Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River

Prepared for:
Spokane River Regional Toxics Task Force

September 15, 2016 DRAFT

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Executive Summary

The Spokane River begins in northern Idaho at the outlet of Coeur d'Alene Lake and flows west 112 miles to the Columbia River. The Spokane River and Lake Spokane have been placed on the State of Washington's 303(d) list of impaired waters because of concentrations of polychlorinated biphenyls (PCBs) that exceed water quality standards. The Spokane River Regional Toxics Task Force, comprised of NPDES permittees, state and local agencies, environmental groups, tribal sovereigns, EPA and other stakeholders), was formed with the objective to work collaboratively to characterize the sources of toxics in the Spokane River and identify and implement appropriate actions needed to make measurable progress towards meeting applicable water quality standards. This objective is being accomplished through the development of a Comprehensive Plan (SRRTTF, 2012b). This document presents that Comprehensive Plan.

Commented [PA1]: PCBs is not the sole reason the river and lake Spokane are on the 303(d) list.

Commented [PA2]: Incorporate the acronym afterwards

An extensive amount of data exists to support development of this Plan, including numerous studies by the Washington State Department of Ecology and recent monitoring efforts by the Task Force itself. These data were analyzed to estimate the mass of PCBs currently present in various source areas throughout the watershed, as well as the loading rate of PCBs to the Spokane River from various delivery mechanisms. PCBs produced intentionally through 1979, termed legacy PCBs, in buildings (i.e. small capacitors, sealants) and legacy soil contamination are estimated to be the largest source areas of PCBs in the watershed. The primary delivery mechanisms of PCBs to the Spokane River were determined to be cumulative loading across all wastewater treatment plants, contaminated groundwater, and stormwater/combined sewer overflows. PCB loading from Lake Coeur d'Alene and Spokane River tributaries are of similar magnitude to the other primary delivery mechanisms, due to much higher flow rates but with lower much concentrations of PCBs.

Because PCBs are introduced to the Spokane River from a number of different source areas and delivery mechanisms, a range of Control Actions (defined as "any activity which prevents, controls, removes or reduces pollution") are required to reduce PCB levels and ultimately attain water quality standards. A total of 45 Control Actions considered potentially applicable to address PCBs in the Spokane River were identified, and assessed in terms of costs and effectiveness. The specific Control Actions to be included in the Comprehensive Plan were determined at a SRRTTF workshop help in Spokane on July 27, 2016. Discussion of Control Actions at that workshop was divided into tiers of: 1) Control Actions already being implemented, and 2) Potential new Control Actions. Existing Control Actions were placed by the group into one of two categories. The first category contained the following Control Actions, where the group decided to maintain current efforts, and document those efforts in the Plan:

Commented [PA3]: I don't think that the Control actions are required to reduce PCB levels

- Wastewater Treatment
- Remediate Known Contaminated Sites
- Stormwater Controls
- Low Impact Development Ordinance
- Street Sweeping
- Purchasing Standards

The second category contained existing Control Actions where the group identified improvements that could be made to current efforts. These consisted of:

- Support of Green Chemistry
- PCB Product Testing Information
- Waste Disposal Assistance
- Regulatory Rulemaking
- Compliance with PCB Regulations
- Emerging End of Pipe Stormwater Technologies

Commented [PA4]: How? Purchasing chemicals that are "green chemistry"?

Commented [PA5]: What are these? For example, are jurisdictions suppose to obtain this info from companies? And if such info is not available, then what?

Commented [PA6]: What were these?

Potential new Control Actions were reviewed next, with two actions identified for inclusion in the Comprehensive Plan and a commitment to implementation:

- Identification of New Sites of Concern for Contaminated Groundwater
- Building Demolition and Renovation Control

Finally, eleven other new Control Actions were identified as being worthy of consideration in the future.

The Implementation Plan portion of this document lists milestones, timelines, and metrics to assess effectiveness for each of the new or expanded Control Actions. The effectiveness of SRRTTF's implementation of Control Actions will be assessed, in part, via annual preparation of an Implementation Review report which will compare actions conducted over the prior year to the timelines and effectiveness metrics spelled out in the Implementation Plan. The implementation review will provide flexibility to adapt strategies, phase out actions that are not working, and phase in new Control Actions as appropriate. In addition to annual review of the implementation of individual Control Actions, the Comprehensive Plan includes a five year reviewed to assess overall PCB loading and system response in terms of observed PCB concentrations in the river.

The Comprehensive Plan concludes with a section on Future Studies, which describes additional Control Action worthy of future consideration, as well as potential studies to be conducted to fill known data gaps about continuing PCB sources, delivery mechanisms, and environmental response.

1 Introduction

The Spokane River Regional Toxics Task Force (SRRTTF) was formed with the objective to work collaboratively to characterize the sources of toxics in the Spokane River and identify and implement appropriate actions needed to make measurable progress towards meeting applicable water quality standards. This objective is being accomplished for PCBs through the development of a Comprehensive Plan (SRRTTF, 2012b). This document presents that Comprehensive Plan, and this introductory section provides background information on the SRRTTF and the content of the Plan.

1.1 Creation and Membership of the SRRTTF

Washington NPDES wastewater discharge permits issued in 2011 by the Washington State Department of Ecology (Ecology) for facilities discharging into the Spokane River included the requirement for the creation of a Regional Toxics Task Force. These permits stated that the Task Force membership should include the NPDES permittees in the Spokane River Basin, conservation and environmental interests, the Spokane Tribe of Indians, Spokane Regional Health District, Ecology, and other appropriate interests. NPDES permittees who discharge to the Spokane River in Idaho subsequently agreed to participate in the Task Force, and their participation is now similarly required in their NPDES permits.

Commented [PA7]: I suggest to use either the Task Force or SRRTTF – not both.

The organization and governance of the Spokane River Regional Toxics Task Force is documented in a Memorandum of Agreement (SRRTTF, 2012a). Although participation is required by the permitting agencies (Ecology and EPA), the Task Force exists independent of, and therefore is not legally required to account to, Ecology or EPA. The Task Force includes voting members (representing NPDES permittees, state and local agencies other than Ecology, environmental groups and other stakeholders) and advisory members (Ecology, tribal sovereigns, and EPA). The Task Force currently consists of the following parties:

- Spokane County
- Liberty Lake Sewer and Water District
- Inland Empire Paper Company
- Kaiser Aluminum
- City of Spokane
- Spokane Regional Health District
- Washington State Department of Health
- Lake Spokane Association
- The Lands Council
- Spokane Riverkeeper
- Kootenai Environmental Alliance
- City of Coeur d'Alene
- Avista
- City of Post Falls
- Washington Department of Fish and Wildlife
- State of Washington: Represented by the Department of Ecology
- United States: Represented by the Environmental Protection Agency
- Spokane Tribe of Indians
- State of Idaho: Represented by the Department of Environmental Quality
- Coeur d'Alene Tribe
- Hayden Area Regional Sewer Board

1.2 Comprehensive Plan

The Comprehensive Plan as defined by the Task Force Work Plan (SRRTTF, 2012b) is a report that describes the data, analytical process, and the outcome of the analytical process regarding sources of PCBs to the Spokane River. The Plan will identify potentially applicable PCB Control Actions, assess the effectiveness of those Control Actions to reduce PCBs, and recommend a plan for implementation of Control Actions that are suitable toward PCB reduction in the Spokane River watershed. The activities to be contained in the Task Force's Comprehensive Plan are consistent with those activities subsequently defined in EPA's Plan for Addressing PCBs in the Spokane River (EPA, 2015).

This document provides that Comprehensive Plan. It is divided into sections describing:

- **Watershed Characterization:** Describes the environmental setting, available data, and impairment status of the Spokane River and its contributing watershed.
- **PCB Source Assessment:** Defines all known PCB sources and pathways and their respective magnitudes, the analyses used to determine these magnitudes, and key data gaps.
- **PCB Control Actions:** Defines the management practices under consideration to control PCBs, and the expected costs and removal efficiency of each option.
- **Implementation Plan:** Defines the specific PCB management practices recommended for implementation, the recommended schedule for their implementation and measurable milestones to assess implementation effectiveness.
- **Future Studies:** Describes future activities designed to assess implementation effectiveness, identify additional Control Actions worthy of future consideration, and fill identified data gaps.

2
Watershed Characterization

Development of a Comprehensive Plan requires an understanding of the environmental setting, available data, and impairment status. This section presents that information, divided into sub-sections of:

- Study Area
- Hydrology
- Land Use and Population
- Available data
- Impairment status

2.1 Study Area

The Spokane River begins in northern Idaho at the outlet of Coeur d'Alene Lake and flows west 112 miles to Franklin D. Roosevelt Lake in the Columbia River (Figure 1). The watershed covers more than 6,000 square miles (15,500 km^2) in Washington and Idaho. This Comprehensive Plan focuses on the portion of the watershed draining to the Spokane River upstream of Long Lake Dam. This segment of the watershed and river has been chosen to be the focus of the SRRTTF's initial efforts for several reasons:

- Discharges from all of the major municipal and industrial sources in the watershed are located in this section of the river;
- Virtually all urban area storm runoff in the watershed enters the river in this section;
- This section of the river contains numerous river flow gaging stations, which allow for the determination of in-stream loadings at multiple locations through semi-quantitative mass balance calculations;
- The vast majority of the aquifer/river interchange occurs In this section of the river, the impact of which has not been quantified by previous studies;
- The likelihood of making near term source contribution reductions is greatest in this section of the river given the concentration of point source and storm runoff locations and the significant level of unidentified source contribution; and
- The ability to monitor and assess the effectiveness of PCB reductions is enhanced by the ability to track in-stream loadings with the infrastructure present (gaging stations) in this section of the river.

