the Site were characterized by Ecology as part of TMDL sampling activities, and included total PCB analyses of suspended particulate matter (SPM) collected in 2003 near Plante's Ferry (roughly RM 85). Total PCB concentrations of approximately 9 μg/kg dw were measured in SPM at this location (J. Roland, personal communication 2004). Similarly low sediment input concentrations (i.e., in surface sediment "fluff" materials) were also reported by Hart Crowser (1995). These data provide additional corroborating evidence of the effectiveness of prior source controls implemented within the basin, which have resulted in natural recovery of in-place sediments. Based on these data, natural recovery processes are ongoing.

Certain wood waste degradation products such as retene were also detected in sediment samples collected within Deposit 1. These results are consistent with the historical release of wood fibers. Although metals were detected in surface samples collected outside the boundary of Deposit 1, metal concentrations were higher in samples collected within the fine-grained deposit. Analysis of core data presented in earlier reports (Exponent and Anchor 2001) indicates that elevated metal concentrations are present throughout the coring depth. These data suggest a more continuous input over time of metals to the area, compared to the more pronounced stratification observed for PCBs. However, variability in the metal core profiles precludes a more detailed analysis and reconstruction of prior metal source control efforts in the basin. Future upstream source control actions are being planned by EPA as a component of federal Superfund remedial actions in the basin, which may be implemented over the next 20 years. Such controls, if implemented, would eventually affect reductions in metal input concentrations to the Site area.

7.2 Cleanup and Screening Level Methodology

This section presents the methodology used to develop proposed cleanup levels for sediment and screening levels for surface water at the Site for the purpose of the RI/FS. Screening and proposed cleanup levels were developed using MTCA Method B equations or applicable state and federal laws (applicable or relevant and appropriate requirements [ARARs]), also accounting for potential cross-media transport.

The MTCA Cleanup Regulations establish procedures to develop screening levels for surface water and other media. MTCA Method B procedures employ a risk-based evaluation of potential human health and environmental exposures to site COPCs. The development of sediment cleanup levels under MTCA is established in WAC 173-340-760 through reference to the SMS (Chapter 173-204 WAC).

As defined in the MTCA regulation, Method B cleanup levels must be at least as stringent as applicable state or federal standards or other laws (ARARs) developed for human health and environmental protection. Potential ARARs considered in the development of cleanup levels for PCBs include the federal Clean Water Act (including the National Toxics Rule and National Pollutant Discharge Elimination System requirements), the federal Safe Drinking Water Act (including Drinking Water Standards and Health Advisories), and the state Water Pollution Control Act (including Surface Water Quality Standards).

The MTCA Method B cleanup level for one media must also be protective of the beneficial uses of other affected media. For example, since existing Site sediments could potentially release PCBs to overlying surface water, site-specific sediment cleanup levels may need to consider surface water protection requirements. The procedures for developing screening levels for Site surface water are outlined in the MTCA cleanup regulation WAC 173-340-730. Included in this section are the specific rules for evaluating cross-media protectiveness.

Baseline risk evaluations to develop potential surface water screening levels were performed using standard MTCA Method B risk equations. Method B default assumptions for unrestricted site uses (e.g., removal of fish advisories) were used in the equations, as follows:

- For surface water, the risk evaluation was based on protection of human health from consumption of fish/shellfish potentially in contact with surface water (e.g., fisheries resources present within the Upriver Dam area), conservatively assuming that a sufficiently large population of such organisms may potentially be available on-site to support such a harvest (MTCA Equations 730-1 [noncarcinogens] and 730-2 [carcinogens]).
- Potential drinking water uses of surface water were also addressed based on protection of human health from drinking water consumption, conservatively assuming withdrawal from hypothetical surface water intakes or nearshore water supply wells (Equations 720-1 [noncarcinogens] and 720-2 [carcinogens]).

For non-carcinogenic chemicals, proposed cleanup levels were developed to be at least as stringent as all ARARs, and to achieve a hazard index of 1. For known or suspected carcinogens, if ARARs are available (as is the case for PCBs), the cleanup level is adjusted downward as necessary to achieve the MTCA-required 1×10^{-5} excess cancer risk. If an ARAR is not available, the cleanup level for an individual carcinogen is established to achieve an excess cancer risk of 1×10^{-6}.

7.3 Surface Water Screening Levels

As discussed above, ARARs for PCBs in surface water include Chapter 173-201A WAC requirements, as well as federal Clean Water Act aquatic life and human health criteria, National Toxics Rule aquatic life and human health criteria (40 CFR 131.36), federal Drinking Water Standards and Health Advisories, and the State Primary Drinking Water Regulations (Chapter 246-290 WAC). Human health risk calculations for reasonable maximum surface water exposures (including bioaccumulation and drinking water pathways) were performed using the standard MTCA Method B risk equations described above.

Consistent with the summary provided in Ecology's current Cleanup Level and Risk Calculation (CLARC) tables, version 3.1, the proposed Method B surface water screening level for PCBs is based on the Chapter 173-201A and National Toxics Rule ARAR for human health protection of 170 pg/L. MTCA also includes the use of a second surface water quality value, the EPA recommended PCB criterion of 64 pg/L (EPA-822-R-02-047). Also note that the ambient water quality standard for the protection of aquatic life from chronic PCB exposure (14,000 pg/L), as well as the drinking water maximum contaminant level (500,000 pg/L), are both considerably less stringent than the bioaccumulation-based Method B cleanup level.

The proposed 170 pg/L Method B surface water screening level for PCBs was used as a point of comparison with water column concentration measurements performed during the focused RI. Significantly, all validated RI sampling data collected within the Upriver Dam PCB Site, even during low flow in the river during summer 2003, indicated surface water PCB concentrations may be below the Method B screening level (Figures 14 to 21). Sediment cleanup actions could potentially further reduce PCB concentrations in surface waters in the long term to below EPA's (2002) recommended water quality criterion for total PCBs of 64 pg/L, although there could be short term releases to surface and groundwater resulting from some removal alternatives.

7.4 Sediment Cleanup Levels

MTCA addresses sediment cleanup levels by reference to the SMS. However, while SMS cleanup levels have been promulgated for sediments in the marine environment, they are not promulgated for sediments in freshwater environments. The marine sediment regulations nevertheless provide guidance for the Site, along with other freshwater sites. Further, closely related state guidelines currently available or under development will be considered by Ecology in developing cleanup levels for the Site.

Non-binding, draft interim guidelines have been released based on draft updates of LAETs for available bioassay tests, calculated using the available regional database of synoptic chemistry and toxicity test information (Michelsen 2003). These draft LAET values have been used in this RI as conservative screening levels to identify COPCs (see Section 6).

For the purpose of this focused RI, a range of existing sediment quality guidelines was evaluated to develop proposed sediment cleanup levels for the Upriver Dam PCB Site. These guidelines were organized relative to the three potential environmental pathways and receptors of concern for PCBs, generally summarized in Section 2.1.1, as follows:

1. **Potential water quality impacts** – As discussed in Section 7.3, on an area-wide scale a potential 170 pg/L surface water cleanup level (based on the surface water quality ARAR, including Section 304 of the Clean Water Act) may not have been exceeded at the Site, based on blank "qualified" results. The total PCB concentration of contaminated sediment porewaters was not directly measured during the RI, but this risk is discussed further in the companion focused FS report. Furthermore, sediment cleanup actions could potentially further reduce PCB concentrations in surface waters in the long term to below EPA's (2002) recommended water quality criterion for total PCBs of 64 pg/L. The effectiveness of different remedial actions on reducing the potential for PCB releases to surface water is more specifically addressed in the accompanying FS.
2. **Potential risks to wildlife (e.g., birds and mink) and human health due to PCB uptake and bioaccumulation** – The 170 pg/L PCB surface water quality standard was developed by EPA, and promulgated into Chapter 173-201A WAC, specifically to address potential bioaccumulation risks to human health and wildlife. The recommended criterion of 64 pg/L is intended to address similar potential risks. Other detailed sediment bioaccumulation studies performed at other PCB sediment sites have focused on bioaccumulation-based surface sediment quality endpoints based on the average across the characteristic home range of the resident biota (e.g., see Ecology's 1999 "*Approaches for Establishing Cleanup Levels for PCBs*," Lon Kissinger, unpublished manuscript). Representative applications of sediment bioaccumulation modeling to derive sediment cleanup levels, presented in order of increasing concentration, are summarized below:
    - In the Lower Columbia River system, preliminary sediment cleanup levels for PCBs ranging from roughly **320 to 700 μg/kg dw** have been developed by various parties using generalized applications of the Gobas and Zhang (1994) food web model focused on potential wildlife (mink) exposures. The modeling conservatively assumed that mink may potentially consume

relatively sessile invertebrate prey located in the nearshore environment, and thus used a relatively small home range assumption.

- Detailed bioaccumulation modeling performed at marine sites such as Commencement Bay resulted in a sediment cleanup level of **450 μg/kg dw** (see EPA 1997; ROD). The cleanup level was developed to be protective of a wide range of human health and ecological risks.
- Similarly detailed bioaccumulation modeling and risk assessments performed in relatively large riverine systems such as the Lower Fox River (Wisconsin) resulted in the development of a **1,000 μg/kg dw** cleanup level (EPA and WDNR 2003; ROD).

3. **Potential for localized toxicity to benthic invertebrate organisms** – As discussed in the sections above, surface sediments located primarily in the fine-grained sediment deposit exceed draft LAET screening levels for potential PCB toxicity in freshwater environments (Michelsen 2003). Although site-specific bioassays can be and have been performed to provide a direct assessment of sediment toxicity, at the Upriver Dam Site this is significantly complicated by the presence of co-occurring metal and wood waste contaminants, which alone are predicted to result in acute sediment toxicity (Kadlec 2000, EPA 2001b, Johnson and Norton 2001). Thus, the evaluation of sediment cleanup levels in this case necessarily focused on a review of benthic toxicity studies associated with sediment PCB exposure at other similar sites, as summarized below:
    - The draft LAET for ecologically relevant freshwater sediment benthic toxicity endpoints (i.e., excluding Microtox® bioluminescence, which is not a risk endpoint at the Upriver Dam Site) is 354 μg/kg dw (Michelsen 2003). However, according to Ecology, the fact that Microtox® is non-indigenous does not diminish or otherwise disqualify it as a biological indicator. Ecology recognizes Microtox® as a viable bioassay in both marine and freshwater systems and recommends its application to decision making for individual freshwater sites. Inclusion of the Microtox® data results in the draft LAET for all freshwater sediment benthic toxicity endpoints of **62 μg/kg** dw (Michelsen 2003).
    - The consensus-based probable effect concentration for PCBs in freshwater sediments is **676 μg/kg** (Ingersoll and McDonald 2000).

As summarized in Section 5.5 above, on a generalized area-wide scale, average total PCB concentrations are relatively low (typically less than 33 µg/kg dw) throughout most of the Site. Sediments exceeding even the most conservative of the potential cleanup levels summarized above (i.e., the 62 µg/kg dw LAET including Microtox®) are confined to an approximate 3 to 4 acre area of the Site that primarily encompasses the fine-grained deposit upstream of the dam apron (Deposit 1; Figure 8).

Note that this same prospective cleanup/natural recovery area also contains significantly elevated (above screening criteria) levels of metals, wood waste and associated degradation products (see Tables 1 to 5). The co-occurrence of different sediment contaminants in this area may have implications for appropriate cleanup strategies. Potential integration and coordination with the various cleanup and TMDL efforts are evaluated in the accompanying FS.

8 REFERENCES

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Tables

Table 1
Summary of Historical Upriver Dam Surface/Near-Surface Sediment Chemical Data

Sample/Station	River Mile	Percent Fines	Percent Solids	TOC (Percent Dry)	Zinc (mg/kg dry)	Total PCBs (µg/kg dry)	Cadmium (mg/kg dry)	Lead (mg/kg dry)	Arsenic (mg/kg dry)
EC-84.5 (94-328270; 0 to 2cm)	84.5	1%		0.40%		5			
EC-84.0 (94-328271; 0 to 2cm)	84	1%		1.10%		67			
EC-9 (99-018085; 0 to 10cm)	83.5	2%	69%	1.80%	1,410	67	4.6	308	3.8
EC-83.4 (94-328272; 0 to 2cm)	83.4	6%		2.20%		170			
EC-81.5 (94-218093; 0 to 2cm)	81.5					5			
EC-81.5 (94-328275; 0 to 2cm)	81.5	5%		1.10%		11			
HC-81.5 (SED/K-1; 0 to 2cm)	81.5		7%	16.80%		120			
USGS-SRC-6 (0 to 27cm)	81.5			6.40%	2,300				
Anchor/Exponent 9-SG (0 to 10 cm)	80.7	1%	95%	0.10%	223	ND			
Anchor/Exponent 7-SG (0 to 10 cm)	80.7	4%	93%	0.50%	598	ND			
Anchor/Exponent 6-SG (0 to 10 cm)	80.6	2%	94%	0.10%	723	ND			
EC 43-8021 (0 to 10cm)	80.6	3%	44%	2.50%	1,650	1,307	9.7	195	4.8
Anchor/Exponent 5-SG (0 to 10 cm)	80.5	5%	84%	0.30%	595	ND			
EC-80.5 (93-318235; 0 to 2cm)	80.5	34%		11.00%		3,000			
EC-80.5 (94-318237; 0 to 2cm)	80.5	22%		11.00%		2,577			
EC-80.5 (94-318274; 0 to 2cm)	80.5	10%		2.20%		23			
EC-80.5 (94-328001; 0 to 5cm)	80.5	33%		13.00%	4,050	4,500			
EC-3 (99-018082; 0 to 10cm)	80.5	13%	15%	13.70%	8,960	9	14	1420	35
Anchor/Exponent 4-SG (0 to 10 cm)	80.4	7%	76%	0.50%	724	ND			
HC-80.4 (SED/HC-5; 0 to 5cm)	80.4		17%	10.20%		1,010			
HC-80.4 (SED/HC-5; 10 to 15cm)	80.4		22%	8.70%		2,341			
EC-2 (99-018081; 0 to 10cm)	80.4	6%	55%	3.60%	1,990	254	13	342	5.8
Anchor/Exponent 3-SG (0 to 10 cm)	80.3	3%	81%	0.20%	611	ND			
EC-1 (99-018080; 0 to 10cm)	80.3	17%	30%	8.40%	3,280	1,273	27	564	12
Anchor/Exponent 2-SG (0 to 10 cm)	80.3	3%	76%	0.50%	651	ND			
Anchor/Exponent 1-SG (0 to 10 cm)	80.2	10%	53%	2.30%	1,230	33			
EC 43-8020 (0 to 10cm)	80.2	21%	30%	6.70%	3,010	1,431	23	479	13

= exceeds Sediment Quality Standards (SQS)

= exceeds Cleanup Screening Levels (CSL)

dry = results reported on a dry weight basis

µg/kg = micrograms / kilogram

mg/kg = milligrams / kilogram

Fines = sum of silt and clay grain size fractions

ND = non detect

*Note: SQS amd CLSs are the probable sediment quality standards from Ecology's Phase II Report on Sediment Quality Values for Freshwater Sediments in Washington State (2003). This document presents these values for discussion purposes only and notes that final SQVs selected may differ from these values.