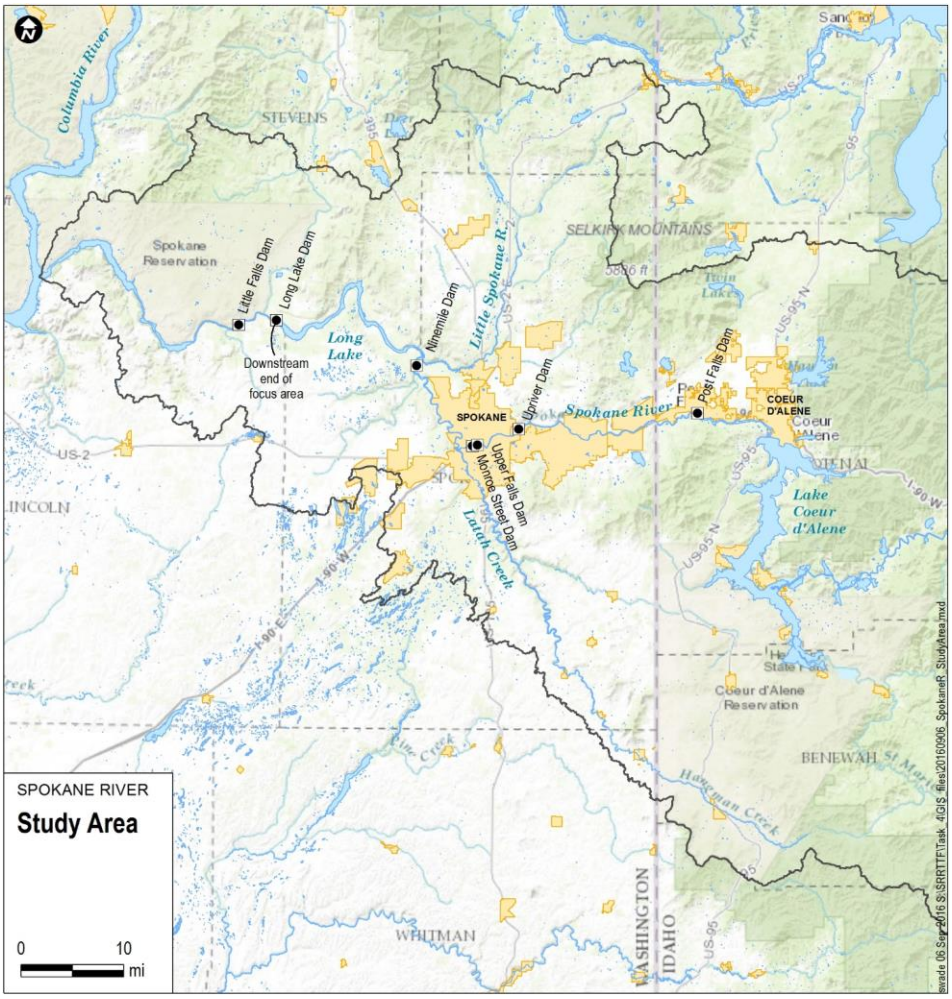

Figure 1. Spokane River Watershed

2.2 Hydrology

The hydrologic characteristics of the Spokane River watershed were described by Ecology (Serdar et al, 2011), which serves as the basis for the following description. The flow regime in the Spokane River is dictated largely by freezing temperatures in the winter followed by spring snowmelt. The annual mean flow for the years 1969-2016 was approximately 175,933 L/sec (6,213 cfs) at Post Falls. Average flows increased to 181,738 L/sec (6,418 cfs) at the Spokane Gage, reflecting the influx of groundwater and wastewater through this river reach. Prior to 1969 there were un-quantified agricultural diversions for irrigation from the Spokane River in the vicinity of Post Falls.

There are seven dams along the Spokane River:

1. Post Falls Dam (RM 100.8).
2. Upriver Dam (RM 80.2).
3. Upper Falls Dam (RM 74.5).
4. Monroe Street Dam (RM 74.0).
5. Ninemile Dam (RM 58.1).
6. Lake Spokane (Long Lake) Dam (RM 33.9).
7. Little Falls Dam (RM 29.3).

The dams create a series of pools which vary in length, the largest being 23-mile long Lake Spokane (also known as Long Lake, herein referred to as Lake Spokane). Downstream from Lake Spokane, the Spokane River forms the southern boundary of the Spokane Tribe of Indians reservation from Chamokane Creek (RM 32.5) to the Columbia River at RM 639.0.

2.3 Land Use and Population

The portion of the Spokane River watershed under focus for this Comprehensive Plan contains a diverse mixture of land uses (Figure 2). Approximately 11% of the focus area is in developed land use; 39% of the area is forested; and 23% of the area is in agricultural use. The river flows through the smaller cities of Post Falls and Coeur d'Alene in Idaho and large urban areas of the Spokane Valley and Spokane in Washington.

Total population in the Study Area watershed was estimated from 2011 census block group data obtained in GIS data format from the U.S. Census Bureau (https://www.census.gov/geo/maps-data/data/tiger-data.html). Population per acre was calculated for each census block group. The block groups were intersected with known watershed boundary delineations, with the area of each block group portion located inside a basin was multiplied by the population density. Those products were summed for each basin to obtain total population. The overall 2011 population for the Study Area watershed was estimated to be 571,045. Of this total, 401,976 people lived in watershed areas draining directly to the Spokane River; 57,669 people lived in watershed areas draining to Latah Creek; and 111,400 people lived in watershed areas draining to the Little Spokane River.

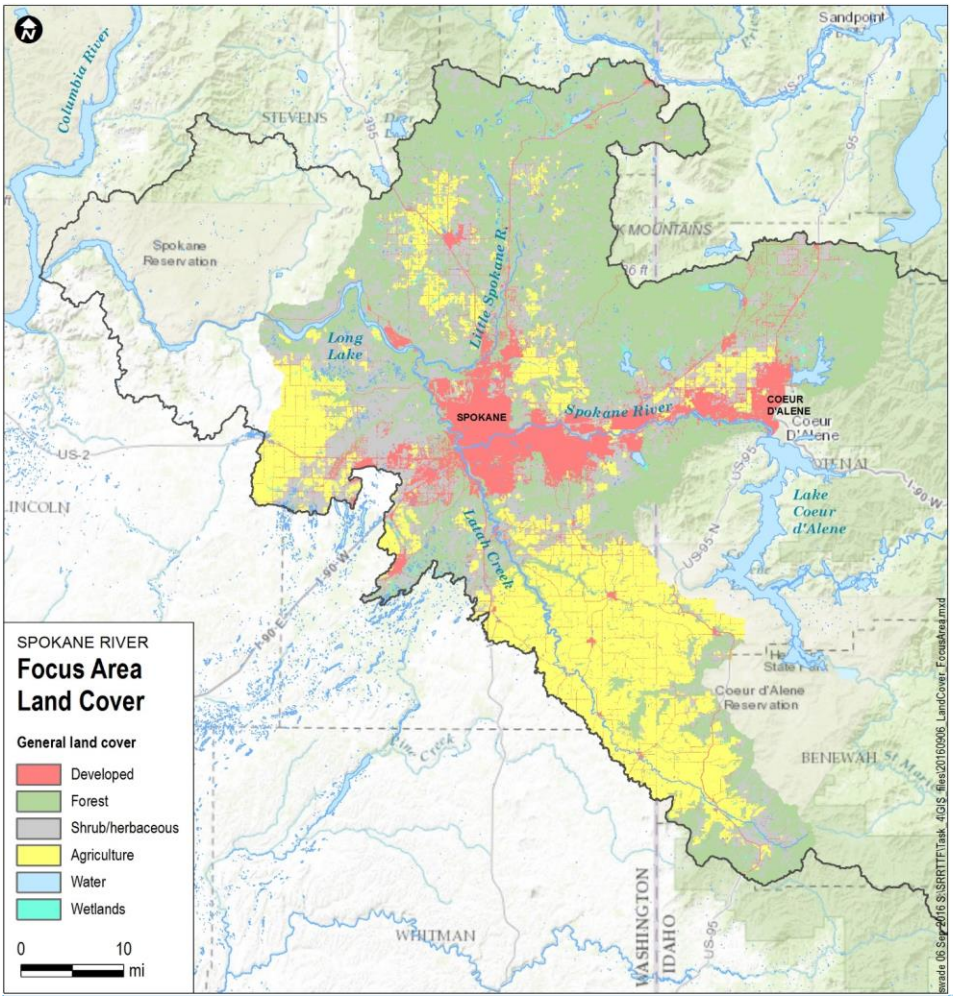

Figure 2. Land Use in the Area of Focus for the Comprehensive Plan

2.4 Available Data

A large amount of PCB-related data exists for development of the Comprehensive Plan. The available data are summarized here, in separate sections discussing a data compilation conducted in 2013 and data collected subsequent to that compilation.

2.4.1 2013 Data Compilation

Initial Task Force efforts included identification and collection of available data to define existing PCB sources and sinks. The intent of that work was to evaluate the quality and credibility of the available data

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Also, does the 2011 estimated population mention above refer to the study area identified within the black line?

relative to satisfying identified data needs, and to store the resulting data in a database facilitating its use later in the project. Approximately 45 data sets were obtained. All data were reviewed to determine whether they met data quality objectives, as the data that were gathered were collected under a wide range of QA/QC procedures. A graded approach was taken with the data review, with data quality divided into categories ranging from "highest quality, fully acceptable for subsequent use" to "lesser quality, suitable only for supporting 'weight of evidence' approaches." Information was collected for the following categories:

- Climate
- Commercial buildings constructed between 1950 and 1980
- Identified contaminated sites
- Illegal dumping/spills
- Number and size of smelters and incinerators
- Number of Vehicle Registrations
- Numbers and sizes of auto dismantlers, computer and electronics recyclers, transfer stations, landfills, metal recyclers, and white goods recyclers
- PCB and PCDD/F emissions from incineration activities
- measurements of PCB and PCDD/F concentrations
- PCBs and PCDD/Fs in Combined Sewer Overflows
- PCBs in fish tissue
- PCBs in groundwater
- PCBs in sediment
- PCBs in soil
- PCBs and PCDD/Fs in stormwater
- Spokane River and tributary water column measurements (e.g., temperature)
- Stormwater loads
- Stream flow information for Spokane River and tributaries
- Wastewater treatment plant loads
- Water column

All relevant data collected during were evaluated and stored in a Microsoft Access data base, which was provided to the SRRTTF. A more complete description of the data collected and the evaluation process is provided in LimnoTech (2013).

2.4.2 Data Collected After 2013

Several additional studies providing data relevant to the Comprehensive Plan were conducted after the 2013 data compilation discussed above. These studies are:

- SRRTFF 2014 Monitoring (LimnoTech, 2015): This report documents SRRTTF Phase 2 technical activities, which focused on carrying out a synoptic survey to identify potential unmonitored dry weather sources of PCBs to the Spokane River. The survey was successfully conducted between August 12 and 24, 2014. Sampling locations included seven Spokane River stations between Lake Coeur d'Alene and Ninemile Dam, one station in Latah Creek, and seven point source discharges. Analysis of the data identified a likely large (i.e. as large as any other single dry weather source) incremental PCB load entering the Spokane River between Barker Road and the Trent Avenue Bridge. There is also the possibility of a large incremental PCB load entering the Spokane River between Greene Street and the Spokane USGS gage. This report also provides PCB data collected at two locations in the Spokane River in May, 2014.
- SRRTTF 2015 Monitoring (LimnoTech, 2016c): This report documents a follow-up survey designed to confirm the findings of the 2014 survey and provide greater detail on the location of the unmonitored PCB source. The follow-up survey was successfully conducted from August 18 to 22, 2015. Sampling locations included five Spokane River stations between Barker Rd. and the Spokane USGS Gage, and three point source discharges. The presence of a large incremental PCB load entering the Spokane River between Barker Road and the Trent Avenue Bridge was confirmed, with the location of where the majority of the load enters the river load narrowed down to between Mirabeau Park and the Trent

Avenue Bridge. Homolog-specific mass balance analyses indicated the potential presence of another groundwater loading source entering the river downstream of the Trent Avenue Bridge.