Table 2
Spokane River -
Summary of Sediment Conventionals and Organic Data

Location ID	AN-10	AN-11	AN-11	AN-11	AN-11	AN-11	AN-11	AN-12	AN-13	AN-14	AN-15	AN-20	AN-20	AN-21	AN-22
Sample ID	AN-10SD-A	AN-11SD-A	AN-11SD-B	AN-11SD-C	AN-11SD-D	AN-11SD-E	AN-61SD-A	AN-12SD-A	AN-13SD-A	AN-14SD-A	AN-15SD-A	AN-20SD-A	AN-70SD-A	AN-21SD-A	AN-22SD-A
Depth Inverval (cm)	0-10	0-10	10-20	20-30	30-40	40-51.5	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10
Sample Type	Field	Field	Field	Field	Field	Field	Field Duplicate	Field	Field	Field	Field	Field	Field Duplicate	Field	Field
Sample Date	9/3/2003	9/6/2003	9/6/2003	9/6/2003	9/6/2003	9/6/2003	9/6/2003	9/6/2003	9/6/2003	9/3/2003	9/3/2003	9/6/2003	9/6/2003	9/6/2003	9/6/2003
Conventionals (%)															
Total Organic Carbon	0.13	0.13	0.08	0.04 J	0.05	4.72	0.6	0.3	0.4	0.58	0.98	0.11	0.13	0.07	0.07
Total solids	92.2	89.8	86.7	92.9	89.6	60.2	94.6	74.2	81	70.3	66.5	92.1	94.1	93.3	92.5
TPH (mg/kg dry)															
TPH - Residual Range	100 U	100 U	--	100 U	--	1200 O	100 U	100 U	100 U	87 J	130 U	--	--	--	--
TPH - Diesel Range	50 U	50 U	--	50 U	--	430	50 U	50 U	50 U	37 Z	60 U	--	--	--	--
TPH - Gasoline Range	20 U	20 U	--	20 U	--	20 U	20 U	20 U	20 U	20 U	20 U	--	--	--	--
Grain Size (%)															
Gravel	48.6	84.4	80.5	60.2	61.7	16.9	80.2	12.9	59.5	1.32	0.62	83.8	95	70.5	66
Sand, Very Coarse	33.3	8.59	6.41	16.7	15.5	7.39	10.2	4.4	9.67	3.35	12.2	13.5	12.6	7.15	12
Sand, Coarse	15.1	3.44	6.45	8.62	13.1	11.9	3.32	23	11.8	38.4	55.4	0.45	0.44	12.2	16.5
Sand, Medium	2.72	5.19	7.2	6.56	9.24	41.3	4.92	52.4	15.8	42.1	20.7	0.48	0.39	8.57	6.22
Sand, Fine	0.52	1.36	0.71	0.4	0.38	10.9	1.13	4.89	4.41	11.5	5.94	0.78	0.78	0.7	0.4
Sand, Very Fine	0.12	0.14	0.11	0.12	0.07	4.31	0.13	0.28	0.81	1.53	2.07	0.08	0.08	0.07	0.04
Silt	0.12	0.2	0.22	0.23	0.11	7.3	0.19	0.38	1.08	1.62	3.15	0.12	0.09	0.11	0.07
Clay	0.09	0.06	0.08	0.03	0.07	1.4	0.06	0.06	0.26	0.15	0.06	0.05	0.08	0.02	0.04
PCBs (µg/kg dry)															
Aroclor 1016	15 U	8.5 U	10 U	10 U	10 U	13 U	8.4 U	9.5 U	8 U	11 U	12 U	10 U	10 U	10 U	11 U
Aroclor 1221	20 U	17 U	20 U	20 U	20 U	25 U	17 U	19 U	16 U	22 U	23 U	20 U	20 U	20 U	21 U
Aroclor 1232	48 U	8.5 U	10 U	10 U	10 U	13 U	8.4 U	9.5 U	8 U	11 U	12 U	10 U	10 U	10 U	11 U
Aroclor 1242	32 U	8.5 U	10 U	10 U	10 U	13 U	8.4 U	9.5 U	8 U	11 U	12 U	10 U	10 U	10 U	11 U
Aroclor 1248	28	8.5 U	10 U	10 U	10 U	14	10	9.5 U	8 U	11 U	20	3.4 J	4.4 J	3 J	5.3 J
Aroclor 1254	8.2 U	8.5 U	10 U	10 U	10 U	32 U	8.4 U	9.5 U	8 U	11 U	12 U	10 U	10 U	10 U	11 U
Aroclor 1260	8.2 U	8.5 U	10 U	10 U	10 U	26	8.4 U	9.5 U	8 U	11 U	12 U	10 U	10 U	10 U	11 U
Total PCBs	28	17 U	20 U	20 U	20 U	40	10	19 U	16 U	22 U	20	3.4 J	4.4 J	3 J	5.3 J
SVOCs (µg/kg dry)															
2,4-Dimethylphenol	49 U	48 U	--	48 U	--	50 U	45 U	51 U	50 U	50 U	49 U	--	--	--	--
2-Methylnaphthalene	9.7 U	9.5 U	--	9.6 U	--	9.1 J	9 U	11 U	9.9 U	4.4 J	9.8 U	--	--	--	--
2-Methylphenol	9.7 U	9.5 U	--	9.6 U	--	10 U	9 U	11 U	9.9 U	10 U	9.8 U	--	--	--	--
4-Methylphenol	9.7 U	9.5 U	--	9.6 U	--	15	9 U	11 U	9.9 U	18	9.8 U	--	--	--	--
Acenaphthene	9.7 U	9.5 U	--	9.6 U	--	10 U	9 U	11 U	9.9 U	10 U	4.7 J	--	--	--	--
Acenaphthylene	9.7 U	9.5 U	--	9.6 U	--	6.4 J	9 U	11 U	9.9 U	10 U	9.8 U	--	--	--	--
Anthracene	9.7 U	9.5 U	--	9.6 U	--	4.8 J	9 U	11 U	9.9 U	10 U	4.9 J	--	--	--	--
Benzo(a)anthracene	9.7 U	9.5 U	--	9.6 U	--	16	9 U	4.3 J	9.9 U	2.8 J	34	--	--	--	--
Benzo(a)pyrene	9.7 U	9.5 U	--	9.6 U	--	16	9 U	4.2 J	9.9 U	3.5 J	63	--	--	--	--
Benzo(b)fluoranthene	9.7 U	9.5 U	--	9.6 U	--	16	9 U	4.3 J	9.9 U	4.2 J	54	--	--	--	--
Benzo(g,h,i)perylene	9.7 U	9.5 U	--	9.6 U	--	14	9 U	4 J	9.9 U	3.6 J	73	--	--	--	--
Benzo(k)fluoranthene	9.7 U	9.5 U	--	9.6 U	--	12	9 U	11 U	9.9 U	10 U	34	--	--	--	--
Benzoic acid	200 U	190 U	--	200 U	--	200 U	180 U	210 U	200 U	180 J	160 J	--	--	--	--
Benzyl alcohol	9.7 U	9.5 U	--	9.6 U	--	10 U	9 U	11 U	9.9 U	8.2 J	6.9 J	--	--	--	--
Carbazole	9.7 U	9.5 U	--	9.6 U	--	10 U	9 U	11 U	9.9 U	10 U	7.4 J	--	--	--	--
Chrysene	9.7 U	9.5 U	--	9.6 U	--	20	9 U	5.1 J	9.9 U	4.3 J	50	--	--	--	--
Dibenzo(a,h)anthracene	9.7 U	9.5 U	--	9.6 U	--	10 U	9 U	11 U	9.9 U	10 U	11	--	--	--	--
Fluoranthene	9.7 U	9.5 U	--	9.6 U	--	30	9 U	6.1 J	9.9 U	4.5 J	51	--	--	--	--
Fluorene	9.7 U	9.5 U	--	9.6 U	--	4.3 J	9 U	11 U	9.9 U	10 U	9.8 U	--	--	--	--
Indeno(1,2,3-cd)pyrene	9.7 U	9.5 U	--	9.6 U	--	13	9 U	3.2 J	9.9 U	10 U	48	--	--	--	--
Naphthalene	9.7 U	9.5 U	--	9.6 U	--	18	9 U	11 U	9.9 U	2.4 J	9.8 U	--	--	--	--
Phenanthrene	9.7 U	9.5 U	--	9.6 U	--	26	9 U	4 J	9.9 U	8 J	27	--	--	--	--
Phenol	29 U	29 U	--	29 U	--	5.3 J	6.3 J	31 U	7.7 J	21 J	19 J	--	--	--	--
Pyrene	9.7 U	9.5 U	--	9.6 U	--	32	9 U	5.6 J	9.9 U	5.1 J	57	--	--	--	--
Retene	97 U	95 U	--	96 U	--	490	90 U	110 U	99 U	100 U	98 U	--	--	--	--

U Non-detect.
J Estimated value.
Z Does not resemble petroleum product.
O Resembles petroleum oil.
mg/kg = milligrams / kilogram
µg/kg = micrograms / kilogram
dry = dry weight basis

Table 2
Spokane River -
Summary of Sediment Conventionals and Organic Data

Location ID	AN-23	AN-24	AN-25	AN-26	AN-27	AN-28	AN-29	AN-30	AN-31	AN-31	AN-32	AN-40	AN-40	AN-41	AN-42	BWE-9
Sample ID	AN-23SD-A	AN-24SD-A	AN-25SD-A	AN-26SD-A	AN-27SD-A	AN-28SD-A	AN-29SD-A	AN-30SD-A	AN-31SD-A	AN-81SD-A	AN-32SD-A	AN-40SD-A	AN-40SD-B	AN-41SD-A	AN-42SD-A	BWE-9
Depth Inverval (cm)	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10	10-15	0-10	0-10	0-10
Sample Type	Field	Field	Field	Field	Field	Field	Field	Field	Field	Field Duplicate	Field	Field	Field	Field	Field	Field
Sample Date	9/6/2003	9/6/2003	9/6/2003	9/6/2003	9/6/2003	9/3/2003	9/6/2003	9/5/2003	9/5/2003	9/5/2003	9/6/2003	9/3/2003	9/5/2003	9/3/2003	9/3/2003	9/4/2003
Conventionals (%)																
Total Organic Carbon	0.25	0.77	6.04	0.5	0.18	0.23	1.41	1.51	0.5	0.53	0.06	3.53	2.81	4.34	2.56	15.6
Total solids	88.7	90.8	48.6		92.1	88.9	91.2	65.2	81.6	82.6	85.1	44		60.4		22.6
TPH (mg/kg dry)																
TPH - Residual Range	--	--	450 Z	--	--	--	--	130 U	--	--	--	550 Z	--	150 U	--	2000 O
TPH - Diesel Range	--	--	86 J	--	--	--	--	50 U	--	--	--	130 Z	--	50 U	--	690
TPH - Gasoline Range	--	--	20 U	--	--	--	--	20 U	--	--	--	40 U	--	20 U	--	130 U
Grain Size (%)																
Gravel	66.8	84.2	14.3	12.2	72	12.4	44.6	22.4	65.4	51.9	70.2	2.72	3.34	9.27	5.88	29.7
Sand, Very Coarse	5.13	3.59	3.7	2.83	10.8	44.2	32.7	2.35	2.55	3.28	11.2	3.06	5.55	7.74	3.29	16.6
Sand, Coarse	15.9	7.13	9.62	6.79	5.12	28.4	17.2	4.49	6.43	7.18	18.2	21.3	33.8	46.1	16.8	12.4
Sand, Medium	10	3.51	17.4	39.6	6.91	12.5	5.4	27.4	14.4	16.5	6.01	41.3	37.4	23.7	25.1	10.7
Sand, Fine	0.63	0.31	32.3	20.2	1.56	1.01	0.28	29.1	7.44	7.79	0.29	16.5	8.2	5.27	21.7	16.9
Sand, Very Fine	0.16	0.1	12.3	6.38	0.18	0.18	0.05	11.3	3.1	3.31	0.06	7.4	2.49	1.43	8.96	10.9
Silt	0.58	0.3	15.5	11.4	0.27	0.24	0.06	7.87	4.99	5.13	0.26	11	4.79	4.06	12	12.7
Clay	0.1	0.04	3.84	1.94	0.08	0.08	0.06	1.73	3.7	3.95	0.1	1.4	1.16	0.73	1.26	1.93
PCBs (µg/kg dry)																
Aroclor 1016	11 U	10 U	19 U	9 U	10 U	10 U	10 U	10 U	11 U	11 U	10 U	15 U	13 U	13 U	14 U	34 U
Aroclor 1221	21 U	20 U	37 U	18 U	20 U	20 U	20 U	20 U	21 U	21 U	20 U	30 U	25 U	26 U	28 U	68 U
Aroclor 1232	11 U	10 U	19 U	9 U	10 U	10 U	10 U	10 U	11 U	11 U	10 U	15 U	13 U	13 U	14 U	34 U
Aroclor 1242	11 U	10 U	19 U	9 U	10 U	10 U	10 U	10 U	11 U	11 U	10 U	15 U	13 U	13 U	14 U	34 U
Aroclor 1248	2.6 J	3.4 J	33	9 U	8.2 J	10 U	3.2 J	6.8 J	2.4 J	2.3 J	10 U	330	95	79	25	260
Aroclor 1254	11 U	10 U	19 U	9 U	10 U	10 U	10 U	10 U	11 U	11 U	10 U	15 U	13 U	13 U	14 U	34 U
Aroclor 1260	11 U	10 U	19 U	9 U	10 U	10 U	10 U	10 U	11 U	11 U	10 U	15 U	13 U	13 U	14 U	34 U
Total PCBs	2.6 J	3.4 J	33	18 U	8.2 J	20 U	3.2 J	6.8 J	2.4 J	2.3 J	20 U	330	95	79	25	260
SVOCs (µg/kg dry)																
2,4-Dimethylphenol	--	--	62 U	--	--	--	--	50 U	--	--	--	69 U	--	500 U	--	140 U
2-Methylnaphthalene	--	--	13 U	--	--	--	--	2.3 J	--	--	--	3.1 J	--	150	--	6.1 J
2-Methylphenol	--	--	13 U	--	--	--	--	10 U	--	--	--	14 U	--	100 U	--	27 U
4-Methylphenol	--	--	16	--	--	--	--	34	--	--	--	45	--	100 U	--	62
Acenaphthene	--	--	13 U	--	--	--	--	10 U	--	--	--	3.3 J	--	230	--	27 U
Acenaphthylene	--	--	13 U	--	--	--	--	10 U	--	--	--	14 U	--	100 U	--	11 J
Anthracene	--	--	13 U	--	--	--	--	2.3 J	--	--	--	25	--	710	--	8.5 J
Benzo(a)anthracene	--	--	5.8 J	--	--	--	--	7.2 J	--	--	--	81	--	1300	--	34
Benzo(a)pyrene	--	--	6.2 J	--	--	--	--	7 J	--	--	--	81	--	920	--	41
Benzo(b)fluoranthene	--	--	6 J	--	--	--	--	7.3 J	--	--	--	58	--	760	--	49
Benzo(g,h,i)perylene	--	--	9.6 J	--	--	--	--	5.1 J	--	--	--	48	--	460	--	35
Benzo(k)fluoranthene	--	--	13 U	--	--	--	--	5.5 J	--	--	--	65	--	700	--	32
Benzoic acid	--	--	230 J	--	--	--	--	200 U	--	--	--	280 U	--	2000 U	--	440 J
Benzyl alcohol	--	--	13 U	--	--	--	--	10 U	--	--	--	14 U	--	100 U	--	27 U
Carbazole	--	--	13 U	--	--	--	--	10 U	--	--	--	6.8 J	--	84 J	--	27 U
Chrysene	--	--	7 J	--	--	--	--	8.8 J	--	--	--	76	--	1400	--	44
Dibenzo(a,h)anthracene	--	--	13 U	--	--	--	--	10 U	--	--	--	11 J	--	160	--	27 U
Fluoranthene	--	--	13	--	--	--	--	14	--	--	--	140	--	1900	--	66
Fluorene	--	--	13 U	--	--	--	--	10 U	--	--	--	4.9 J	--	350	--	27 U
Indeno(1,2,3-cd)pyrene	--	--	8.6 J	--	--	--	--	5.2 J	--	--	--	49	--	480	--	30
Naphthalene	--	--	3.8 J	--	--	--	--	4 J	--	--	--	5.3 J	--	45 J	--	25 J
Phenanthrene	--	--	7.4 J	--	--	--	--	9.6 J	--	--	--	81	--	2400	--	34
Phenol	--	--	40	--	--	--	--	15 J	--	--	--	48	--	300 U	--	99
Pyrene	--	--	12 J	--	--	--	--	16	--	--	--	150	--	2500	--	59
Retene	--	--	130 U	--	--	--	--	100 U	--	--	--	1600	--	100 U	--	21000

U Non-detect.
J Estimated value.
Z Does not resemble petroleum prc
O Resembles petroleum oil.
mg/kg = milligrams / kilogram
µg/kg = micrograms / kilogram
dry = dry weight basis

Table 3
Sediment Analytical Results from 2004 Sampling

Location ID	51	52	53	53	54	55	56	57	58	59	60	61
Sample ID	**UPR-51-041007**	**UPR-52-041007**	**UPR-53-041007**	**UPR-103-041007**	**UPR-54-041007**	**UPR-55-041007**	**UPR-56-041007**	**UPR-57-041007**	**UPR-58-041007**	**UPR-59-041007**	**UPR-60-041007**	**UPR-61-041007**
Sample Date	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**	**10/7/2004**
Sample Type	**Field**	**Field**	**Field**	**Field Duplicate**	**Field**	**Field**	**Field**	**Field**	**Field**	**Field**	**Field**	**Field**
Depth Interval (cm)	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**	**0-10**
Conventionals (%)												
Total Organic Carbon	16.0%	0.28%	7.4%	NA	4.7%	0.45%	6.4%	2.1%	2.9%	5.7%	10.1%	1.5%
Total Solids	26.1%	88.1%	47.4%	NA	46.3%	73.4%	50.8%	74.7%	56.3%	47.6%	47.3%	72.5%
Grain Size (%)												
Gravel	9	80.2	23	NA	1.9	1.1	2.2	0.2	0.2	3	4.7	0.7
Sand, Very Coarse	11.7	10.3	4.3	NA	3.3	4.3	3.6	1.9	1.1	4	3.4	1.2
Sand, Coarse	8.6	3.5	5.3	NA	4.8	53	18.6	19.2	7.8	8.5	6.3	23.3
Sand, Medium	31.8	4	14	NA	21.5	35	26.2	36.6	45.9	22.5	46.2	59.4
Sand, Fine	25.3	1.3	41	NA	55	4.5	28.9	20.8	31.2	15.1	29.4	9.2
Sand, Very Fine	2.5	0.3	7.2	NA	5.8	0.8	10	7.5	4.1	14.6	3.7	1.6
Silt	9	0.4	3.1	NA	4.7	1	7.8	8.7	7.3	21.2	4.1	2.5
Clay	2.1	0	1.9	NA	3.1	0.2	2.7	5	2.4	11	2.2	2
PCBs (µg/kg dry)												
Aroclor 1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1248	**13**	ND	**22**	**25**	**11**	ND	ND	ND	**12**	ND	**13**	ND
Aroclor 1254	**13 J**	ND	**18**	**17**	ND	ND	ND	ND	**34**	ND	ND	ND
Aroclor 1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PCBs	**26**	**0**	**40**	**42**	**11**	**0**	**0**	**0**	**46**	**0**	**13**	**0**

ND = not detected (<10 µg/kg)

NA = not analyzed

dry = dry weight basis

µg/kg = micrograms/kilogram

Table 4
Spokane River -
Summary of Metals Sediment Data

Location ID Sample ID* Sample Date	AN-10 AN-10SD-A-01 9/3/2003	AN-10 AN-10SD-A-02 9/3/2003	AN-11 AN-11SD-A-01 9/6/2003	AN-11 AN-11SD-A-02 9/6/2003	AN-12 AN-12SD-A-01 9/6/2003	AN-12 AN-12SD-A-02 9/6/2003	AN-13 AN-13SD-A 9/6/2003	AN-14 AN-14SD-A 9/3/2003	AN-15 AN-15SD-A 9/3/2003	AN-20 AN-20SD-A 9/6/2003	AN-21 AN-21SD-A 9/6/2003	AN-22 AN-22SD-A 9/6/2003	AN-23 AN-23SD-A 9/6/2003	AN-24 AN-24SD-A 9/6/2003	AN-25* AN-25SD-A-01 9/6/2003
Depth Interval (cm)	0-10		0-10		0-10		0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10
Water Depth (feet)	11		12		10		10	3	2	22	22	18	14.5	16	10
Metals (mg/kg dry)															
Arsenic	5.59	5.32	ND	ND	ND	ND	ND	9.84	7.42	5.07	ND	ND	5.08	5.04	21.0
Cadmium	1.64	1.55	2.57	2.82	2.08	3.11	1.51	2.77	2.83	3.66	0.993	1.35	0.993	0.973	30.1
Lead	96.6	103	103	262	77.5	94.6	131	431	262	167	74.2	77.9	96.1	99.7	2920
Zinc	619	618	827	897	643	872	1080	1310	1220	1190	600	623	671	676	4940

* Selective sieving (600u dry sieved) was performed on sediment samples dominated by materials of a size greater than the course sand range. The samples that were sieved are AN-25, AN-30, AN-40, AN-41, AN-42, and BWE-9
mg/kg = milligrams / kilogram
dry = dry weight basis

Table 4
Spokane River -
Summary of Metals Sediment Data

Location ID Sample ID* Sample Date	AN-25 AN-25SD-A-02 9/6/2003	AN-25 AN-25SD-A-03 9/6/2003	AN-26 AN-26SD-A 9/6/2003	AN-27 AN-27SD-A 9/6/2003	AN-28 AN-28SD-A 9/3/2003	AN-29 AN-29SD-A 9/6/2003	AN-30* AN-30SD-A 9/5/2003	AN-31 AN-31SD-A-01 9/5/2003	AN-31 AN-31SD-A-02 9/5/2003	AN-32 AN-32SD-A 9/6/2003	AN-40* AN-40SD-A-01 9/3/2003	AN-40* AN-40SD-A-02 9/3/2003	AN-41* AN-41SD-A 9/3/2003	AN-42* AN-42SD-A 9/3/2003	BWE-9* BWE-9 9/4/2003
Depth Interval (cm)			0-10	0-10	0-10	0-10	0-10	0-10		0-10	0-10		0-10	0-10	0-10
Water Depth (feet)			8.6	22	27	12	13.5	14.4		20	1.5		1.5	2.5	28
Metals (mg/kg dry)															
Arsenic	20.5	ND	ND	ND	5.76	5.28	7.91	ND	ND	5.32	5.80	5.31	8.71	36.4	17.2
Cadmium	29.1	8.07	0.713	2.75	1.27	1.65	7.40	0.917	3.4	0.745	9.40	9.72	2.80	15.8	49.5
Lead	2840	289	854	98.7	109	92.5	1010	26.8	94.8	84.4	601	599	278	1860	618
Zinc	4630	1650	1450	820	737	627	2200	460	751	527	1720	1800	1090	2540	3550

Table 5
Sediment Screening Values
Ecology's Freshwater Lowest Apparent Effects Threshold

		LAET*	2LAET**	SQS***	CSL****
Conventionals (%)					
	Total Organic Carbon	9.82	--	--	--
TPH (mg/kg)					
	TPH - Residual Range	--	--	--	--
	TPH - Diesel Range	--	--	--	--
	TPH - Gasoline Range	--	--	--	--
PCBs (µg/kg dry)					
	Total PCBs	62	354	60	120
SVOCs (µg/kg dry)					
	2,4-Dimethylphenol	--	--		
	2-Methylnaphthalene	469	555	470	560
	2-Methylphenol	--	--		
	4-Methylphenol	760	2360	--	--
	Acenaphthene	1060	1320	1060	1320
	Acenaphthylene	470	640	470	640
	Anthracene	1230	1580	1200	1580
	Benzo(a)anthracene	4260	5800	4260	5800
	Benzo(a)pyrene	3300	4810	3300	4810
	Benzo(bk)fluoranthenes	11000	13800	11000	14000
	Benzo(g,h,i)perylene	4020	5200	4020	5200
	Benzoic acid	1910	3790	--	--
	Benzyl alcohol	--	--	--	--
	Carbazole	923	--	--	--
	Chrysene	5940	6400	5940	6400
	Dibenzo(a,h)anthracene	800	839	800	840
	Fluoranthene	11100	15000	11000	15000
	Fluorene	1070	3850	1000	3000
	Indeno(1,2,3-cd)pyrene	4120	5300	4120	5300
	Naphthalene	529	1310	500	1310
	Phenanthrene	6100	7570	6100	7600
	Phenol	--	--	--	--
	Pyrene	8790	16000	8800	16000
	Retene	6020	--	--	--
Metals (mg/kg dry)					
	Arsenic	31.4	50.9	20	51
	Cadmium	2.39	2.9	0.6	1.0
	Lead	335	431	335	430
	Zinc	683	1080	140	160

LAET = lowest observed effects threshold

2LAET = second lowest observed effects threshold

SQS = sediment quality standard

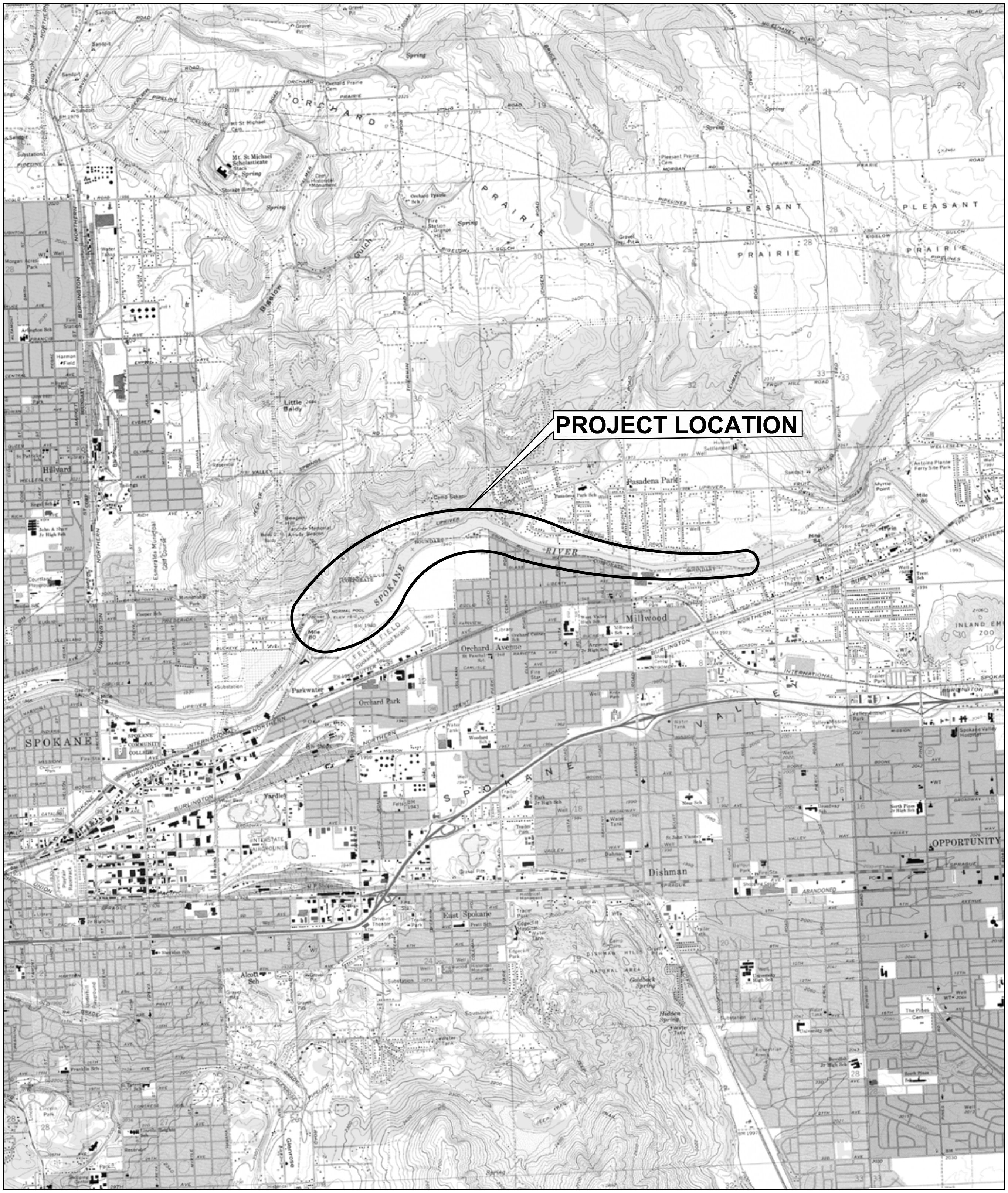
CSL = cleanup screening level

mg/kg = milligrams / kilogram

µg/kg = micrograms / kilogram

Figures

Nov 23, 2004 9:01am cdavidson K:\Jobs\020073-Upriver\02007301\02007301-41.dwg FIG 1



Note: Base map prepared from Terrain Navigator Pro USGS 7.5 minute quadrangle maps of Green Acres and Spokane NE, Washington.

0 1
Scale in Miles

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Vicinity Map
Upriver Dam
Spokane, Washington

K:\Jobs\020073-Upriver\02007301\02007301-23.dwg FIG 2
Nov 16, 2004 1:25pm cdavidson

Notes:

1) Aerial photo provided by Avista dated June 2002.
2) Bathymetry based on survey data provided by Blue Water Engineering dated May 20-22, 2003.
3) Horizontal Datum: State Plane NAD83 Washington, North
4) Vertical Datum: NAVD88

Previous Sample Locations

- Core Station Location
- Surface Sediment Station Location
- BWE-5 Visual Surface Grab Location and Identification
- > 5% Fines
- Deposit 1

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2
Previous Sediment Sampling Locations
Upriver Dam
Spokane, WA

Photo 1. Arial View of Powerhouse Intake Channel and Powerhouse

Photo 2. Powerhouse and Bank Erosion from Downstream

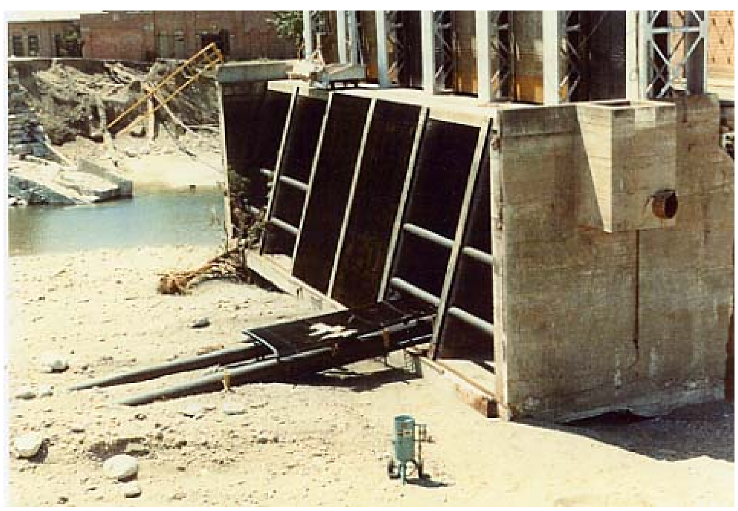


Photo 3. Channel Erosion adjacent to Powerhouse Intake

Figure 3a
Photos from 1986 Upriver Dam Failure
Upriver Dam Spokane, WA

ANCHOR ENVIRONMENTAL, L.L.C.

Photo 4. Repairs at Mouth of Powerhouse Intake Channel

Photo 5. Erosion at Upriver Dam from Downstream

Photo 6. Repairs South of Dam Face from Upstream

ANCHOR ENVIRONMENTAL, L.L.C.

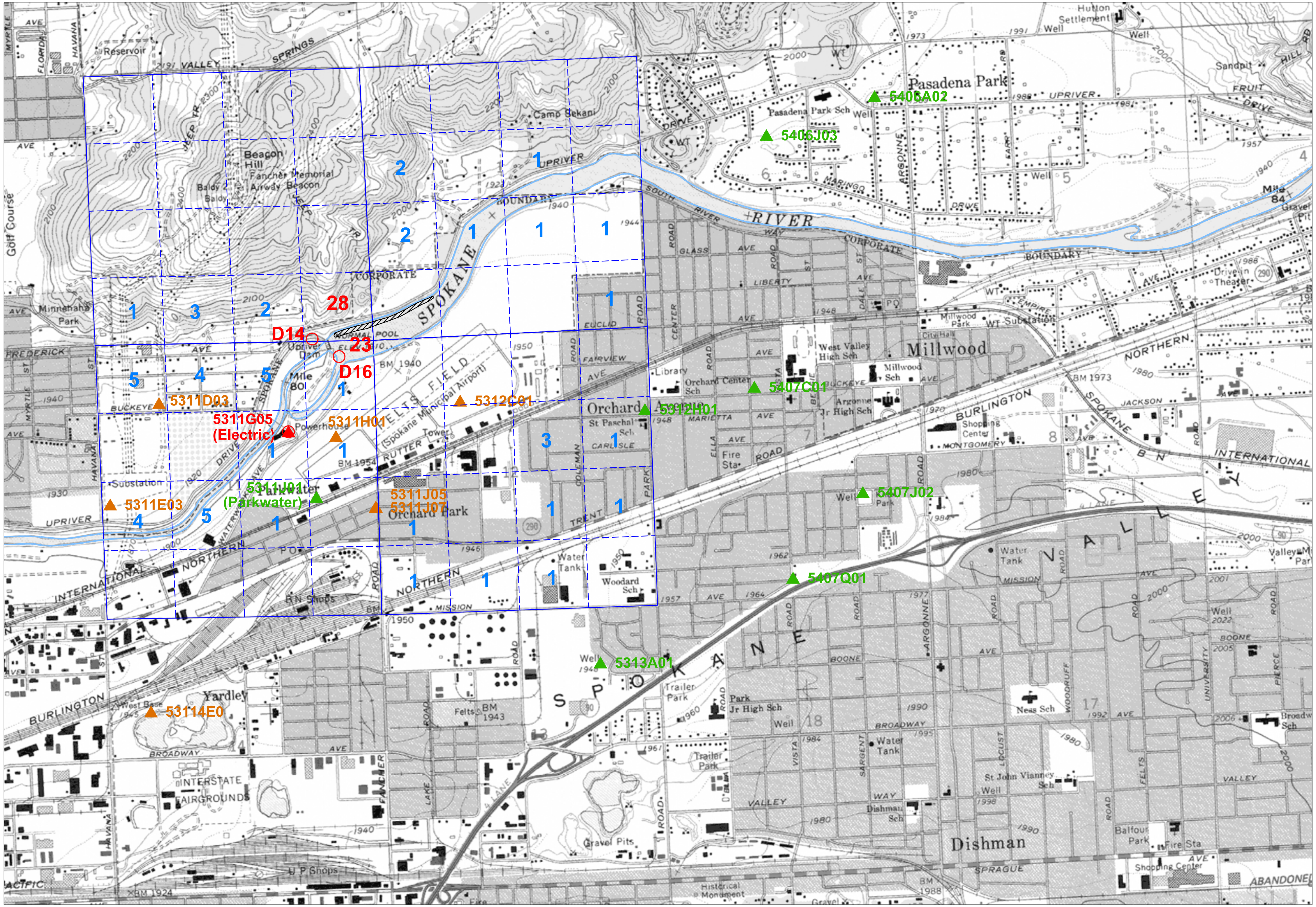
Figure 3b
Photos from 1986 Upriver Dam Failure
Upriver Dam Spokane, WA

Note: Aerial photo provided by Avista dated June 2002.