- Spokane River Toxics Sampling 2012-2013 – Surface Water, CLAM and Sediment Trap Results (Era-Miller, 2014): Ecology conducted a study to evaluate several types of sample collection methods and analytical methods for toxics monitoring in the Spokane River during fall 2012 through spring 2013. Surface water composite grabs samples was not a good monitoring tool for low level PCBs in the Spokane River, as the PCB congener sample data in general did not give a clear environmental signal above the analytical background noise. The CLAM collection method was judged to be a good surrogate for grab sampling for PCB congeners in the Spokane River. Sediment trap sampling was rated "good" for PCB analysis.
- PCBs in Municipal Products (City of Spokane, 2015a): Nearly 50 product samples were collected and analyzed for PCBs using EPA Method 1668C. The majority of samples were composed of roadway, pipe, and vehicle maintenance products. Because PCBs are also ubiquitously detected in sanitary wastewater samples, five personal care products were sampled as well.
- PCBs in General Consumer Products (Ecology, 2014b): Ecology evaluated the presence of PCBs in general consumer products, with particular emphasis placed on products likely to be contaminated with PCBs due to the inadvertent production of PCBs in the manufacturing process (e.g. paints, newspapers, glossy magazines, cereal boxes, and yellow plastic bags). 68 products were tested for PCBs.
- Hydroseed Pilot Project (SRRTTF, 2015): In response to high levels of PCBs in Hydroseed identified during initial product testing by the City of Spokane (2015a), SRRTTF undertook a Hydroseed Analysis and Reformulation PCB Removal Pilot Project. The purpose of this study was to confirm the elevated levels observed from the City's original analysis and to identify specific component(s) that may be contributing to these elevated levels. Results from this analysis are intended to be used to assist manufacturers of Hydroseed to develop specifications and/or reformulations with reduced levels of PCBs.
- PCB Characterization of Spokane Regional Vactor Waste Decant Facilities (City of Spokane, 2015b): Stormwater runoff has been identified as contributor of PCBs to the Spokane River. The Eastern Washington Phase II Municipal Permit requires that stormwater catch basins be periodically cleaned out to remove buildup of solids. Previous testing by the City of Spokane had shown that catch basin sediment can contain orders of magnitude greater PCB content than the stormwater itself. Stormwater sediment is removed from catch basins in the Spokane area by using vacuum eductor trucks (vactors). Environmental concerns were raised in recent years about how this material was being handled. The primary goal of this project was to characterize the PCB content of the material at regional decant facilities.
- Screening Survey of PCBs in Little Spokane River Water, Sediment, and Fish Tissue (Ecology, 2016): The lower section of the Little Spokane River has been listed as being water quality-impaired for PCBs in fish tissue. The objectives of this study were to verify the level of PCB contamination in fish tissue fillets in 2014-2015 and attempt to spatially characterize the extent of potential PCB contamination in the Little Spokane River. Three fish species – rainbow trout, mountain whitefish, and northern pikeminnow – were analyzed as fillet composites at three sites. Although PCB levels were lower than those measured in 1994 and 1996, most fish tissue samples still exceeded the National Toxics Rule human health criterion for PCBs.
- 2012 Freshwater Fish Contaminant Monitoring Program (Ecology, 2014a): This report summarizes results from Ecology's Freshwater Fish Contaminant Monitoring Program in 2012 for three areas in Washington: the Spokane River, Pend Oreille River, and North Cascades National Park. The sampling goals were to: (1) characterize contaminant levels in fish, and (2) determine spatial and temporal patterns in contaminant levels in Spokane River fish. Results showed that levels of PCBs in fish from the Spokane River remain elevated compared to most areas in Washington.

- Long Term Monitoring at the Spokane River Spokane Tribal Boundary (Ecology, 2016c): This report provides a summary of Preliminary Findings to Date surface water monitoring at the Spokane Tribal boundary (just upstream of Chamokane Creek) during three hydrologic periods in 2015 – 2016.

2.5 Impairment status

The Spokane River and Lake Spokane have been placed on [Category 5 of] the State of Washington's 303(d) list of impaired waters because of concentrations of polychlorinated biphenyls (PCBs) that exceed water quality standards. The Spokane River and Lake Spokane exceed the water quality standard (170 pg/l – based on a fish consumption rate of 6.5 g/day) for PCBs. Fifteen waterbody segments of the Spokane River and Lake Spokane and one segment of the Little Spokane River are on the 2008 303(d) list for exceeding human health water quality criteria for PCBs. It is noted that the PCB concentrations utilized to place these waters on the 303(d) list were derived from fish tissue concentrations and a bioconcentration factor rather than direct water column measurement. The Spokane Tribe of Indians have water quality standards for PCBs in the Spokane River below Lake Spokane that are more than 95% lower than State standards (1.3 pg/l), based on a higher fish consumption rate (865 g/day) than the general population (Spokane Tribe of Indians, 2010). PCBs are not listed in Idaho.

Commented [PA9]: Same comment as previous. TMDLs are another reason for category 5 listing and TMDLs exist for other constituents (i.e. DO, metals, etc.)

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3 PCB Source Assessment

The intent of a PCB source assessment is to define PCB sources and pathways and their respective magnitudes, in order to identify key sources to be reduced via the implementation of Control Actions. The source assessment is also designed to identify key data gaps contributing to uncertainty in estimates of these sources and pathways, to help guide future monitoring efforts. The source assessment for PCBs in the Spokane River was conducted in two steps:

- Define the range of potentially important the sources of PCBs in the Spokane River watershed and the pathways by which these PCBs are delivered to the river
- Define the magnitude of the sources and pathways identified above, along with key data gaps.

Determination of the sources and pathways of PCBs in the Spokane River Watershed is described in detail in LimnoTech (2016a), which is included as Appendix A to this Comprehensive Plan. The calculation of the magnitude of these sources and pathways is described in detail in LimnoTech (2016b) and included as Appendix B to this Plan. The remainder or this section summarizes how these sources and pathways were determined, and how their magnitudes were estimated. It is divided into three sub-sections, corresponding to:

- PCBs Source Areas
- Delivery mechanisms of PCBs to the Spokane River
- Transport pathways between sources and delivery

3.1 PCBs Source Areas

There is the potential for confusion when discussing PCB sources, as the term "sources" commonly refers to the true origin of the contaminant. In the case of PCBs, the dominant source was intentional production by Monsanto through 1979. Although this source no longer exists, those legacy PCBs now exist throughout the environment. The Comprehensive Plan follows the nomenclature of SFEI (2010) and uses the term "source areas" to represent those environmental compartments containing PCBs. Source areas are defined as the places where PCBs were used, inadvertently released, systematically discarded or accumulated. Source areas of PCBs are divided into three broad categories in this Plan, based on refinement of earlier PCB source characterization done for San Francisco Bay (SFEI, 2010) and Spokane (LimnoTech, 2013). Source areas of PCBs are divided into three broad categories for purposes of discussion here:

Commented [PA10]: What does this stand for?

- Legacy source areas of PCBs currently present in the Spokane watershed
- Ongoing source areas of PCBs continuing to be introduced to the watershed via inadvertent production in commercial products
- Environmental transport of non-local PCBs into the watershed study area, which may either be legacy or continuing source areas

Legacy source areas correspond to PCBs that were brought into the Spokane watershed in the past, but are not continuing to be produced. These were produced by Monsanto and marketed as Aroclors which were used in machine oils, transformers, etc. Legacy sources can be further divided into categories of buildings, environmental, and industrial equipment. Building source areas can either be fixed to the building itself (e.g., paint, caulk) or non-fixed and removable (e.g., light ballasts). Legacy environmental source areas of PCBs correspond to contaminated surface soils, contaminated subsurface

soils/groundwater, and in-place aquatic sediments in the Spokane River and Lake Spokane. Historically produced PCBs are also still contained in various forms of electrical equipment such as transformers and hydraulic equipment.

Despite the ban on the intentional production of PCBs instituted in 1979, PCBs still continue to be inadvertently produced in the chemical synthesis of many commercial products. Characterization of PCB loads from inadvertent sources have identified pigments in printed materials/fabrics (Guo et al, 2013) and paints (Hu and Hornbuckle, 2010) as two primary categories of inadvertent production. It is recognized that inadvertent PCB production occurs in other categories of products as well, although the magnitude of these other sources is largely unknown and/or considered to be much smaller than sources in the first two categories.

PCBs also enter the Spokane watershed study area via non-local source areas. Non-local source areas can either be delivered via the atmosphere or enter the river from Lake Coeur d'Alene. The term "non-local" is used to distinguish source areas that originate outside of the watershed from atmospheric sources that originate from the volatilization of PCBs in the Spokane watershed. It is recognized that these non-local environmental source areas can originate from either legacy PCB source areas or ongoing inadvertently produced sources.

The amount of mass contained in each PCB source area was estimated using available data and literature values, with specific calculations provided in Appendix B. The resulting estimates are provided in Table 1 and Figure 3 specified as ranges, sometimes covering an order (or orders) of magnitude, because of the extensive reliance on literature values. Although uncertain, these estimates are still worthwhile in distinguishing between source areas as likely significant or relatively unimportant in developing the Comprehensive Plan. Legacy PCBs in buildings (e.g. small capacitors, caulks) and legacy soil contamination are estimated to be the largest source areas of PCBs in the watershed.

Table 1. Mass of PCB Estimated in each Source Area Category

Source Area Category	PCB Mass (kg)
Legacy	
Building sources	
Non-fixed[1]	50 – 40,000
Fixed[2]	60 - 130,000
Environmental	
Watershed soils	550 - 55,000
Sub-surface soils – cleanup sites	Unknown
Spokane R. deep sediments	4 -100
L. Spokane deep sediments	8 - 200
L. Spokane shallow sediments	0.4 - 10
Spokane R. shallow sediments	0.06 – 0.15
Industrial equipment	6.4 - 25
Ongoing	
Inadvertent production	0.2 – 450
Non-Local Environmental	
Lake Coeur d'Alene	~0 – 0.047
Atmospheric	Unknown

[1] PCBs in small capacitors in items such as appliances and lamp ballasts.
[2] Building materials such as paints and sealants (e.g. caulks).

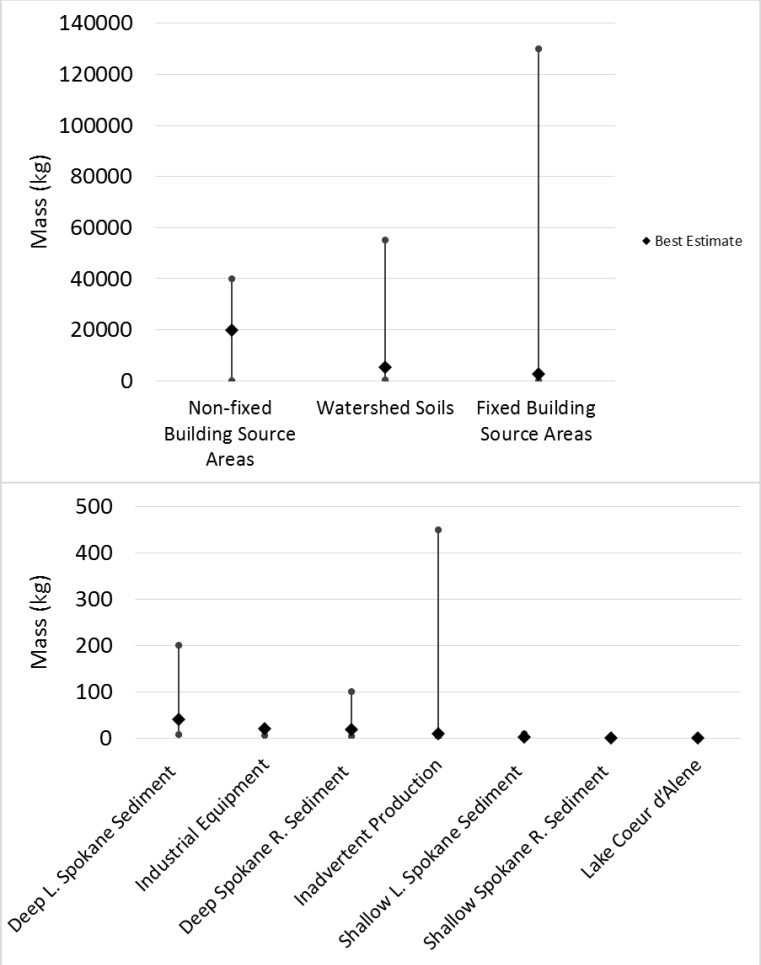

Figure 3. Estimated Range of Mass of PCB in each Source Area Category (Note the large difference in scale between the two embedded graphs)