Dec 03, 2004 1:24pm cdavidson K:\Jobs\020073-Upriver\02007301\02007301-42.dwg FIG 4

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 4
Plan View of Erosion from 1986 Dam Failure
Spokane River, Washington



Well Location and Designation

5312C01 ▲ Wells Maintained in Spokane County Monitoring Well Network

5312H01 ▲ Water Supply Well

Well Inventory Notation

1 Number of Domestic, Industrial, or Irrigation Wells in Quarter, Quarter Section

1 Number of City of Spokane Wells in Quarter, Quarter Section

○D14 Location of Wells

Section Line

Quarter, Quarter Section Line

Deposit 1

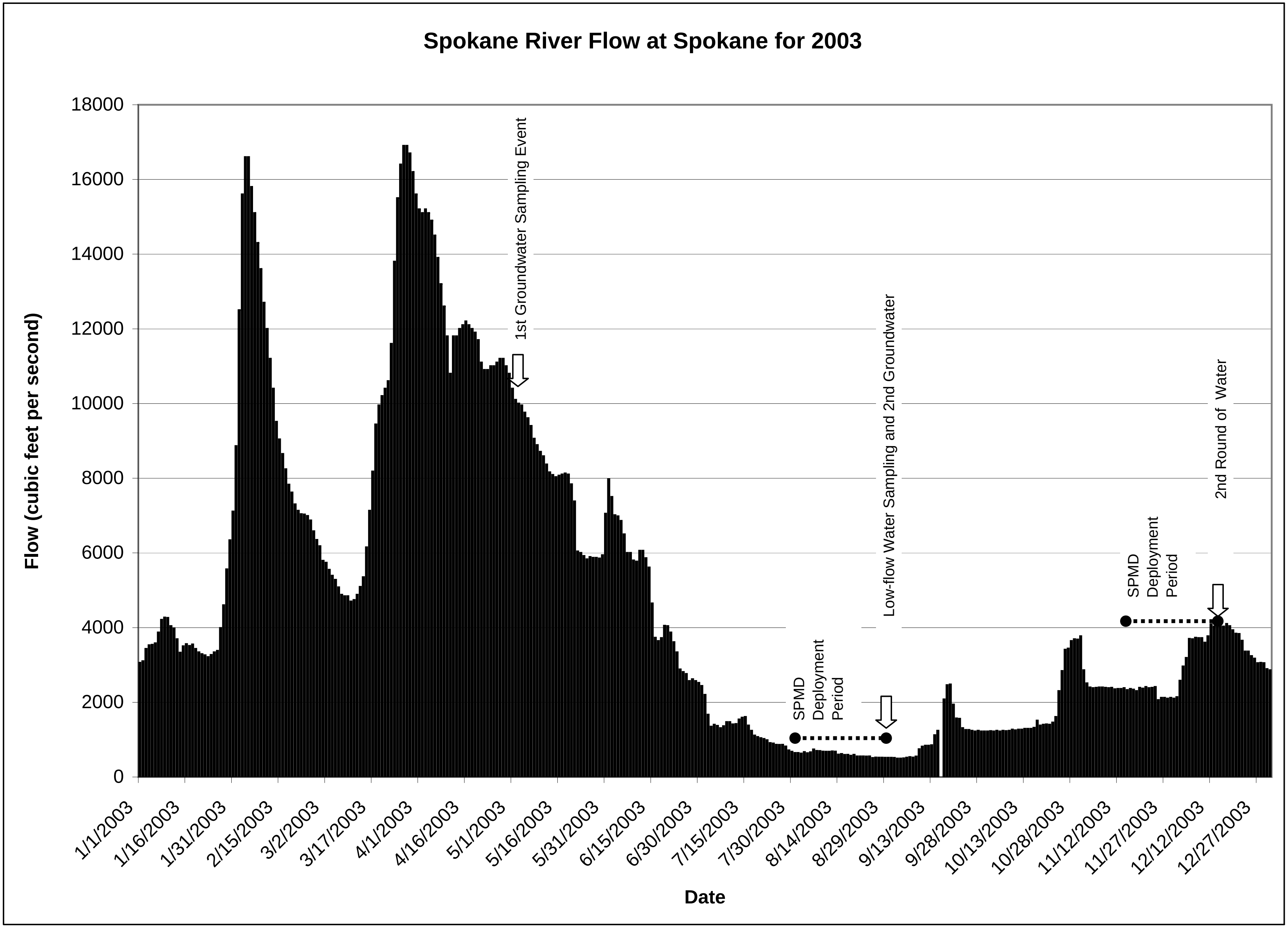
0 2000
Scale in Feet

Note: Base map prepared from drawing provided by Hart Crowser entitled "Well Inventory Map", dated March 2003.

Dec 03, 2004 8:21am cdavidson K:\Jobs\020073-Upriver\02007301\02007301-25.dwg FIG 5

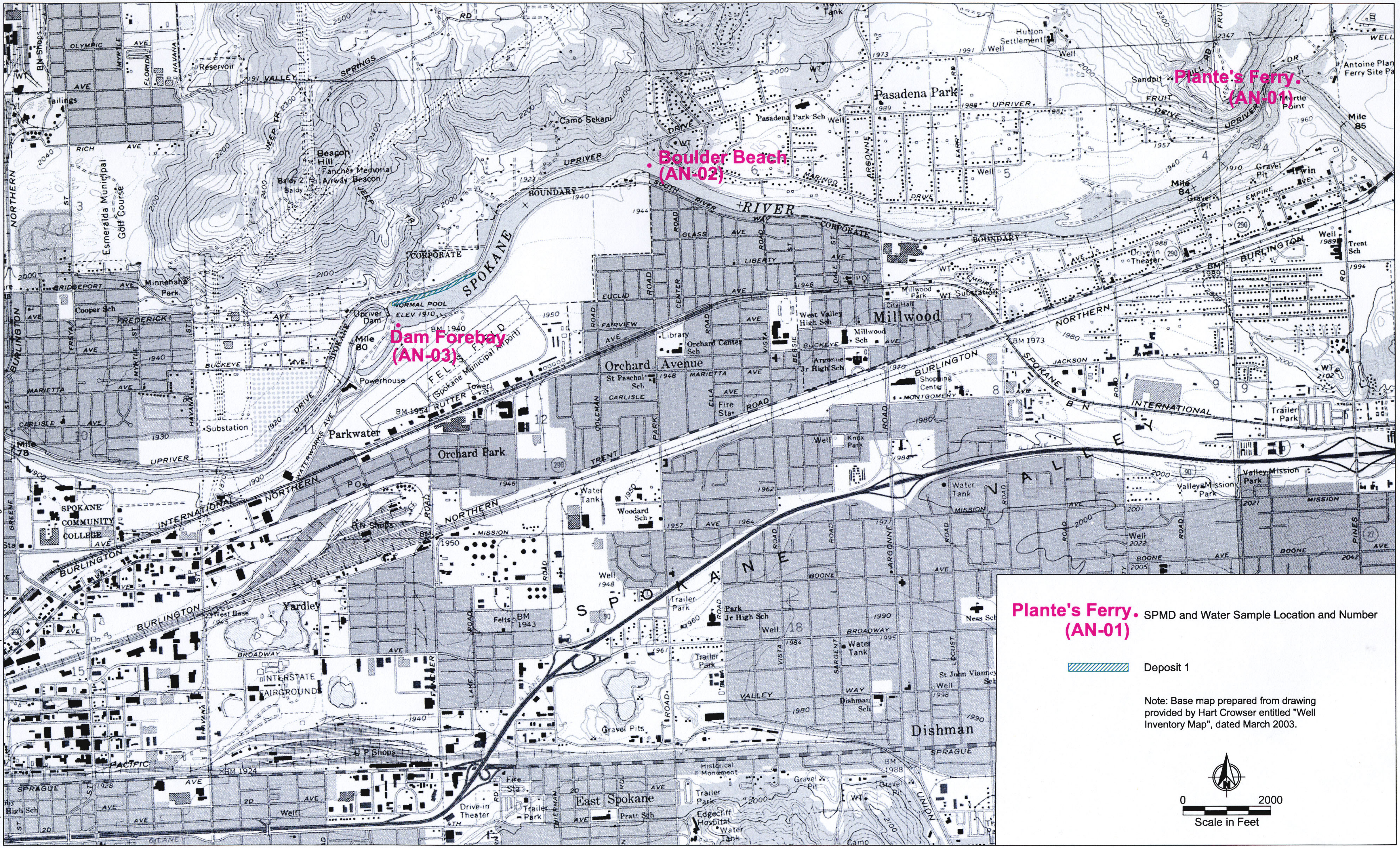
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 5
Well Sampling Locations
Upstream of Upriver Dam
Spokane River, Washington



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 6
Spokane River Flow at Spokane
Upriver Dam at Spokane, WA



K:Jobs\020073-Upriver\020073011\02007301-26.dwg FIG 7

Dec 03, 2004 8:23am cdavidson

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Figure 7
SPMD and Water Sample Locations - Upriver Dam Area
Spokane River, Washington

K:\Jobs\020073-Upriver\02007301\02007301-29.dwg FIG 8

Dec 03, 2004 9:02am cdavidson

Notes:

1) Aerial photo provided by Avista dated June 2002.
2) Bathymetry based on survey data provided by Blue Water Engineering dated May 20-22, 2003.
3) Horizontal Datum: State Plane NAD83 Washington, North
4) Vertical Datum: NAVD88

Sample Locations

- Core Station Location
- Surface Sediment Station Location
- Deposit 1
- Deposit 2
- Potential Fine Grained Deposit

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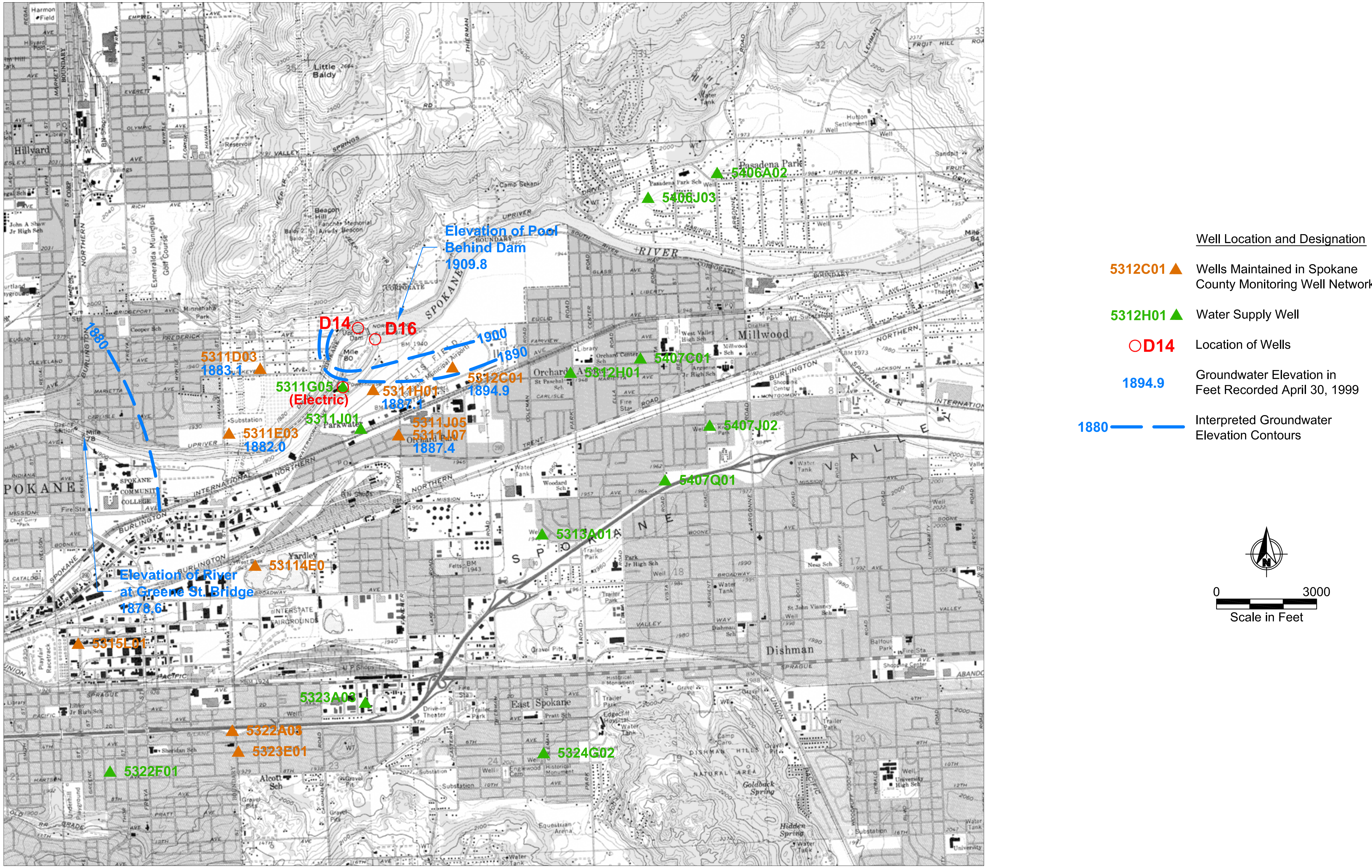
Figure 8
Sediment Sampling Locations
Upriver Dam
Spokane, WA

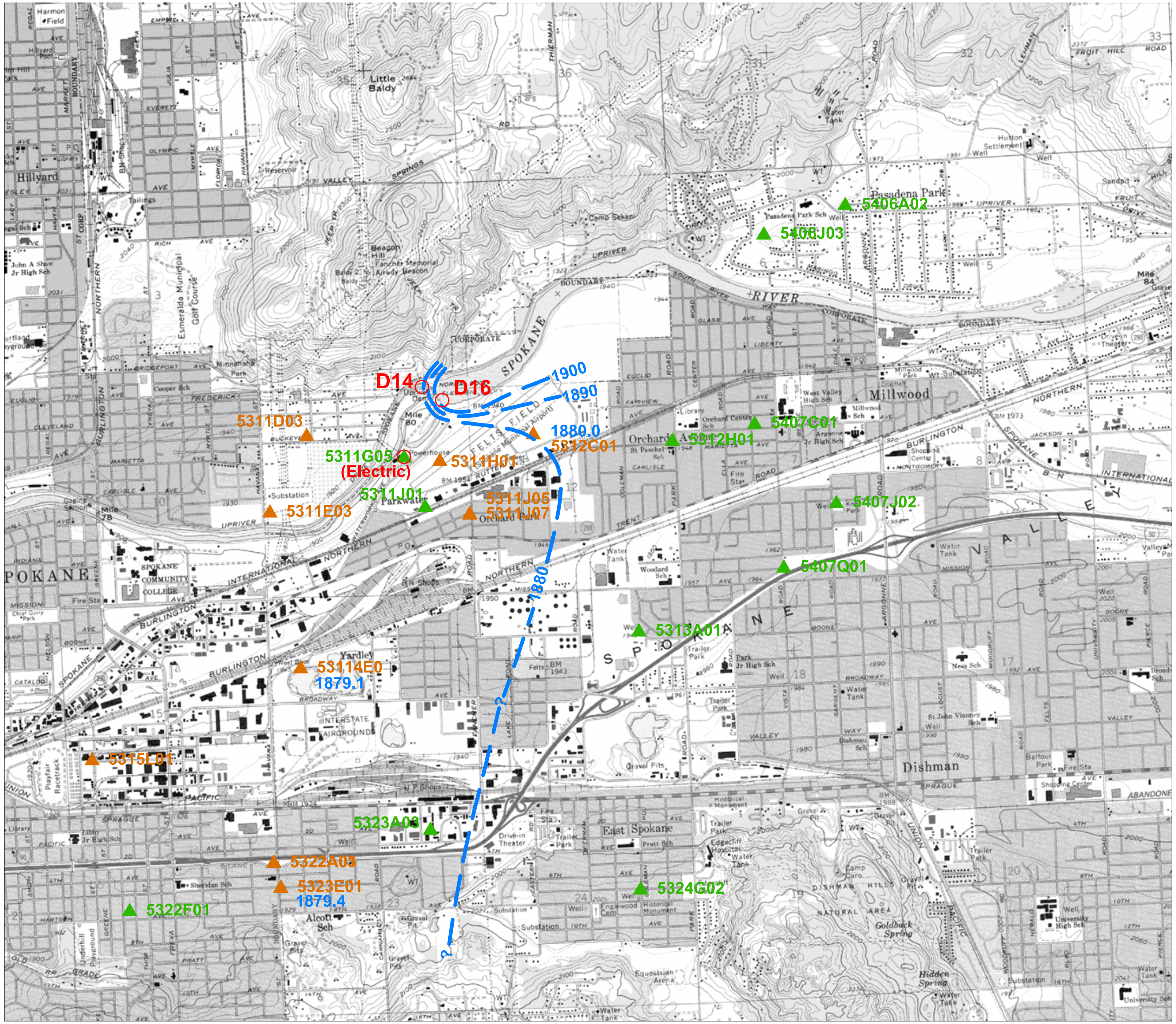


Note: Base map prepared from drawing provided by Hart Crowser entitled "Well Inventory Map", dated March 2003.

Dec 03, 2004 9:04am cdavidson K:\Jobs\020073-Upriver\02007301\02007301-24.dwg FIG 9

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 9
Groundwater Elevation Map - Peak Spring Runoff
Upstream of Upriver Dam
Spokane River, Washington



Note: Base map prepared from drawing provided by Hart Crowser entitled "Well Inventory Map", dated March 2003.

Well Location and Designation

5312C01 ▲	Wells Maintained in Spokane County Monitoring Well Network
5312H01 ▲	Water Supply Well
○D14	Location of Wells
1894.9	Groundwater Elevation in Feet Recorded April 30, 1999
1880 — —	Interpreted Groundwater Elevation Contours

0 3000

Scale in Feet

Dec 03, 2004 9:06am cdavidson K:\Jobs\020073-Upriver\02007301\02007301-24.dwg FIG 10

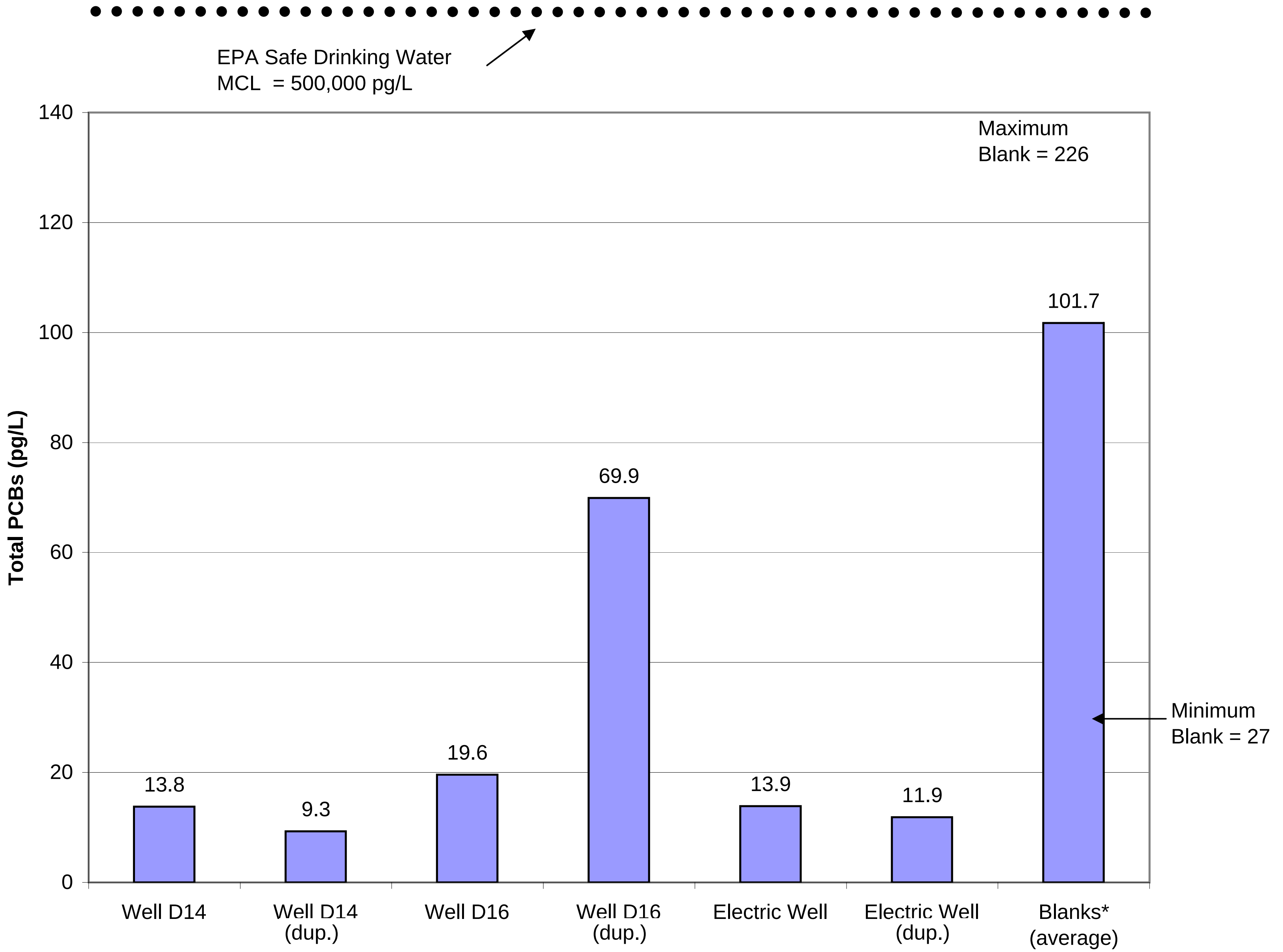
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 10

Groundwater Elevation Map - Seasonal Low Flow

Upstream of Upriver Dam

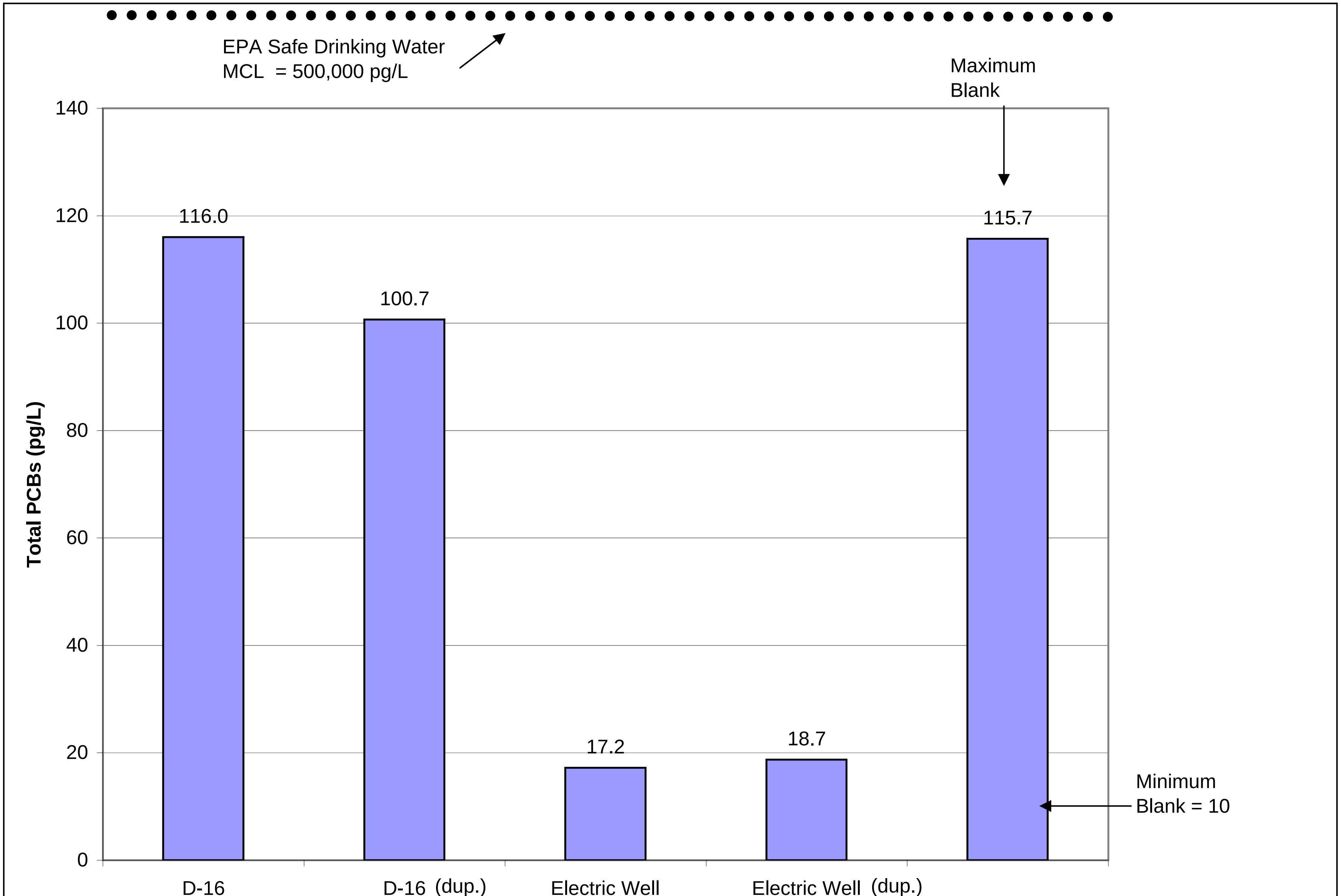
Spokane River, Washington



* Both field blanks and laboratory blanks are presented

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 11
PCBs in Groundwater - May 2003 Sampling Event
Upriver Dam, Spokane, WA



* Both field blanks and laboratory blanks are presented

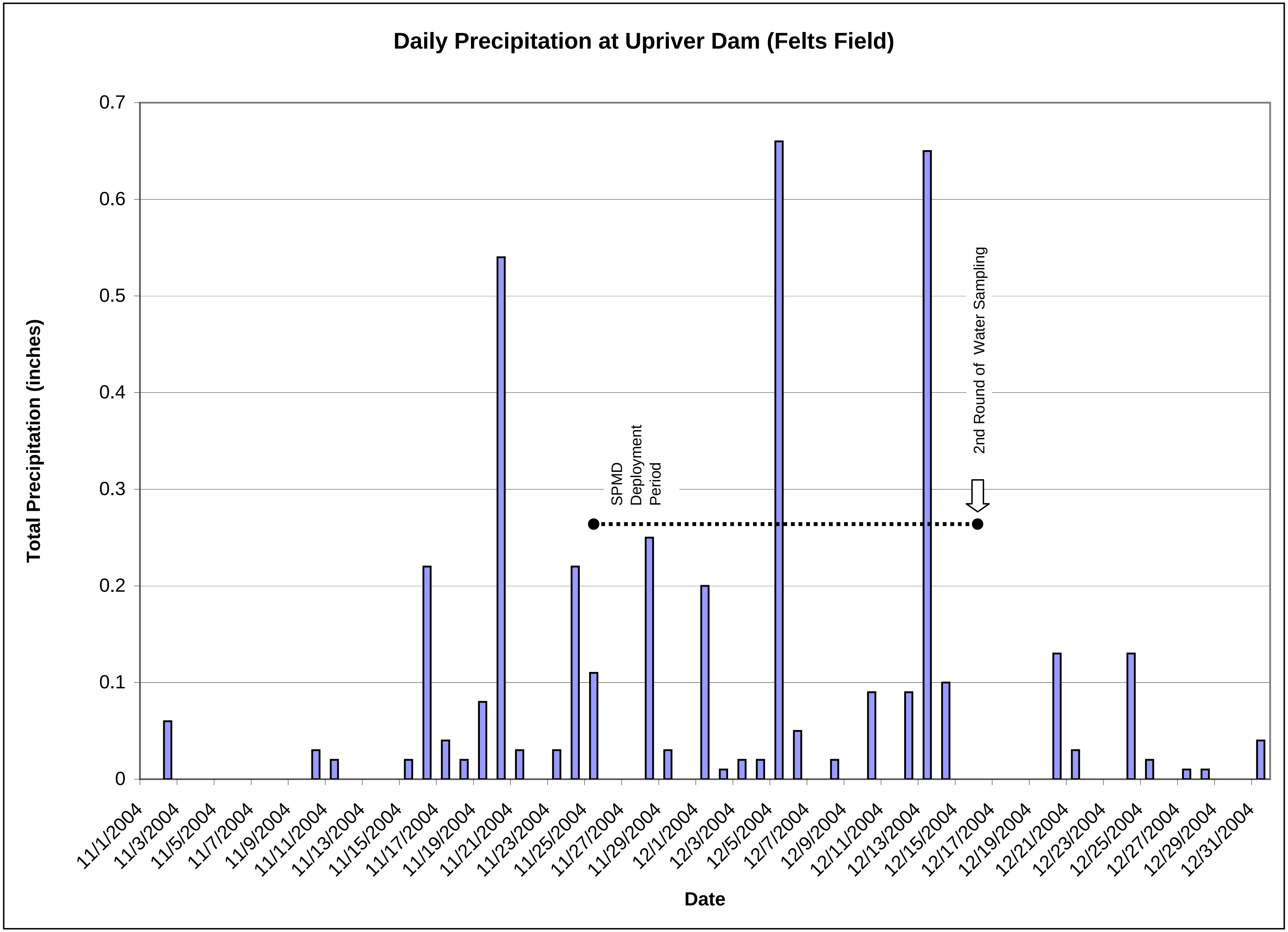
** It was not possible to sample Well D-14 in September due to low water level

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 12

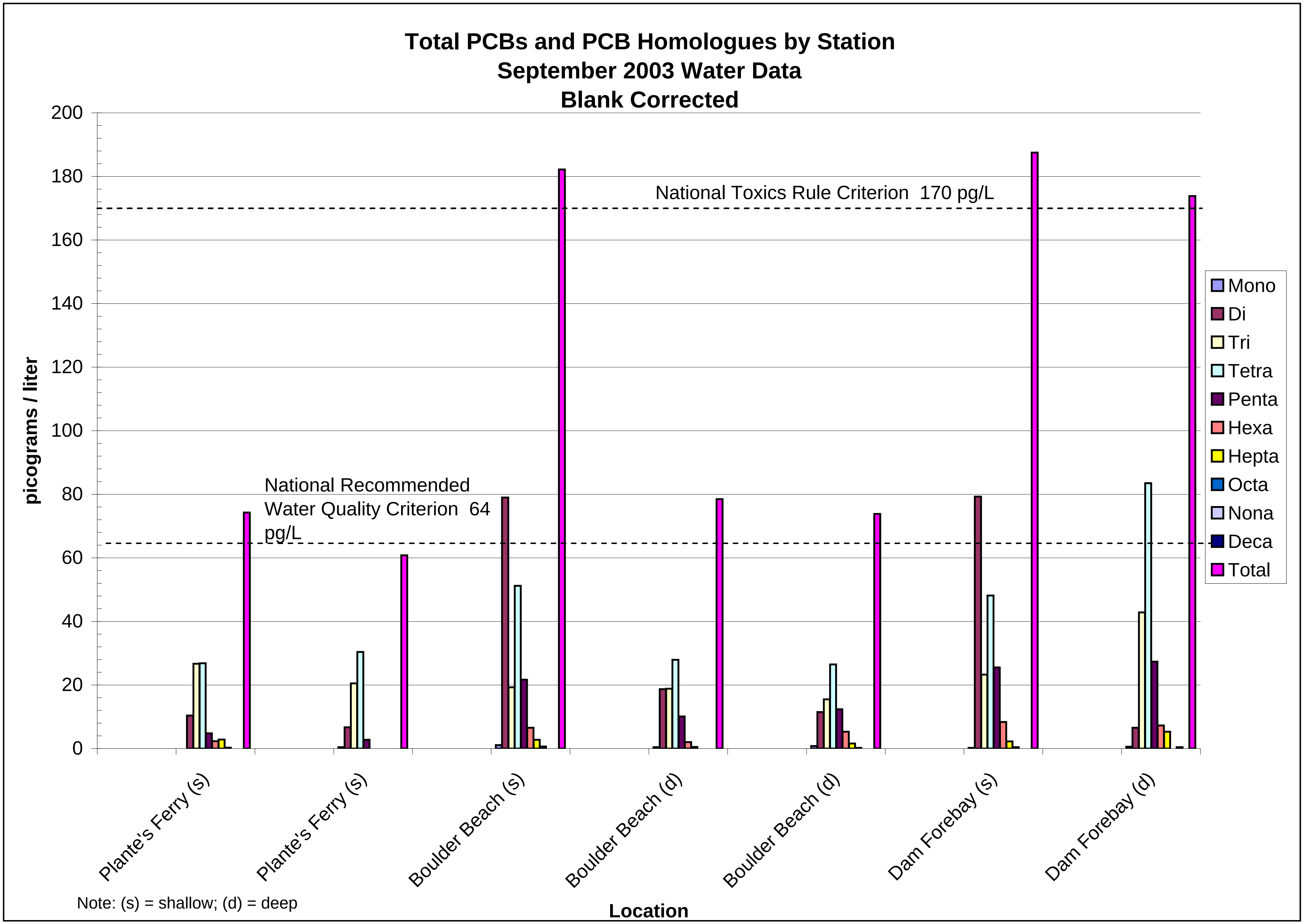
PCBs in Groundwater - September 2003 Sampling Event