3.2 Delivery Mechanisms of PCBs to the Spokane River

PCBs were determined by LimnoTech (2016a) to be delivered to the Spokane River study area via a number of mechanisms, consisting of:

- Transport of PCBs from upstream sources through Lake Coeur d'Alene
- Atmospheric deposition
- Groundwater loading
- Stormwater runoff, either as part of an MS4 stormwater system or via direct drainage
- Combined sewer overflows (CSOs)

- Tributaries
- Discharge from municipal and industrial wastewater treatment plants
- Discharge of waste water and stocking of fish from fish hatcheries
- Diffusion or resuspension of PCBs from bedded sediments in the Spokane River and Lake Spokane

The mass loading rate for PCBs estimated in each source category was estimated using available data and literature values, with the specific calculations provided in Appendix B and results provided below in Table 2 and Figure 4. The primary delivery mechanisms of PCBs to the Spokane River were determined to be cumulative loading across all wastewater treatment plants, contaminated groundwater, and stormwater/combined sewer overflows. PCB loading from Lake Coeur d'Alene and Spokane River tributaries are of similar magnitude to the other primary delivery mechanisms, due to much higher flow rates but with lower much concentrations of PCBs.

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Table 2. PCB Loading Rates Estimated for each Delivery Mechanism

Delivery Mechanism	PCB Loading Rate (mg/day)
WWTPs	
Total Municipal	6 - 2652
Total Industrial	48 - 271
Groundwater loading	60 - 300
Upstream sources	~0 - 260
Tributaries	
Latah Creek	~0 - 215
Little Spokane River	15-200
MS4 stormwater/CSOs	15 - 94
Bottom sediments	0.2 - 20
Fish hatcheries	Unknown
Atmospheric deposition to surface water	<0

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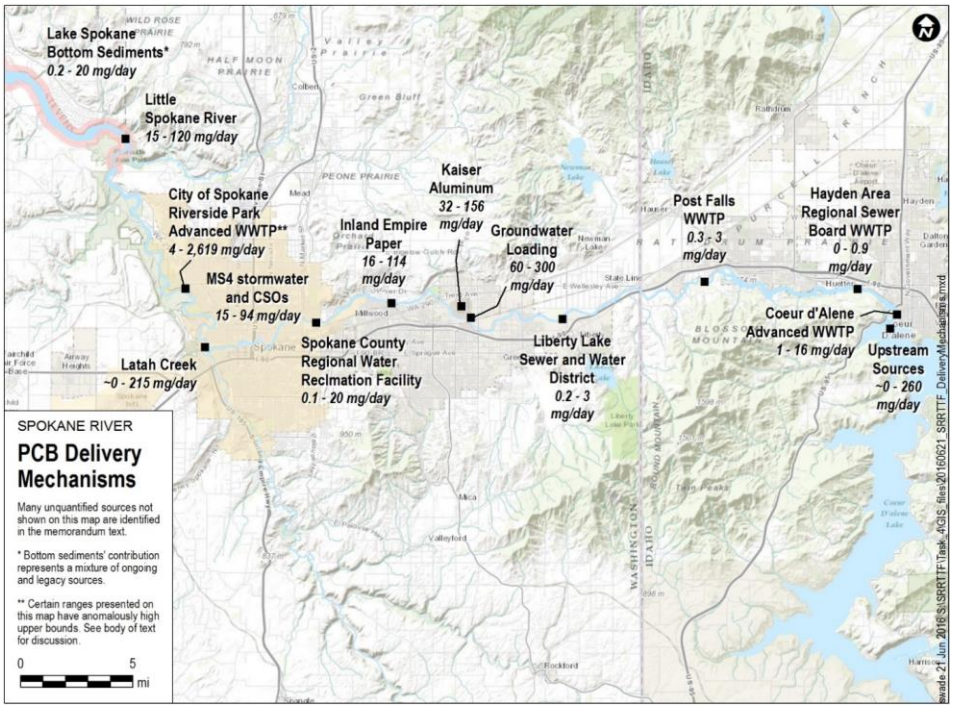

Figure 4. Estimated Range of PCB Loading Rates (mg/day) for each Delivery Mechanism

3.3 Transport Pathways between Source Areas and Delivery

Although quantitative estimates were generated for the PCB mass currently residing in the watershed and for the magnitude of different delivery mechanisms to the Spokane River, much less information was available to quantify the transport pathways between these source areas and delivery mechanisms. The primary categories transport pathways linking PCB source areas to delivery mechanisms are defined as:

- Mobilization in the watershed
- Volatilization to the atmosphere
- Delivery to sewer infrastructure
- Contribution to groundwater

Many of the watershed source areas of PCBs are not immediately available for transport to the river, and must first undergo a mobilization step. Mobilization in the watershed occurs via several mechanisms. For example, fixed building sources can be released to surface soil during building demolition and PCBs contained in industrial sources can be mobilized via spills to surrounding soils. The magnitudes of these individual mobilization pathways were estimated to the extent possible, with results shown in Figure 5. Mobilization from fixed building sources appears to be a significant transport pathway, and mobilization from non-fixed building sources, consumer product, and land application also identified as potentially important pathways. Insufficient data exist to define the magnitude of pathways between this initial mobilization step and delivery to the Spokane River.

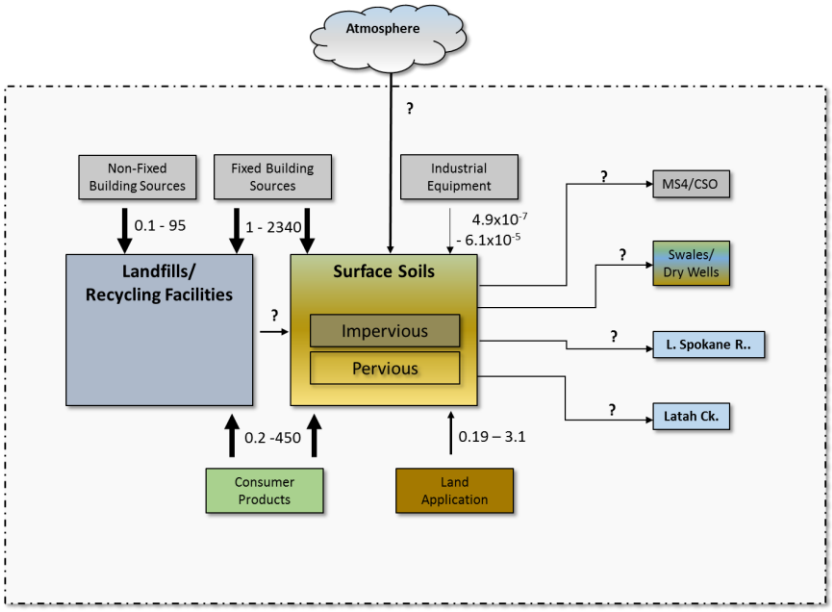

Figure 5. Estimated Magnitudes (kg/yr) for Watershed Mobilization Pathways

Numerous sources contribute to local atmospheric concentrations of PCBs via volatilization, i.e. conversion into a gas phase. Most of these pathways consist of volatilization directly from one of the previously listed source categories (i.e., buildings, surface soils). Volatilization from contaminated surface soils was determine to be the dominant pathway of PCBs to the atmosphere, with an estimated volatilization load of 16-1600 kg/yr. Potential combustion sources (e.g., incinerators, residential burning) were estimated to contribute an atmospheric load of 17 kg/yr. Volatilization of land-applied wastewater treatment sludge was determined to be negligible. Little definitive information exists on the specific amount of PCBs delivered to the Spokane area from atmospheric source areas. Ecology's Environmental Assessment Program (Ecology, 2016b) is currently undertaking a study that will provide information on this transport pathway.

The Spokane watershed contains a range of sewer infrastructure capable of delivering PCBs, either directly or indirectly, to the river. This infrastructure can be broadly divided into categories of stormwater and wastewater. Stormwater infrastructure can be further divided into categories of systems that directly discharge directly to the river and those that do not directly discharge (e.g., dry wells). No quantitative estimate exists defining the quantity of PCBs being delivered to the stormwater system, although a lower bound estimate of loading to the City of Spokane's MS4 system can be obtained from the stormwater loading estimate provided above of 0.01 kg/year. No information exists to estimate PCB loading to non-discharging stormwater systems. An estimate of PCBs delivered to municipal wastewater systems was derived from observed influent PCB concentrations, and caculated at 0.77 kg/yr.

The final intermediate transport pathway is contribution to groundwater. Subsurface soils can contribute to groundwater either via legacy contamination, landfill disposal of PCB-containing products, leaking submersible well pumps, or private septic systems. The Magnitude of Source Areas section above concluded that insufficient data exist to estimate the total mass of legacy subsurface PCB contamination; correspondingly, insufficient data are available to estimate the rate at which this legacy subsurface

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contamination contributes to groundwater. A lower bound estimate can be gained from the groundwater loading calculation presented above in the Magnitude of Delivery Mechanisms section, which estimated the groundwater loading in the river section directly below Mirabeau Park at 0.054 kg/year. This is considered a lower bound estimate because it only considers legacy contamination loading from a portion of the aquifer. No data were found describing groundwater PCB loading from landfills, although modern landfills are designed and operated to prevent any adverse effects to groundwater. No quantitative information was available describing the rate of leakage from submersible well pumps or the rate at which private septic systems are delivering PCBs to the groundwater.

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Maybe include section #s if/when referencing within the text

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4
PCB Control Actions

As discussed above, PCBs are introduced to the Spokane River from a number of different source areas, transport pathways, and delivery mechanisms. This diversity of sources and pathways requires the application of a diverse range of Control Actions to reduce PCB levels and ultimately attain water quality standards. In addition, there are a wide range of PCB Control Actions that have been applied elsewhere for various source areas and pathways, that may or may not be applicable for Spokane. Evaluation of PCB Control Actions for inclusion in the Comprehensive Plan was conducted in three steps:

- Definition of the inventory of Control Actions to be evaluated for the Spokane River
- Evaluation of the cost and effectiveness of each PCB Control Action under consideration
- Definition of the specific Control Actions to be included in the Comprehensive Plan

The inventory of Control Actions to be evaluated in the Spokane River watershed is described in detail in LimnoTech (2016b), which is included as Appendix C to this Comprehensive Plan. The evaluation of the cost and effectiveness of each of PCB Control Actions under consideration is described in detail in LimnoTech (2016e), which is included as is included as Appendix D. The specific Control Actions to be included in the Comprehensive Plan were determined at a SRRTTF workshop help in Spokane on July 27, 2016. This section describes how these Control Actions were identified, evaluated, and selected for inclusion in the Comprehensive Plan. It is divided into three sub-sections, corresponding to:

- Inventory of Control Actions to be evaluated
- Evaluation of Control Action cost and effectiveness
- Selection of Control Actions for inclusion in the Comprehensive Plan

4.1 Inventory of Control Actions to Be Evaluated

Identification of the universe of Control Actions that have the potential to reduce PCB loading to the Spokane River is a necessary first step in the development of the Comprehensive Plan. These Control Actions have commonly been referred to as Best Management Practices (BMPs) in other studies. The term Best Management Practice is not being used in the Comprehensive Plan, because it has a specific legal meaning that varies between Washington and Idaho. In the context of the Spokane River Comprehensive Plan, Control Actions are defined consistent with SFEI (2010) as "any activity, technology, process, operational method or measure, or engineered system, which when implemented prevents, controls, removes or reduces pollution." The Control Actions identified for consideration in the Comprehensive Plan were obtained from several sources:

- BMP Toolbox for the San Francisco Bay Area (SFEI, 2010)
- Stormwater Management Manual for Eastern Washington (Washington Department of Ecology, 2004)
- Spokane Regional Stormwater Manual (Spokane County, City of Spokane, and City of Spokane Valley, 2008)
- Spokane River Regional Toxics Task Force February 6-8, 2016 Workshop
- PCB Chemical Action Plan (Washington Department of Ecology, 2015)
- Discussions within the SRRTTF BMP subgroup

For purposes of initial assessment, Control Actions were divided into the following four categories based upon discussions of the SRRTTF BMP planning group.

- Institutional
- Stormwater Treatment
- Wastewater Treatment
- Site Remediation

Institutional Control Actions include information sharing (educational campaigns) and governmental practices to help businesses and the general public identify, avoid, clean up and/or properly dispose of products containing PCBs. These control actions require the least amount of infrastructure, engineering work, maintenance, and disturbance of existing land because their intent is to avoid the continued use, inadvertent production, or release of PCBs. Institutional control actions can be further broken down into two categories, government practices and educational control actions. Governmental practices can include regulatory actions that restrict the use or disposal of PCB-containing items, as well as providing incentives for voluntary programs such as hazardous waste take-back programs. Educational control actions consists of activities that will indirectly reduce loading of PCBs, by altering public behavior and/or providing information to help direct future PCB reduction efforts. Stormwater Treatment Control Actions are engineered options to be installed or built with the existing storm sewer infrastructure to capture soil and water containing PCBs and prevent it from being discharged to the Spokane River. Wastewater treatment Control Actions are those intended to reduce the loading of PCB from municipal and industrial wastewater treatment plants (WWTPs), either by actions to reduce the amount of PCBs being delivered via influent to the WWTP or increasing the rate of PCB removal with the WWTP itself. Site remediation Control Actions involve: 1) identifying, and 2) cleaning up soil/groundwater that have been contaminated from past use of PCBs, before they can be mobilized and transported to the river.

A total of 45 Control Actions considered potentially applicable to address PCBs in the Spokane River were identified. Each Control Action ultimately considered is listed by category in Table 3. Summary descriptions of each of these Control Actions are provided in Appendix D of this Plan.

Table 3. Menu of Control Actions Identified as Potentially Applicable for Reducing PCB Loads to the Spokane River and Lake Spokane

Category	Sub-Category	Control Action
Institutional	Government Practices (Regulatory Actions and/or Incentivized Voluntary Programs)	Disposal assistance for PCB-containing items
		Land use/development ordinance that encourages LID
		Leaf removal
		Street sweeping
		Catch basin/pipe cleanout
		Purchasing standards
		Survey of local utilities for electrical equipment
		Regulation of waste disposal
		Removal of carp from Lake Spokane
		Building demolition control actions
		PCB-product labeling law
		Leak prevention/detection in electrical equipment
		Accelerated sewer construction
		PCB identification during inspections
		Regulatory rulemaking
		Compliance with PCB regulations
		Support green chemistry alternatives
	Educational	Survey of PCB-containing materials in schools/public buildings
		Education/outreach about PCB sources
		Education about discharge through septic systems in aquifer recharge area
		Education about filtering of post-consumer paper products
		PCB product information

Table 3 (continued). Menu of Control Actions Identified as Potentially Applicable for Reducing PCB Loads to the Spokane River and Lake Spokane

Category	Sub-Category	Control Action
Stormwater Treatment	**Pipe Entrance**	Infiltration control actions
		Retention and reuse control actions
		Bioretention control actions
		Isolation of contaminated source areas from the MS4
		Filters
		Screens
		Wet vault
		Hydrodynamic separator
	End of Pipe	Constructed wetlands
		Sedimentation basin
		Discharge to ground/dry well
		Diversion to treatment plant
		Fungi (mycoremedation) or biochar incorporated into stormwater treatment
Wastewater Treatment		Development of a Toxics Management Action Plan
		Implementation of a source tracking program
		Chemical fingerprinting or pattern analysis
		Remediation and/or mitigation of individual sources
		Elimination of PCB-containing equipment
		Public outreach and communications
		Review of procurement ordinances
		Pretreatment regulations
Site Remediation		Identification of contaminated sites
		Clean up of contaminated sites

4.2 Evaluation of Control Action Cost and Effectiveness

The second step in identifying those Control Action that may be most appropriate for inclusion in the Comprehensive Plan consisted of a detailed review of the inventory of Control Actions listed above. This section summarizes that review, and is divided into sections of Review Factors and Findings. A more detailed description of this assessment is provided in Appendix D.

4.3 Review Factors

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Each Control Action was reviewed with respect to the following factors:

- Magnitude of pathway
- Reduction efficiency
- Cost
- Implementing entity

- Pollution prevention hierarchy
- Potential overlap with existing efforts
- Ancillary benefit
- Timeframes for implementation and results

The information gathered for this review indicated that many of the reviewed Control Actions have no quantitative information available on costs or effectiveness. In addition, the magnitude of the transport pathways between many source areas and delivery mechanisms as discussed above were determined to be either highly uncertain, or unknown. Because quantitative information was lacking for many aspects of this review, a qualitative scoring system was used. The definition of each aspect of the review, as well as the qualitative ranking system used, is described below.

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"Magnitude of Pathway" describes the importance of the pathway in terms of delivering PCBs to the river or lake from the source area or pathway being targeted by the Control Action. Control Actions that interrupt significant pathways may be very effective in preventing PCB sources from contributing PCBs to the system. Even though many intermediate transport pathways are uncertain or not quantified, sufficient information exists to allow at least a qualitative understanding of the importance of many pathways. As such, Control Actions were rated as follows:

- Highly suitable: Pathway provides >1% of the total PCB load delivered to the system
- Moderately suitable: Pathway provides 0.1- 1% of the total PCB load delivered to the system
- Less suitable: Pathway provides <0.1% of the total PCB load delivered to the system

"Reduction Efficiency" is a primary consideration in terms of prioritizing Control Actions, as it describes the extent to which a given action is expected to reduce PCB movement from its targeted source area or pathway. Although quantitative information defining reduction efficiency was not available for many Control Actions, sufficient information exists to allow the majority of Control Action to be rated as follows:

- Highly suitable: >50% reduction in targeted source area or pathway
- Moderately suitable: 10-50% reduction in targeted source area or pathway
- Less suitable: <10% reduction in targeted source area or pathway

"Cost" describes the expected long-term cost of implementing the Control Action, considering both capital and operating costs. Control Actions that remove PCBs at lower costs will be preferred over Control Actions that remove similar amounts of PCBs at greater costs. Even in the absence of quantitative data, a qualitative understanding exists regarding the costs of many Control Actions, and they are rated as follows:

- Highly suitable: <$100,000
- Moderately suitable: $100,000-$1,000,000
- Less suitable: >1,000,000

"Implementing Entity" describes the extent to which there is a clearly identified responsible party for implementing the control action due to their enrollment in a regulatory or voluntary program, along with an assessment of their willingness to do so. It is rated as follows:

- Highly suitable Entity identified and willing to implement
- Moderately suitable: Entity identified, willingness uncertain
- Less suitable: No willing entity identified

Experience with a wide range of pollutants has shown that preventing the creation or release of a pollutant is far more effective than controlling it once released. "Pollution Prevention Hierarchy"

describes where the Control Action is located on the spectrum from limiting production and use of PCBs to treating PCBs prior to their release to the river or lake. It is rated as follows:

- Highly suitable: Controls production or use of PCBs
- Moderately suitable: Manages the mobility of PCBs in the environment
- Less suitable: Performs "end-of-pipe" treatment of PCBs prior to discharge

"Existing Efforts" describes the extent to which a given Control Action relates with existing PCB control efforts that are required by state or federal law or currently being conducted under voluntary programs. It is rated as follows:

- Highly suitable: Addresses a source area or pathway that is not currently being addressed
- Moderately suitable: Expands upon existing controls of a source area or pathway
- Less suitable: Redundant with existing efforts

"Ancillary Benefit" describes the extent to which a given Control Action provides benefits beyond removal of PCBs from the system. It is rated as follows:

- Highly suitable: Provides significant additional benefits beyond reduction of PCB loads
- Moderately suitable: Provides some additional benefits beyond reduction of PCB loads
- Less suitable: Provides minimal additional benefit beyond reduction of PCB loads

"Timeframe" assesses the amount of time it will take for a given Control Action to be implemented and a system response observed. It is rated as follows:

- Highly suitable: Expected response within two year timeframe
- Moderately suitable: Expected response within five year timeframe
- Less suitable: Expected response within twenty year timeframe