Upriver Dam Spokane, WA



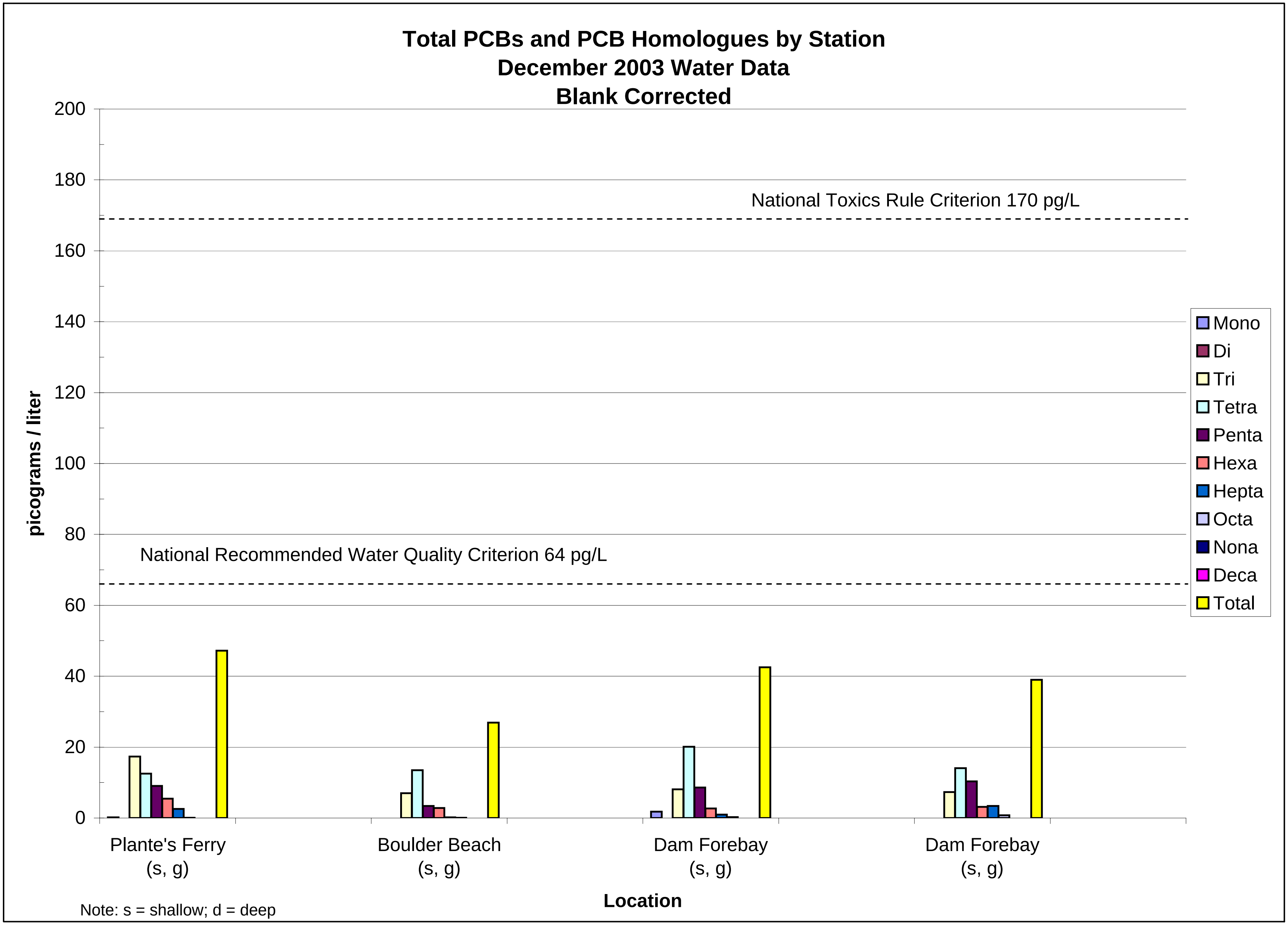
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 13
Daily Precipitatoin at Upriver Dam - November to December 2003
Upriver Dam Spokane, WA



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 14
Total PCBs and Homologues - September 2003 Water Data Blank Corrected
Upriver Dam Spokane, WA



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 15
Total PCBs and Homologues - December 2003 Water Data Blank Corrected
Upriver Dam Spokane, WA

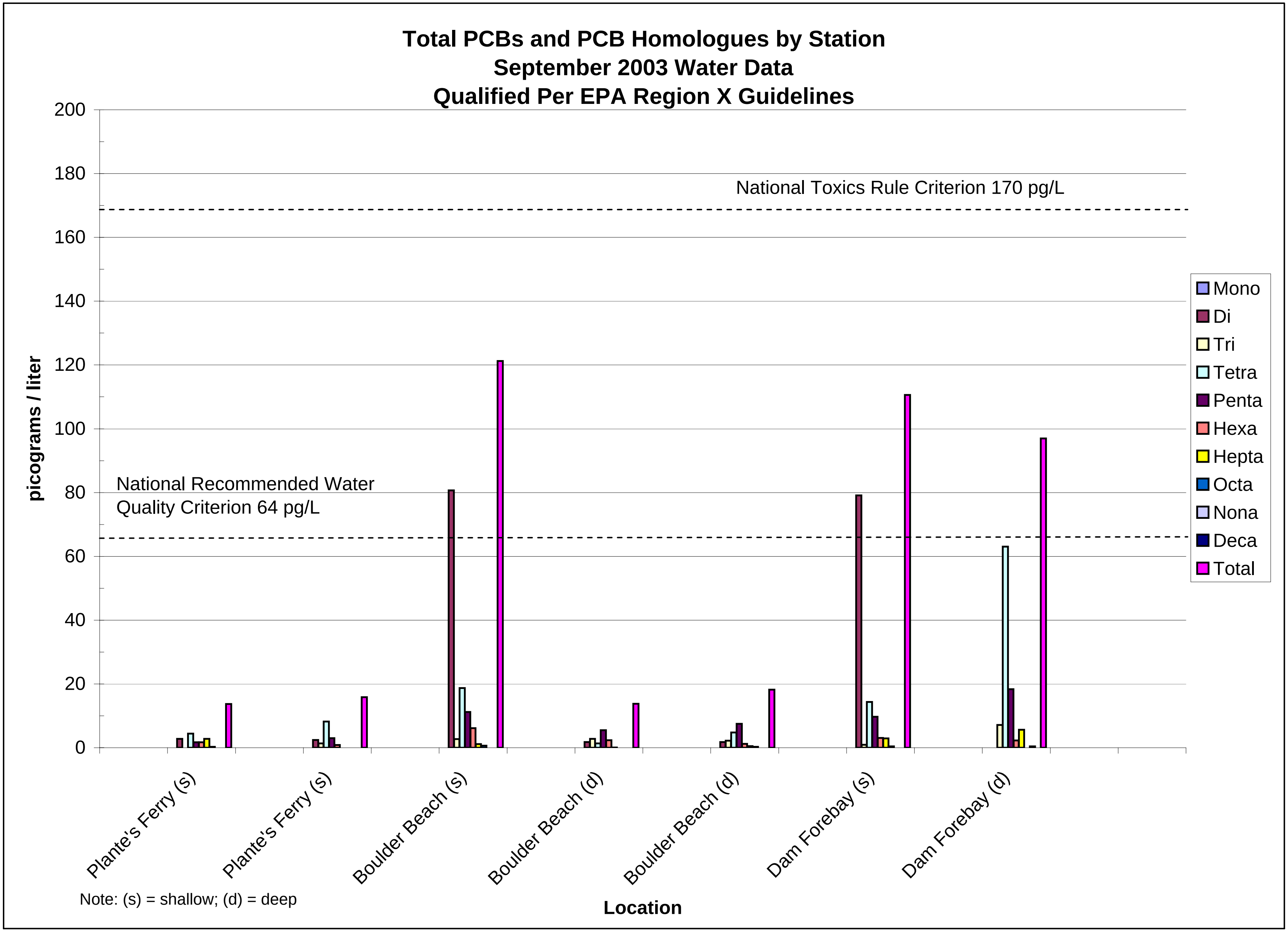
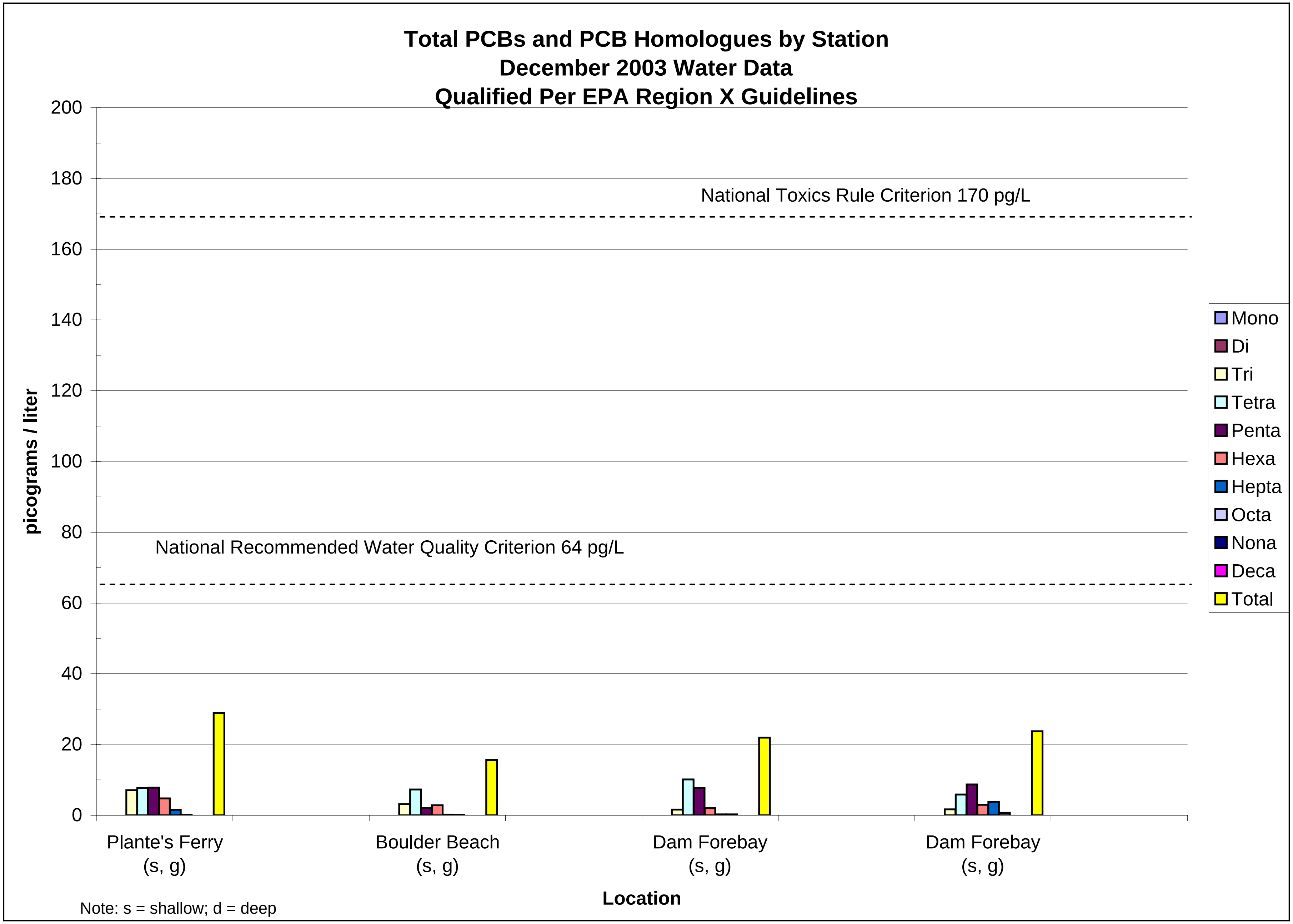
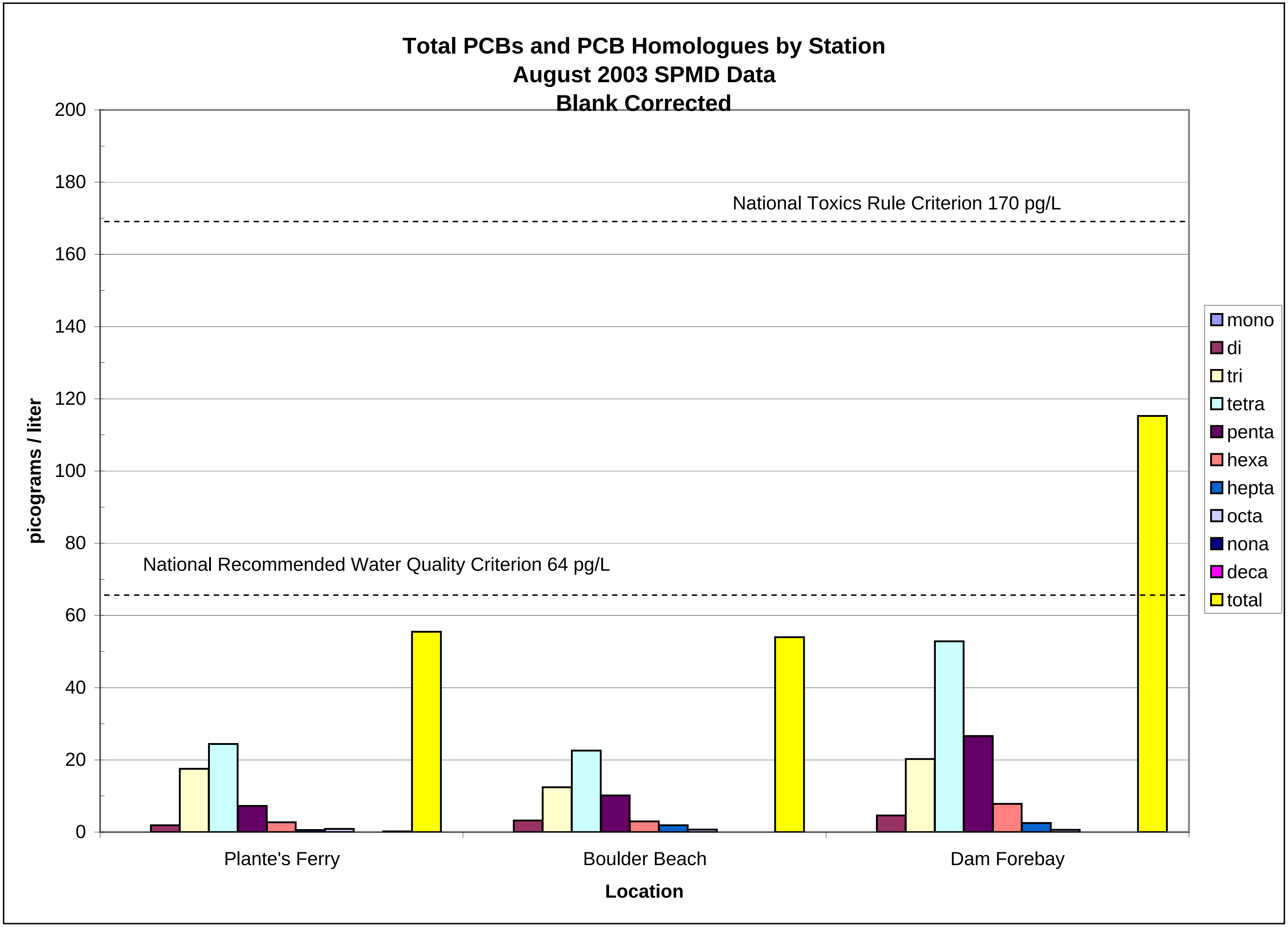


Figure 16
Total PCBs and Homologues - September 2003 Water Data Blank Qualified
Upriver Dam Spokane, WA