4.4 Review Findings

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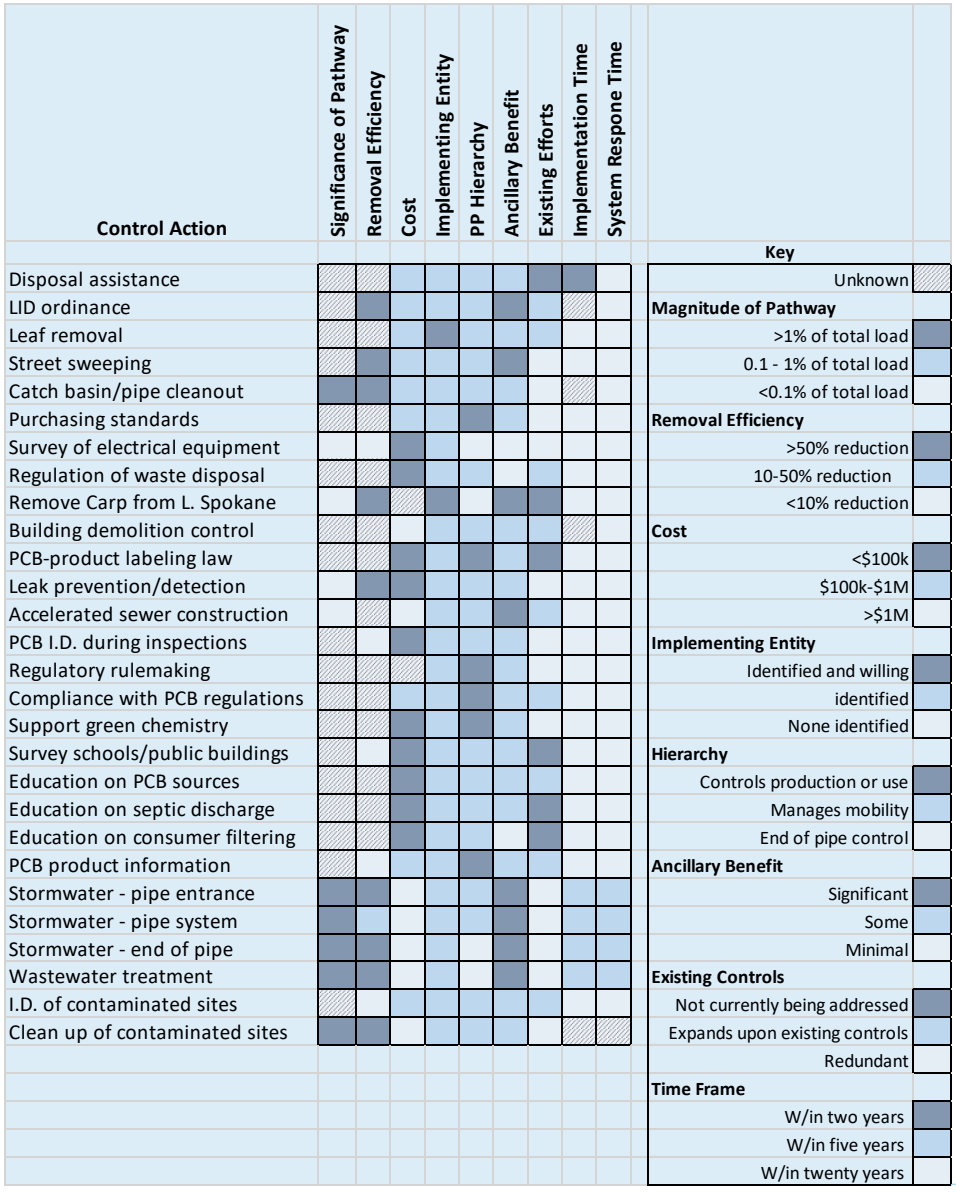
Table 4 summarizes the findings of the above review, using a simple shading scheme to identify whether each aspect of each Control Action is:

- Highly suitable
- Moderately suitable
- Less suitable
- Unable to be evaluated, due to a lack of information

Table 4. Initial Summarization of Control Actions



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One key observation made from this review was that the most significant delivery mechanisms of PCBs all have existing Control Actions in various phases of development. Specific PCB-related Control Actions underway in Spokane are:

- Wastewater treatment plants discharging to the Spokane River are all required to develop and install treatment systems to reduce nutrient loading that will concurrently result in reductions of PCB loading. In addition, each wastewater facility has developed a Toxics Management Action Plan that includes a PCB source identification study and associated control actions. These treatment plants are operated by:
  - City of Coeur d'Alene
  - City of Spokane
  - Kaiser Aluminum
  - Spokane County
  - City of Post Falls
  - Liberty Lake Sewer and Water District
  - Inland Empire Paper
  - Hayden Area Regional Sewer Board
- Remediation activities for known contaminated sites in Washington are being implemented and managed under the jurisdiction of the Model Toxics Control Act (MTCA). Marti and Maggi (2015) searched for sites in Spokane that could be contributing PCB contamination to groundwater in the area of the Spokane River. They identified 31 clean-up sites, three of which have confirmed release of PCBs and subject to MTCA remediation. They are:
  - Spokane River Upriver Dam and Donkey Island
  - Kaiser Aluminum
  - General Electric Company, E. Mission Ave.
- The City of Spokane is actively addressing stormwater and CSO loading of PCBs as part of their Integrated Clean Water Plan. Other entities are also controlling their stormwater loads under NPDES permits, including:
  - Idaho Transportation Department
  - City of Post Falls
  - Spokane County
  - Washington Department of Transportation
  - City of Coeur d'Alene
  - Post Falls Highway Department
  - City of Spokane Valley
- The large majority of stormwater in the remainder of the watershed (including Spokane County and the City of Spokane Valley) is being diverted to groundwater, as opposed to direct surface discharge to the River. This activity is consistent with many of the PCB Control Actions discussed previously under the category of "Stormwater Treatment--Pipe Entrance," and is regulated under the State of Washington's Underground Injection Control Program.
- Local electric utilities have replaced their transformer oils with essentially PCB-free oils, and eliminated the use of large capacitors.

4.5 Selection of Control Actions for Inclusion in the Comprehensive Plan

The results of the evaluation of Control Actions presented above were discussed at a SRRTTF workshop held in Spokane on July 27, 2016. The objective of this workshop was to define, in a consensus-based manner among SRRTTF members, the specific Control Actions to be included in the Comprehensive Plan. A summary of the Control Actions under consideration were presented in spreadsheet format as shown in Table 5. The 45 Control Actions originally identified were condensed into 27 categories, primarily by grouping individual stormwater controls into categories corresponding their location (i.e. pipe entrance, in the pipe system, or end of pipe). Discussion of Control Actions at the workshop was divided into tiers of:

- Control Actions already being implemented
- Potential new Control Actions

Table 5. Summary of Control Options Presented at July 27, 2016 Workshop

PCB Control Action	Magnitude of Source Area	Magnitude of Delivery Mechanism	Magnitude of Pathway Being Controlled	Ongoing? Action?	by Whom?	Actionable Recommendation	by Whom?	Time to Implement	Time to Noticeable System Response	Outcome	Cost, Possible $ Sources	Ancillary Benefit
Already Being Implemented												
Wastewater Treatment	Unknown	54 - 2923 mg/day	54 - 2923 mg/day	Toxics Mgt Plans, source tracking, public outreach, pretreatment regs, etc.	Permits (EPA/ Ecology); dischargers	-	-	-	-	-	-	-
Remediate Known Contaminated Sites	Unknown	60 - 300 mg/day	60 - 300 mg/day	Ongoing	Ecology, w/responsible parties	-	-	-	-	-	-	-
LID Ordinance	Unknown	15 - 94 mg/day	Unknown	Create & implement land use/ development standards encouraging low impact development	City of Spokane	-	-	-	-	-	-	-
Stormwater Pipe Entrance	Unknown	15-94 mg/day	15-94 mg/day	Infiltration controls (trenches, basins, dry-wells), bio-retention	City of Spokane	-	-	-	-	-	-	-
Stormwater Pipe System	Unknown	15-94 mg/day	15-94 mg/day	Screens, filters, wet vaults, hydrodynamic separators	City of Spokane	-	-	-	-	-	-	-
Catch Basin/Pipe Cleanout	Unknown	15 - 94 mg/day	Unknown	Partial; removal of sediments from catch basins, pipes	City of Spokane	-	-	-	-	-	-	-
Support green chemistry	0.2 to 450 mg/day	Unknown	Unknown	Ongoing	Ecology	Outreach/education	SRRTTF members	Within 5 years	20 years or more	Reduced import of PCBs to watershed	$100K-$1M	Marginal
Street sweeping	Unknown	15-94 mg/day	Unknown	Ongoing	Many communities	Increased frequency	Municipal public works	Within 2 years	20 years or more	Fewer particulates contributing to stormwater	$100K-$1M	Significant
Leaf Removal	Unknown	15 - 94 mg/day	Unknown	Ongoing	City of Spokane, Spokane County, Coeur d'Alene	Enhance current municipal leaf removal programs	Municipal public works	Within 2 years	20 years or more	Less leaf litter contributing to stormwater	$100K-$1M	Marginal
ID New Contaminated Sites	Unknown	Unknown	Unknown	Ongoing	Ecology	Mining of existing data, targeted monitoring	Ecology, SRRTTF	Within 5 years	20 years or more	Identify sites for remediation	$100K-$1M	Marginal
Purchasing Standards	0.2 to 450 mg/day	Unknown	Unknown	In place in Washington	Ecology, City of Spokane, Spokane County	Expansion to Idaho?	State of Idaho, DEQ, municipalities	Within 5 years	20 years or more	Reduced import of PCBs to watershed	$100K-$1M	Marginal

PCB Control Action	Magnitude of Source Area	Magnitude of Delivery Mechanism	Magnitude of Pathway Being Controlled	Ongoing? Action?	by Whom?	Actionable Recommendation	by Whom?	Time to Implement	Time to Noticeable System Response	Outcome	Cost, Possible $ Sources	Ancillary Benefit
Potential New Actions												
PCB Product-Labeling Law	0.2 to 450 mg/day	Unknown	Unknown	-	-	Lobby for development of ordinance	All SRRTTF members (potentially)	Within 5 years	20 years or more	Reduced import of PCBs to watershed	<$100K	Marginal
PCB Product Info	0.2 to 450 mg/day	Unknown	Unknown	-	-	Lobby for development of ordinance	All SRRTTF members (potentially)	Within 5 years	20 years or more	Reduced import of PCBs to watershed	<$100K	Marginal
Survey Electrical Equipment	5.5 to 22 kg	0.001 – 0.02 mg/day	0.001 – 0.02 mg/day	-	-	Regulatory requirement or voluntary action	States, utilities, industries	Within 5 years	20 years or more	Better source area identification	<$100K	Marginal
Leak Prevention/ Detection	5.5 to 22 kg	0.001 – 0.02 mg/day	0.001 – 0.02 mg/day	-	-	Regulatory requirement or voluntary action	States, utilities, industries	Within 5 years	20 years or more	Reduced leaks/spills	<$100K	Marginal
PCB ID During Inspections	50 – 40,000 kg	Unknown	Unknown	-	-	Training inspectors to identify materials and what to do next	Munici-palities	Within 5 years	20 years or more	Better source area identification	<$100K	Marginal
Survey Schools & Public Buildings	Unknown	Unknown	Unknown	-	-	Survey PCB-containing materials in schools/public buildings	Ecology; Regional Health Districts	Within 5 years	20 years or more	Better source area identification	<$100K	Marginal
Building Demolition Control	60 - 130,000 kg	Unknown	Unknown	-	-	Regulations/ ordinances requiring mgmt. of PCB-containing materials during demolition and renovation	EPA, States, local governments	Within 5 years	20 years or more	Under investigation	<$100K	Marginal
Waste Disposal Assistance	Unknown	Unknown	Unknown	-	-	Develop programs to accept and dispose of PCB-containing items	Numerous organizations	Within 5 years	20 years or more	Reduced illegal disposal	<$100K	Marginal
Carp Removal	Unknown	N/A	1.5 – 4.1 g PCBs per 1000 carp removed	Pilot study	Avista/Ecology	Remove carp from Lake Spokane	Avista/ Ecology	Within 2 years	20 years or more	Reduced human exposure	?	Significant
Educational on Septic Disposal	Unknown	Unknown	Unknown	-	-	Educate on-site septic system owners located over aquifer recharge area on proper waste disposal	Local governments	Within 2 years	20 years or more	Less disposal of PCB containing material into septics	<$100K	Marginal
Educational on Filtering Post-consumer Paper	Unknown	Unknown	Unknown	-	-	Educate on separating paper recycling materials w/yellow inks/ pigments into the garbage stream	Local governments	Within 2 years	20 years or more	Less PCB-containing trash sent to recycling	<$100K	Marginal
Accelerated Sewer Construction	Unknown	Unknown	Unknown	-	-	Accelerate sewer construction to replace septic systems	Local munici-palities	Within 5 years	20 years or more	Reduced load to aquifer	>$1M	Marginal
Regulatory Rulemaking	0.2 to 450 mg/day	Unknown	Unknown	-	-	Engage with federal agencies to reform TSCA and FDA packaging regs	SRRTTF members	5 - 20 years	20 years or more	Reduced import of PCBs to watershed	$100K-$1M	Marginal
Compliance with PCB Regulations	0.2 to 450 mg/day	Unknown	Unknown	-	-	Engage with agencies to require stricter accountability for compliance with existing rules	SRRTTF members	5 - 20 years	20 years or more	Reduced import of PCBs to watershed	$100K-$1M	Marginal
Regulation of Waste Disposal	Unknown	Unknown	Unknown	-	-	Review laws regulating waste disposal and revise as necessary	Local governments	5 - 20 years	20 years or more	Reduction in improper disposal	<$100K	Marginal
Emerging End of Stormwater Pipe Technologies	Unknown	15-94 mg/day	15-94 mg/day	Research fungi, bio-char, activated carbon	City of Spokane	Support additional research	Municipal public works	5 - 20 years	20 years or more	Reduced import of PCBs to watershed	?	Marginal