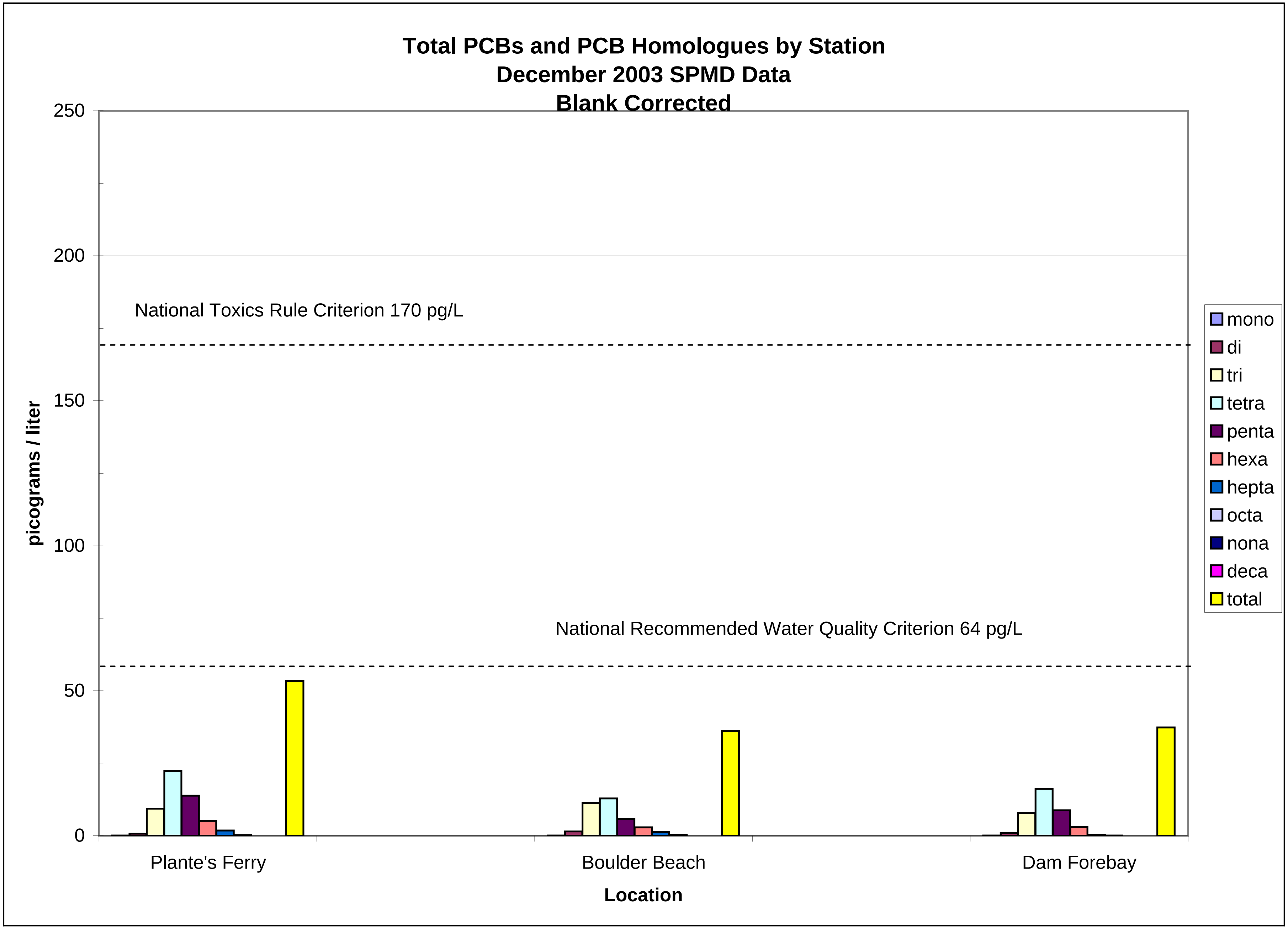
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 17
Total PCBs and Homologues - December 2003 Water Data Blank Qualified
Upriver Dam Spokane, WA



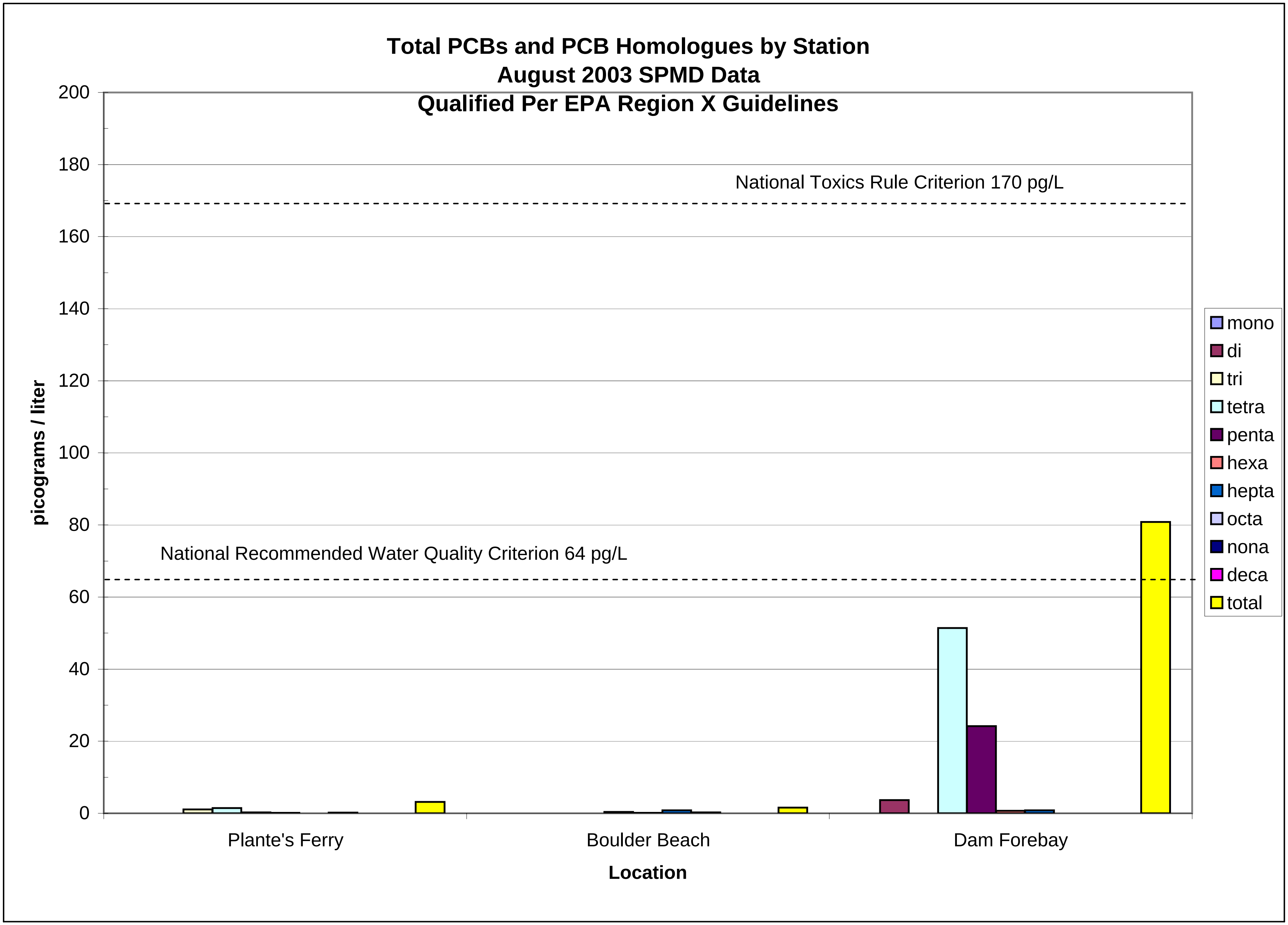
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 18
Total PCBs and PCB Homologues - August 2003 SPMD Data Blank Corrected
Upriver Dam Spokane, WA



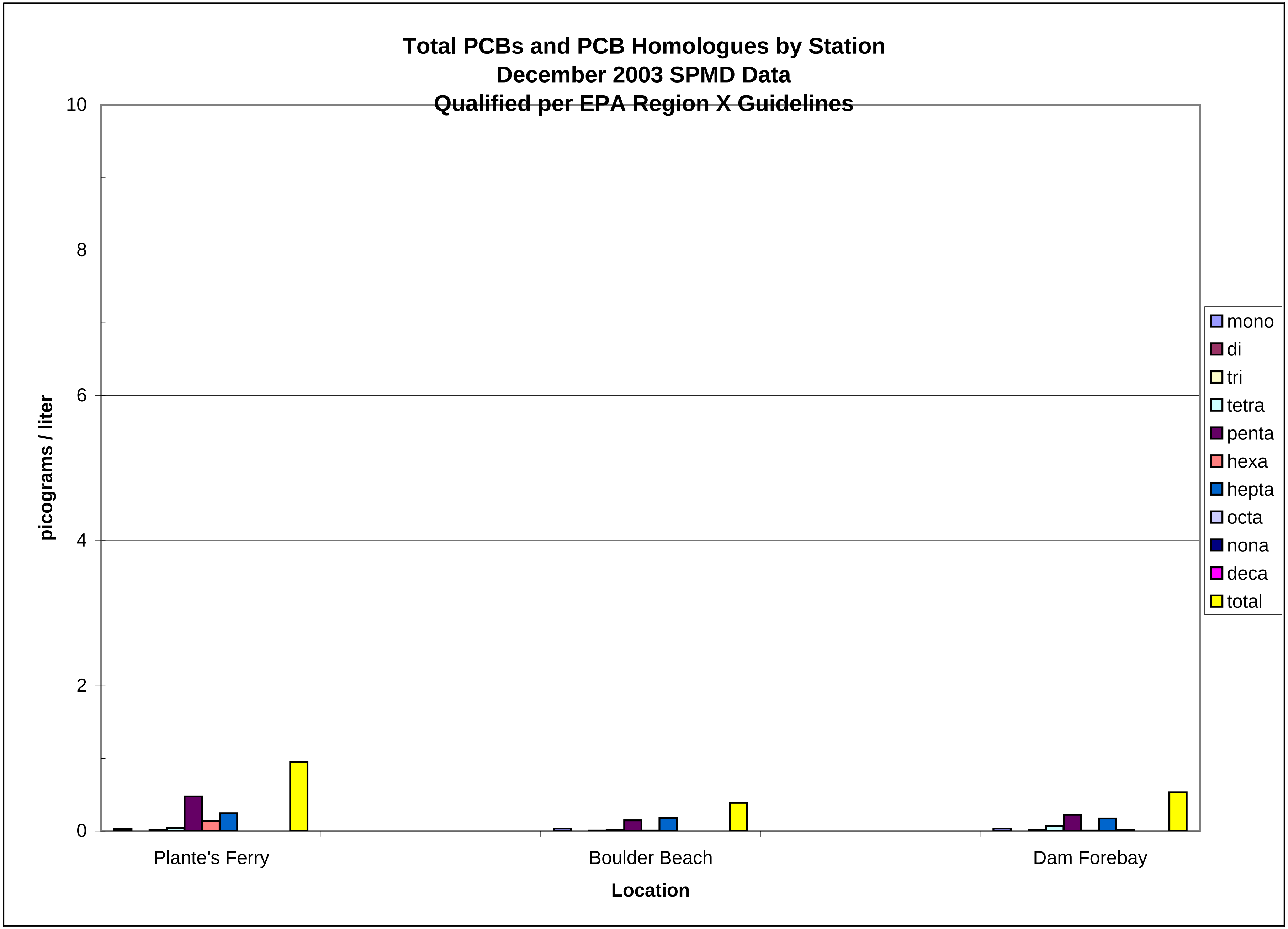
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 19
Total PCBs and Homologues - December 2003 SPMD Data Blank Corrected
Upriver Dam Spokane, WA



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 20
Total PCBs and PCB Homologues - August 2003 SPMD Data Blank Qualified
Upriver Dam Spokane, WA



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 21
Total PCBs and Homologues - December 2003 Data Blank Qualified
Upriver Dam Spokane, WA

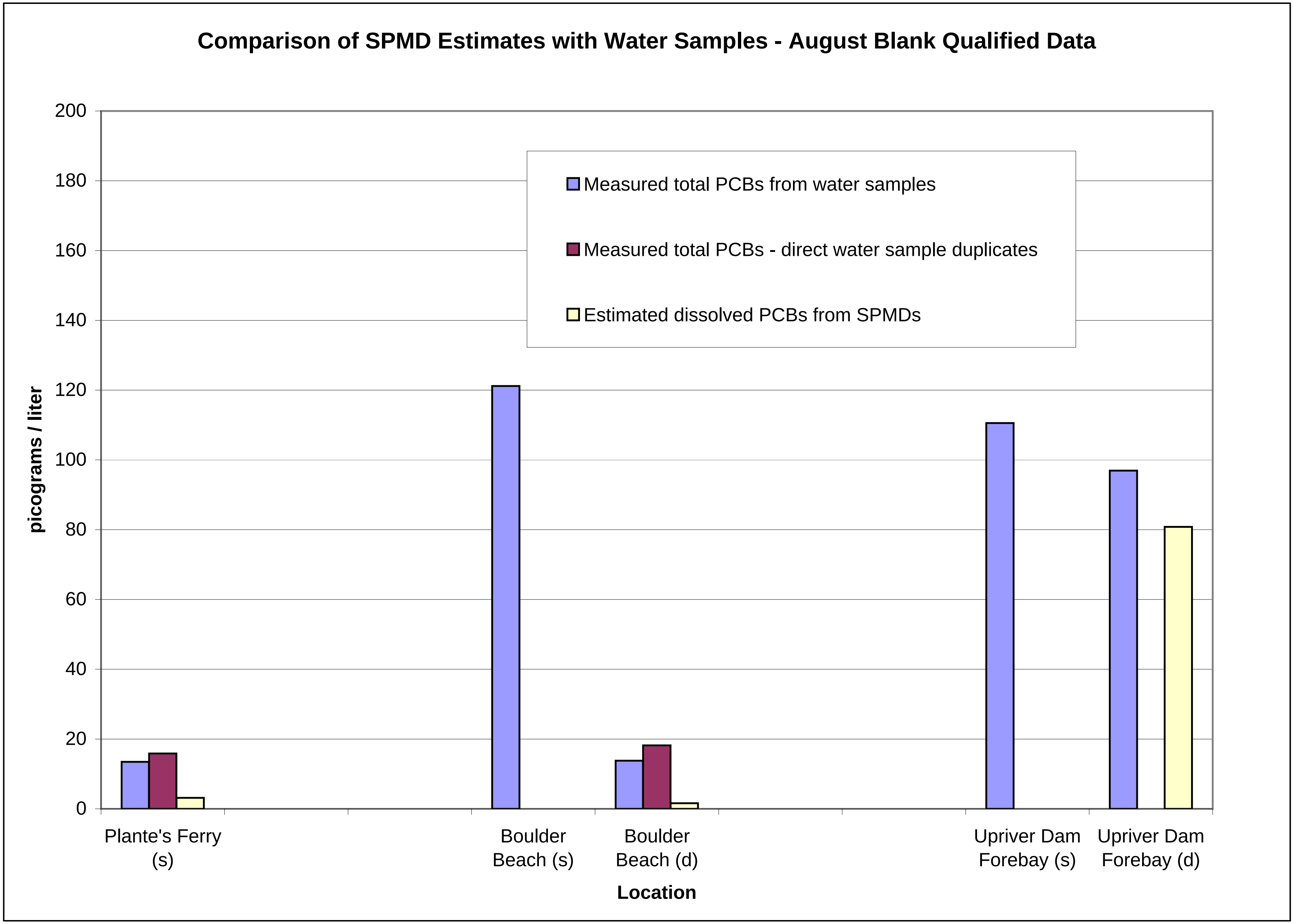


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Figure 22
Comparison SPMD Estimates with Direct Water Sampling - August 2003 Blank Qualified Data
Upriver Dam Spokane, WA

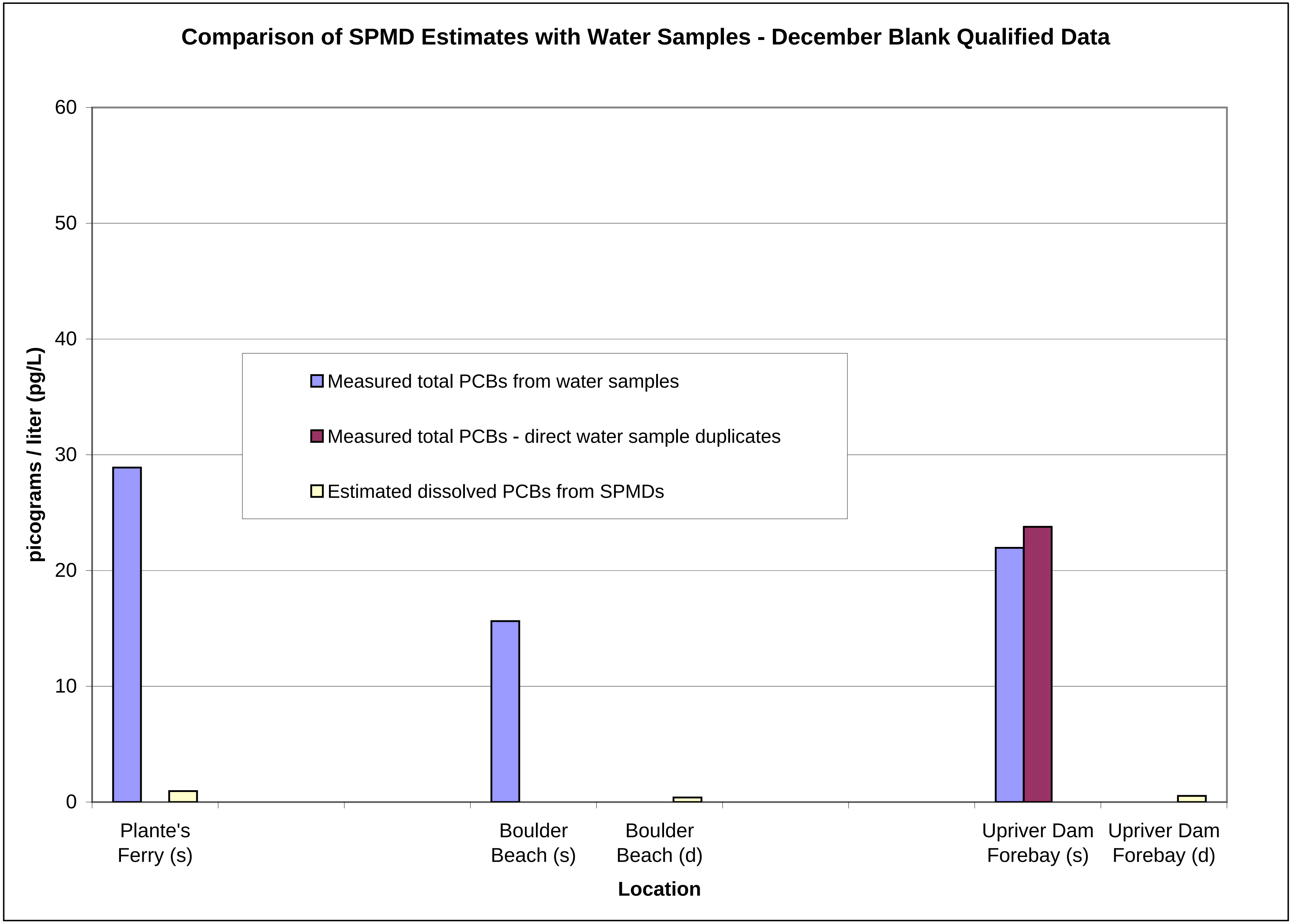

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Figure 23
Comparison SPMD Data Estimates with Direct Water Sampling - December 2003 Blank Qualified Data
Upriver Dam Spokane, WA