Existing Control Actions were discussed first, and placed by the group into one of two categories. The first category (called Category A) contained Control Actions where the group decided to maintain current efforts, and document those efforts in the Plan. The following Control Actions were identified as Category A:

- Wastewater Treatment
- Remediate Known Contaminated Sites
- Stormwater Controls
- Low Impact Development Ordinance
- Street Sweeping
- Purchasing Standards

The second category (called Category B) contained Control Actions where the group identified improvements that could be made to existing efforts. The following Control Actions were identified as Category B:

- Support of Green Chemistry
- PCB Product Testing Information
- Waste Disposal Assistance
- Regulatory Rulemaking
- Compliance with PCB Regulations
- Emerging End of Pipe Stormwater Technologies

Potential new Control Actions were reviewed next, and placed into one of three categories by the group:

C. Include in Comprehensive Plan and commit to implementation
D. Include in Comprehensive Plan as an activity worth exploring in the future
E. Do not include in Comprehensive Plan

Two Control Actions were identified as Category C for inclusion in the Comprehensive Plan with a commitment to implementation: Identification of New Sites of Concern for Contaminated Groundwater and Building Demolition and Renovation Control. The following nine Control Actions were identified as Category D, to be included in the Comprehensive Plan as an activity worth exploring in the future:

- Survey Schools and Public Buildings
- Accelerated Sewer Construction
- Emerging Wastewater Technology
- Survey Electrical Equipment
- Leak Prevention/ Detection
- Regulation of Waste Disposal
- Removal of Carp from Lake Spokane
- PCB Identification during Inspections
- Compliance with PCB Regulations for Imported Products
- Education on Septic Disposal
- Stormwater Source Tracing

Three Control Actions were identified as Category E, and not considered for future implementation:

- Expanded Leaf Removal
- PCB Product Labeling Law
- Education on Filtering Postconsumer Paper

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5 Implementation Plan

This section discusses the specific Control Actions selected to be undertaken to reduce PCBs in the Spokane River, the recommended schedule for their implementation, and measurable milestones to assess their implementation effectiveness. It contains sections corresponding to each of the Category A, B, and C Control Actions identified in the previous section. Category D Control Actions (i.e. ones intended for future consideration) are discussed later in this document.

The effectiveness of SRRTTF's implementation of Control Actions will be assessed annually through the preparation of an Implementation Review report. The report will determine the extent to which each individual milestone listed in this section was attained, and will provide flexibility to adapt strategies, phase out actions that are not working, and phase in new Control Actions as appropriate.

5.1 Category A: Wastewater Treatment

NPDES permits regulate discharges from wastewater and industrial facilities in Washington and Idaho, as well as fish hatcheries (under a general permit). The Washington and Idaho (EPA) NPDES permits require each wastewater facility discharging to the Spokane River to develop and install treatment systems to reduce nutrient loading that will concurrently result in reductions of PCB loading. Additional permit requirements that relate to the monitoring and reduction of PCB loads are described for the following categories of permits: Idaho Municipal Permits, Washington Municipal Permits, Washington Industrial Permits, and Fish Hatchery General Permit. The information that follows is based on the most current permits as of September 2016, and does not include information in draft permits that have not yet been approved.

5.1.1 Idaho Municipal Permits

The City of Coeur d'Alene (ID0022853), City of Post Falls (ID0025852), and Hayden Area Regional Sewer Board (ID0026590) all have NPDES permits with numerous PCB-related requirements. These permits have very similar, if not identical requirements to monitor PCB congeners at influent, effluent and instream locations and participate in the SRRTTF. Other requirements that are common to these three permits and which will reduce PCB loads to the Spokane River are:

- Submit a Toxics Management Plan to EPA and IDEQ, with the goal of reducing loadings of PCBs to the Spokane River to the maximum extent practicable. The Toxics Management Plan must address source control and elimination as follows:
  - From contaminated soils, sediments, storm water and groundwater entering the POTW collection system via inflow and infiltration
  - From industrial and commercial sources, including compliance with pre-treatment regulations for industrial users indirect discharges of PCBs that cause pass through or interference
  - From any person discharging PCBs to the POTW water in excess of applicable pre-treatment local limit established by the POTW, or 3 ug/L, whichever is less.
  - By means of eliminating existing sources that are within direct control of the permittee.
  - By means of changing the permittee's procurement practices, control and minimize the future generation and release of PCBs that are within the direct control of the permittee, including

preferential use of PCB free substitutes for those products containing PCBs below the regulated level of 50 ppm
  - Develop and implement a public education program to educate the public about: the difference between products free of PCBs and those labeled non-PCB but which contain PCBs below the TSCA regulatory threshold of 50 ppm; and proper disposal of waste products that may contain PCBs including those containing PCBs below the TSCA regulatory threshold of 50 ppm and the hazards associated with improper disposal.
  - Distribute appropriate educational materials to target audiences at least once per year.
  - At least once a year, prepare and distribute information relevant to the TMP to a newspaper, and make all relevant TMP documents available to the public.
- Submit an annual report to EPA and IDEQ that contains: PCB monitoring results, copies of educational materials, ordinances, inventories, guidance materials or other products produced as part of the TMP.
  - Description and schedule for implementation of additional actions that may be necessary, based on monitoring results, to ensure compliance with applicable water quality standards
  - Summary of actions taken to reduce discharges of PCBs during the previous 12-month period, and a separate summary of actions planned for the next reporting cycle

5.1.2 Washington Municipal Permits

There are three Washington municipal permits. These are permit WA-002447-3, which covers the City of Spokane Riverside Park WRF and CSOs, and Spokane County Pretreatment Program, and permit WA-0045144 which covers the Liberty Lake Sewer and Water District. The third permit (WA-0093317) covers the Spokane County Regional WRF. These permits are similar to each other with regards to PCBs, and are also similar to the Idaho municipal permits. Requirements common to the three Washington municipal permits are listed below with a few differences noted.

Each permit includes requirements to monitor PCB congeners at minimum specified frequencies in raw sewage and final effluent and participate in the SRRTTF. PCBs sampling and analysis must be in accordance with the quality assurance plan and scope of work submitted to the Department of Ecology. The quality assurance plan will be reviewed annually and revised if needed. (The QAPP language is slightly different for the County permit). The effluent monitoring results will be compiled and analyzed by Ecology for the purpose of establishing a performance-based PCB effluent limitation for the following permit cycle. The Spokane County permit additionally requires biosolids PCB monitoring.

A report[3] must be submitted to Ecology annually, containing a report of the sampling results. Annually, the permittee and Ecology will review the data, including pattern analysis of homologs, detection limits, QA/QC procedures and a draft action plan (The Toxics Management Plan) listing identified sources, potential sources suggested by data analysis and future source identification activities. Annually the permittee and Ecology will confer and revise locations and frequency of raw sewage PCB sampling in the collection system.

Similar to the Idaho municipal permits, the goals of the Toxics Management Plan are to reduce loadings of PCBs to the Spokane River to the maximum extent practicable realizing statistically significant reductions in the influent concentration of toxicants to the treatment plants over the next 10 years, and reduce PCBs in the effluent to the maximum extent practicable to bring the Spokane River into

[3] The Spokane City and Liberty Lake Sewer and Water District permits refer to this report as a "Receiving Water and Effluent Study," whereas the Spokane County permit refers to it as a "Toxics Management Report."

compliance with WQS for PCBs. The Toxics Management Plan must address source control and elimination of PCBs from:

- Contaminated soils and sediments,
- Storm water entering the wastewater collection system,
- Industrial and commercial sources. As an element of the Spokane City and Spokane County permitted pretreatment programs (not Liberty Lake), the scope of their inspections and monitoring will be expanded to include PCBs. The PCB monitoring must follow a QAPP.
- By means of eliminating active sources such as: older machinery, older electrical equipment and components, construction material content, commercial materials
- By means of changing procurement practices and ordinances control and minimize toxics, including preferential use of PCB free substitutes for those products containing PCBs below the regulated level of 5 ppm, in sources such as: construction material content, commercial materials, soaps and cleaners.
- The Permittee must also prepare public media educating the public about the difference between products free of PCBs and those labeled non-PCB but which contain PCBs below the TOSCA regulatory threshold of 5 ppm.

Washington Industrial Permits

There are two Washington industrial permits, the Inland Empire Paper Company permit (WA-000082-5) and the Kaiser Aluminum permit (WA0000892).

The Inland Empire Paper Company permit contains monitoring requirements for PCB congeners, but does not contain PCB effluent limits. After Inland Empire Paper Company collects total PCB data according to the initial testing frequency, Ecology intends to modify the permit to set an interim numeric effluent limit for total PCBs.

This permit also includes requirements to submit a scope of work for a PCB Source Identification Study, and completion of that study after approval by the Department. The scope of work for the PCB Source Identification Study should include raw materials used at the facility that may contain PCBs, a site review where PCB containing equipment was/may have been used, a sampling plan with proposed sampling locations, quality control protocols, sampling protocols and PCB text methods.

Following approval of the scope of work, Inland Empire Paper Company shall submit a report of the results and incorporate findings into the PCB BMP Plan. The PCB BMP plan shall include:

- A list of members of a cross-functional team responsible for developing the BMP plan, including the name of a designated team leader.
- A description of current and past source identification, source control, pollution prevention, and wastewater reduction efforts and their effectiveness.
- Identification of technical/economical evaluation of new BMPs. BMPs should include, but are not limited to: modification of equipment, facilities, technology, processes, and procedures; source control; remediation of any contaminated areas, etc.
- A schedule for implementation of economically feasible BMPs.
- Methods used for measuring progress towards the BMP goal and updating the BMP plan.
- Results from testing of any waste streams for PCBs taken in support of the PCB BMP plan and PCB Source Identification Study.

Following initial submission of the PCB BMP plan, an annual report is due to the Department and shall include: a) all BMP plan monitoring results for the year; b) a summary of effectiveness of all BMPs implemented to meet the BMP plan goal; and c) any updates to the BMP plan.