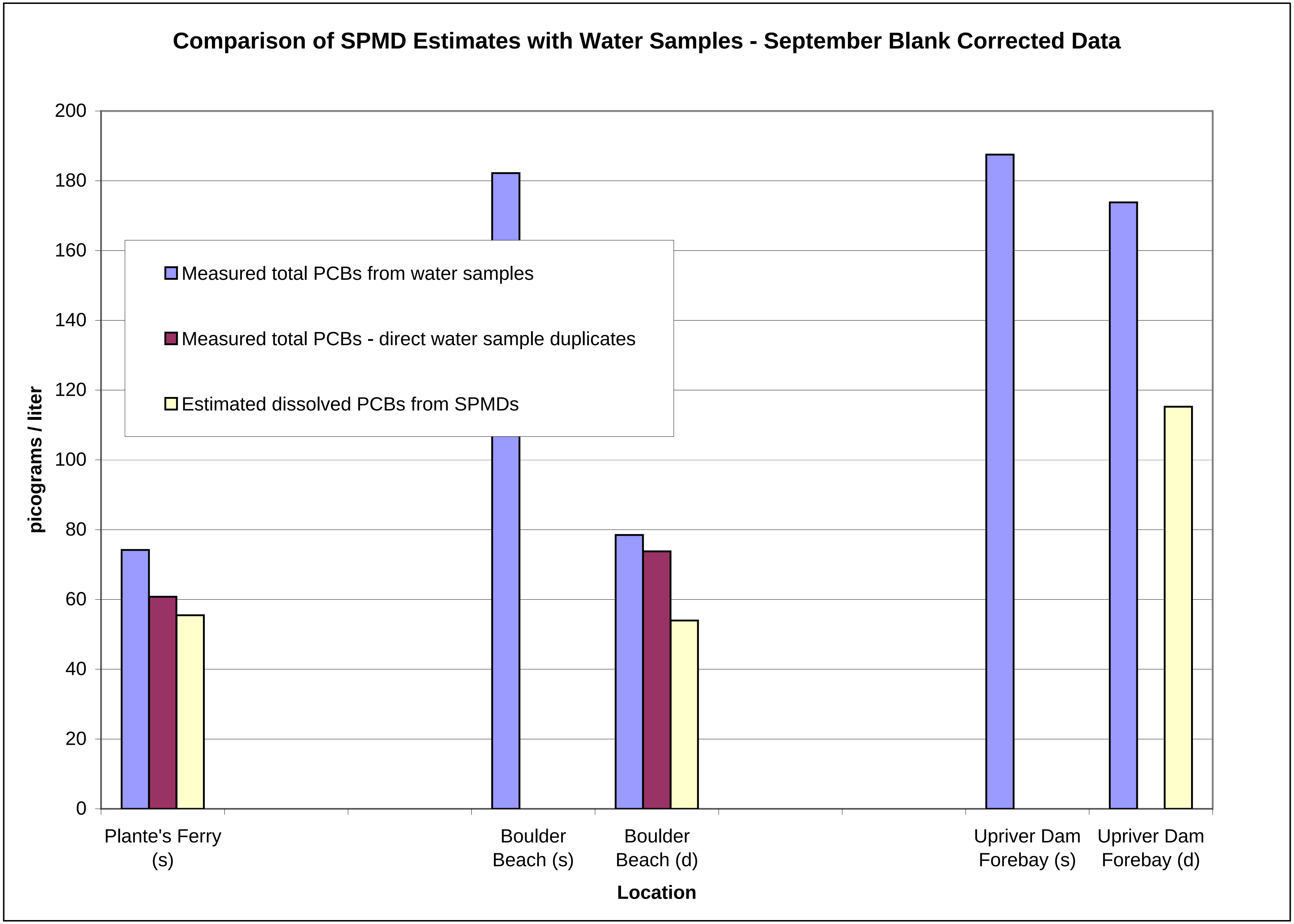

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Figure 24
Comparison SPMD Estimates with Direct Water Sampling - August 2003 Blank Corrected Data
Upriver Dam Spokane, WA

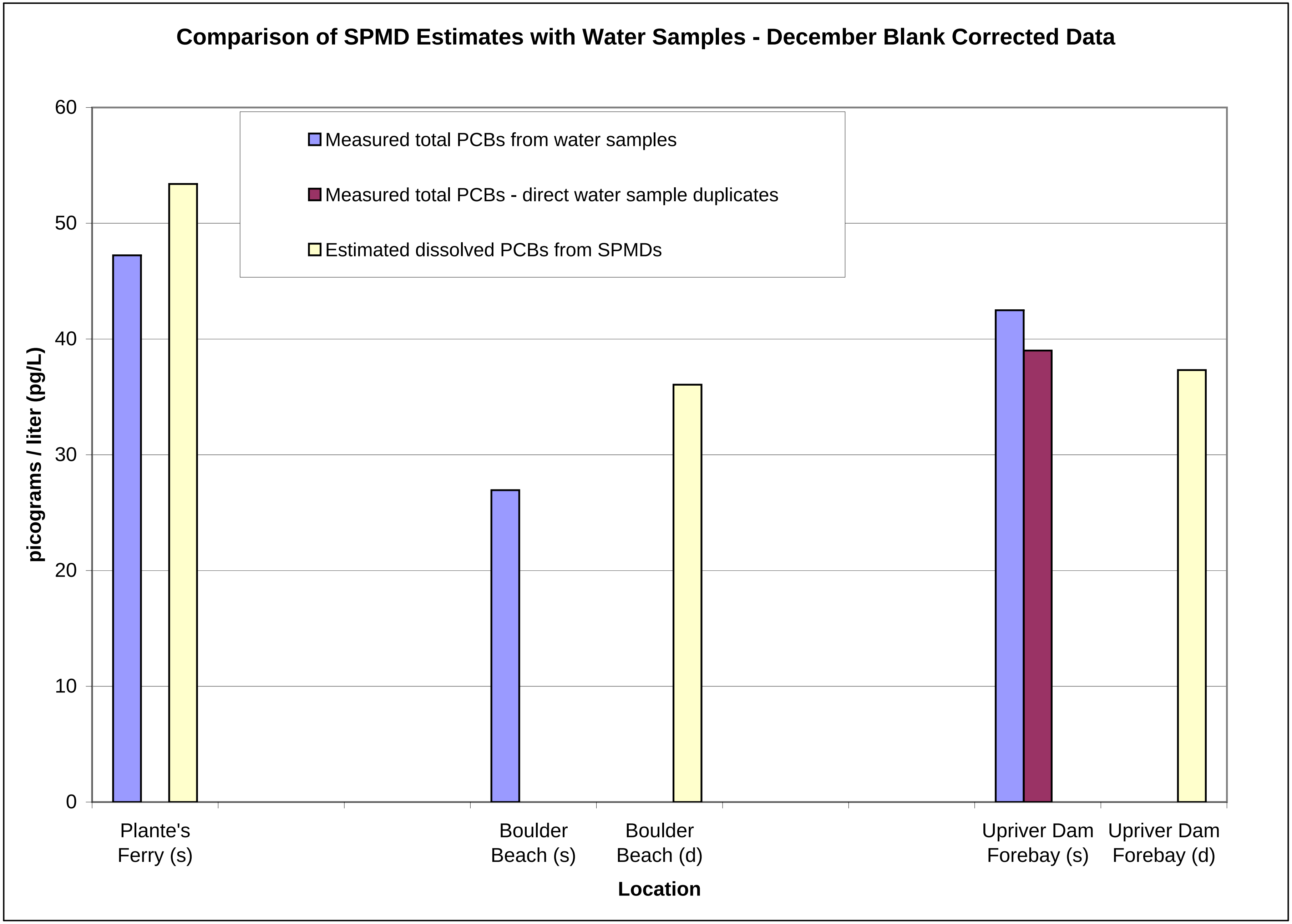

Figure 25
Comparison SPMD Data Estimates with Direct Water Sampling - December 2003 Blank Corrected Data
Upriver Dam Spokane, WA

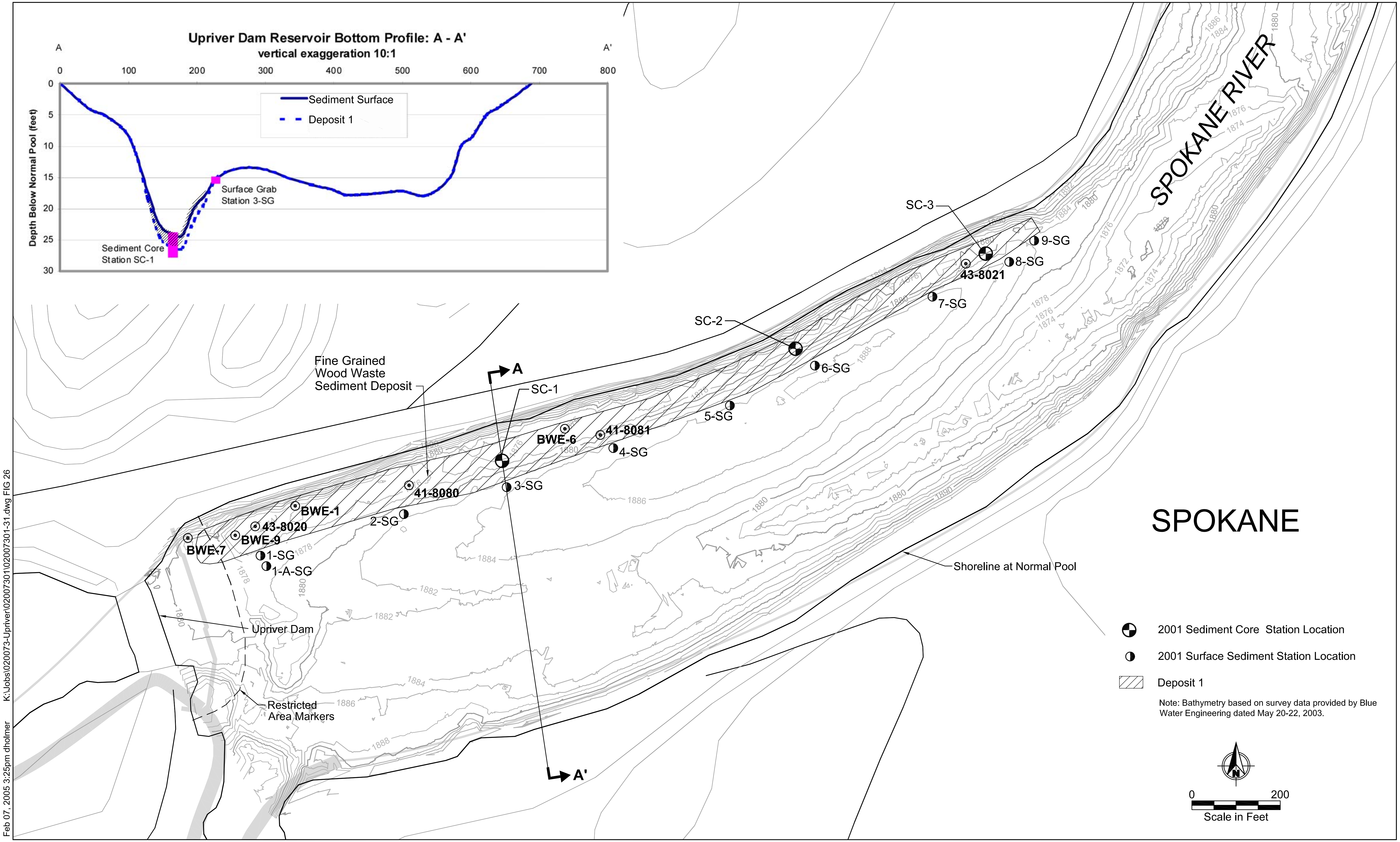

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Figure 26
Sediment Deposit Area 1 - Upriver Dam
Upstream of Upriver Dam
Spokane River, Washington

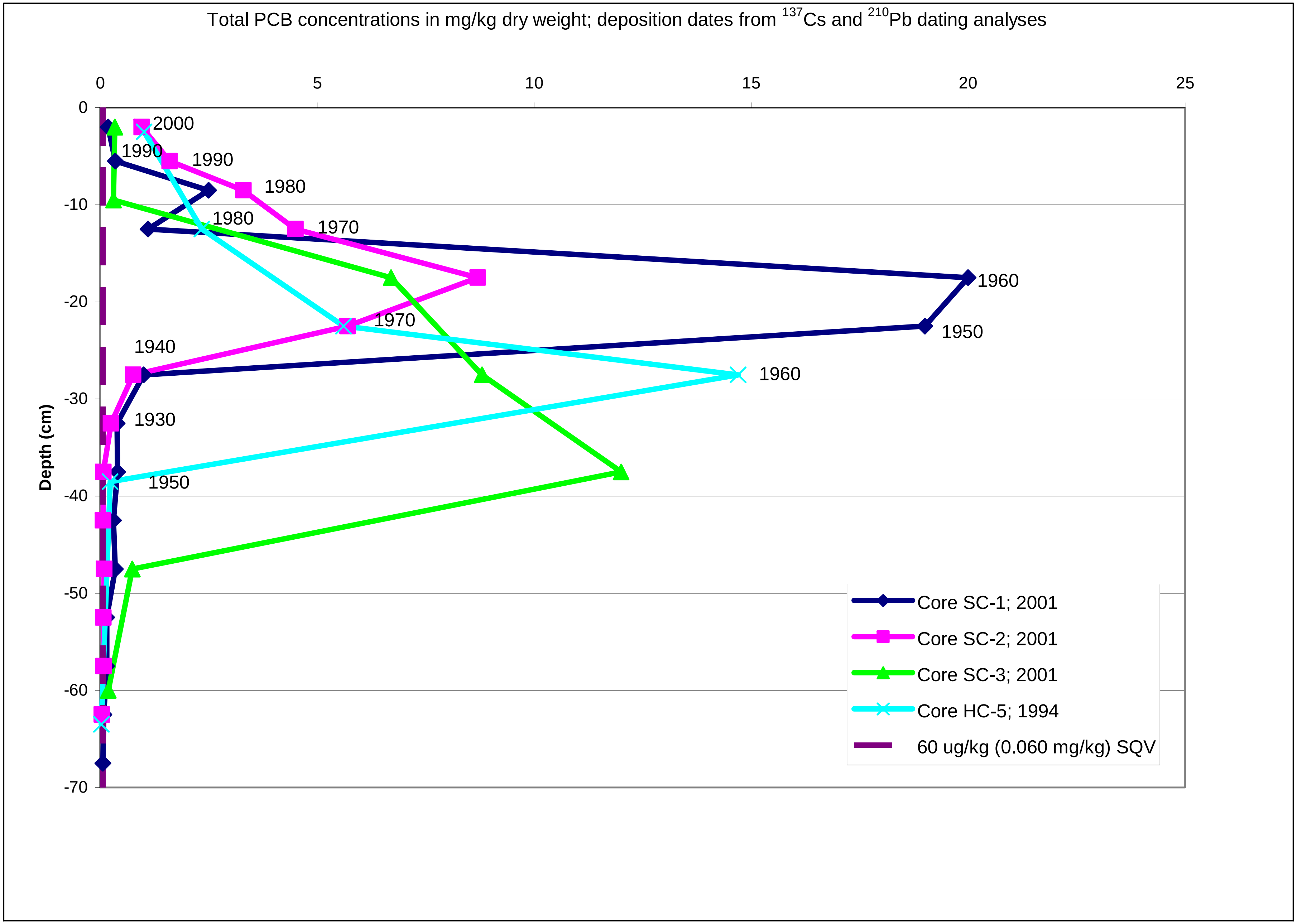

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Figure 27
Depth Profiles of PCB Concentrations in Sediments Above Upriver Dam
Upriver Dam Spokane, WA