The Kaiser Aluminum permit assumes use of a black walnut shell (BWS) filtration system to aid in removing PCBs from the process wastewater. This system was constructed in response to an Agreed Order issued by Ecology, which was subsequently amended in October, 2005, to require influent sampling to the BWS to verify that the design PCB loadings to the filters were being maintained (among other requirements). The permit specifies PCB influent sampling and loading limits for the black walnut shell filtration system inlet, to verify that the design PCB loadings to the filters are being maintained. This permit also requires continued PCB source identification and cleanup actions that were initiated under Amended Order No. 2868, to reduce PCBs in the effluent to the maximum extent practicable to bring the Spokane River into compliance with applicable water quality standards for PCBs. Among other things, the Amended Order required Kaiser Aluminum investigate the high levels of PCBs discharged in 2002 and identify and remove PCBs still remaining in the wastewater treatment and collection systems. In addition, Kaiser Aluminum is required to prepare a scope of work for additional source identification efforts that utilizes information from a 2012 report, and which includes a sampling plan with proposed sampling locations, sampling protocols, PCB test methods and a work schedule. A report summarizing the status of the PCB source identification and cleanup must be provided semiannually to Ecology.

5.1.3 Fish Hatchery General Permit

The general NPDES permit (WAG130000) for Federal Aquaculture Facilities and Aquaculture Facilities located in Indian Country has permit requirements related to PCBs. Some requirements apply to all permittees and a subset applies only to permittees that discharge to waters in WRIA 54 (Lower Spokane) and WRIA 57 (Middle Spokane). These are generally described below.

All facilities that discharge to waters in the Lower Spokane and Middle Spokane watersheds must:

- Monitor their effluent for PCB congeners. This currently applies to the Ford State Fish Hatchery and Spokane Tribal Hatchery. Total concentration of dioxin-like PCB congeners and a complete congener analysis must be reported.
- Use any available product testing data to preferentially purchase paint and caulk with the lowest practicable total PCB concentrations
- Facilities in the Spokane River area must also request PCB content information from fish food suppliers and include documentation of that request in their files.

All facilities must develop and implement a BMP plan (and annually review the plan) that meets specific requirements, including the following that apply to PCBs:

- Implement procedures to eliminate the release of PCBs from any known sources in the facility.
- Implement purchasing procedures that give preference for fish food that contains the lowest amount of PCBs that is economically and practically feasible.

5.1.4 Schedule and Monitoring Program

Each of the above permits are renewed periodically, typically on a five-year basis. Because this is a Category A Control Action (maintain existing activities), this Comprehensive Plan is not specifying additional scheduling or monitoring requirements beyond the long-term implementation effectiveness monitoring discussed in Section 6 of this Plan.

5.2 Category A: Remediate Known Contaminated Sites

Ecology's Toxics Cleanup Program (TCP) is responsible for remediating known contaminated sites, working under regulatory authority from Washington's Model Toxics Control Act (MTCA). Four

contaminated sites with potential to contribute PCBs to the Spokane River are in various stages of remediation:

- Spokane River Upriver Dam and Donkey Island
- General Electric Co.
- City Parcel
- Kaiser Aluminum

The status of each site is discussed below.

5.2.1 Spokane River Upriver Dam and Donkey Island

Historical discharges PCBs to Spokane River upstream of the Upriver Dam and Donkey Island led to contamination of river sediments. Two PCB deposits in river-bottom sediments were investigated and cleaned up from 2003 to 2007 in accordance with a consent decree Ecology entered into with Avista and Kaiser Aluminum & Chemical Corporation. The remedy involved the removal and containment of PCB-contaminated sediments. Due to the design of the selected remedy to cap contaminated sediments in place, PCBs remain in sediments at concentrations exceeding the selected cleanup level for the site. Post-remediation surface and subsurface sediment sampling were required to be performed as part of the Cleanup Action Plan. Surface grab samples were collected from material on top of the cap and subsurface sediment profile cores were collected from the cap extending into the material below the cap. In addition, a bathymetric survey was conducted prior to each sampling event to evaluate cap thickness and help select locations for the surface and subsurface sediment samples. Ecology has determined, based upon review of the collected data, that: 1) the cleanup remedy implemented at the Site is currently protective of human health and the environment; and 2) monitoring of the effectiveness of the remedial action and the integrity of the cap should continue in the future at a rate of once every five years to ensure long-term protectiveness (Ecology, 2015).

5.2.2 General Electric Co.

The General Electric Co. site is approximately 1200 feet south of the Spokane River in Spokane, and less than two acres in size. The site was used by General Electric to operate a transformer service shop from 1961 to 1980. Oils containing PCBs were released to soils during service operations. Investigations in the mid to late 1980s confirmed the presence of PCBs in soils and groundwater. Cleanup actions began in 1991. Remedies were accepted as complete in 1999 included vitrification, removal, containment, groundwater monitoring, and institutional controls. Institutional controls include fencing the General Electric property, inspecting and maintaining an asphalt cap, and recording of restrictive covenants. Cleanup is now considered complete and monitoring continues to ensure protection of human health and the environment. Periodic reviews have been conducted in 2003, 2008, and 2013 and have included the evaluation of groundwater data, inspection of the reports on the asphalt cap, and existing institutional controls. The most recent review concludes that the site cleanup continues to be protective of human health and the environment. Groundwater monitoring in seven of eight monitoring wells are in compliance with specified clean-up levels (Ecology, 2013).

5.2.3 City Parcel

The City Parcel site covers just over half an acre. Spokane Transformer, Inc. repaired and recycled transformers at the site from 1961 through 1979. In 1979, the site was sold to City Parcel, Inc., a package delivery service. Soil samples collected between 1976 and 1997 consistently contained PCB contamination at concentrations exceeding both residential and industrial standards. Groundwater has been sampled multiple times, and no contamination was detected. Ecology conducted a state-funded feasibility study and developed a cleanup action plan in 2004 that included removing the building, contaminated soil, all

drain lines and dry wells and an underground storage tank. In 2009, the building was demolished, and contaminated debris were removed. Contaminated soil was also excavated and disposed off-site at this time. Soil samples taken following this revealed PCB contamination along the northern and western fence lines surrounding the property. Ecology will conduct periodic reviews at least every five years to ensure site uses continue to protect human health and the environment (Ecology web site).

5.2.4 Kaiser Aluminum

The Kaiser Aluminum Fabricated Products facility had in the past used hydraulic oils containing high concentrations of PCBs for aluminum casting operations. Kaiser's long term use and storage of PCB-contaminated soils contaminated the soil and underlying groundwater with PCBs. Since 2005, Kaiser has conducted a series of investigation and cleanup activities for soil and groundwater under the authority and requirements of Ecology's cleanup regulations, the state's MTCA. In 2012, Ecology issued an Amended Agreed Order requiring soil excavation and capping of deeper soil to address PCB contamination; these actions have been completed, resulting in the removal of 540 tons of soil that contained elevated levels of PCBs. The 2012 order also required Kaiser to initiate a PCB groundwater treatment pilot study by October 30, 2015. The contamination of groundwater underlying the Kaiser facility is widespread, with PCB levels exceeding 500,000 pg/L (Hart Crowser, 2012). After completion of this pilot study, Ecology will issue a cleanup action plan that will specify the actions that Kaiser must take to remediate the PCB-contaminated groundwater. Ecology estimates that this groundwater treatment system will be operational by 2020 (EPA, 2015).

5.2.5 Schedule and Monitoring Program

Each of the above sites has stipulated cleanup and/or period review schedules and monitoring requirements as discussed above. Because this is a Category A Control Action (maintain existing activities), this Comprehensive Plan is not specifying additional scheduling or monitoring requirements beyond the long-term implementation effectiveness monitoring discussed in Section 6 of this Plan.

5.3 Category A: Stormwater Controls

Many of the communities in the Spokane River watershed are regulated by Municipal Separate Sewer System (MS4) permits that will restrict discharges of PCBs to the river. While most of these regulations are not PCB-specific, the practices they require will indirectly reduce PCB loads via reduction in stormwater volume and/or reduction in suspended solids (a known carrier of PCBs) concentrations in stormwater. In addition to MS4 permits, the City of Spokane has committed to an Integrated Clean Water Plan. These existing stormwater control actions are described below.

5.3.1 NPDES permits for MS4s

The Washington communities of City of Spokane, City of Spokane Valley and Spokane County are covered under the Eastern Washington general MS4 Phase 2 permit. This permit has an effective date of August 1, 2014, and expires July 31, 2019. Washington State Department of Transportation (DOT) has a separate MS4 permit that was effective as of August 1, 2013. The Idaho communities and highway districts (City of Post Falls, City of Coeur d'Alene, Post Falls Highway District, and Idaho DOT, District 1) will all be covered under the forthcoming general permit for all regulated MS4s in Idaho. The preliminary draft permit and fact sheet were issued in April 2016.

The Eastern Washington general permit requires permittees to allow Low Impact Development (LID) stormwater management techniques in new development and redevelopment projects, where feasible. Second, the permit features new requirements for permittees to cooperatively develop and conduct

Ecology-approved studies to assess effectiveness of permit-required stormwater management program activities and best management practices" (City of Spokane's Clean Water Plan 2014). Other components of existing MS4 permits that will lead to reduction of PCBs in stormwater include (from Ecology, 2012):

- All new development and redevelopment projects meeting a specified threshold must preserve natural drainage systems to the extent possible at the site.
- Stormwater collection and conveyance system, including catch basins, stormwater sewer pipes, open channels, culverts, structural stormwater controls, and structural runoff treatment and/or flow control facilities. The Operation and Maintenance (O&M) Plan shall address, but is not limited to: regular inspections, cleaning, proper disposal of waste removed from the system in accordance with street waste disposal requirements, and record keeping. No later than 180 days prior to the expiration date of this permit, Permittees shall implement catch basin cleaning, stormwater system maintenance, scheduled structural BMP inspections and maintenance, and pollution prevention/good housekeeping practices. Decant water shall be disposed of in accordance with street waste disposal requirements.
- The O&M Plan shall address for roads, highways, and parking lots: deicing, anti-icing, and snow removal practices; snow disposal areas and runoff from snow storage areas; material (e.g. salt, sand, or other chemical) storage areas; and all-season BMPs to reduce road and parking lot debris and other pollutants from entering the MS4. No later than 180 days prior to the expiration date of this permit, Permittees shall implement all pollution prevention/good housekeeping practices established in the O&M Plan for all roads, highways, and parking lots with more than 5,000 square feet of pollutant generating impervious surface that are owned, operated, or maintained by the Permittee.
- A minimum of 95% of all known stormwater treatment and flow control facilities (except catch basins) owned, operated or maintained by the Permittee shall be inspected at least once every two years before the expiration date of this permit, with problem facilities identified during inspections to be inspected more frequently.
- All catch basins and inlets owned or operated by the Permittee shall be inspected at least once by December 31, 2018 and every two years thereafter. Catch basins must be cleaned if the inspection indicates cleaning is needed to comply with maintenance standards.

The Idaho general MS4 permit (EPA, 2016) lists low impact development as a topic to consider when permittees are developing their education and outreach programs. More specific to PCBs, there is required monitoring of stormwater discharges and catch basin sediments for PCBs at least twice per year for the Idaho permittees in the Spokane River watershed listed above. Permittees must report the total concentration of dioxin-like PCB congeners and use EPA method 1668C for analysis. Two or more permittees may cooperate to conduct any of the required monitoring.

5.3.2 City of Spokane's Integrated Clean Water Plan

The City of Spokane (2014) Clean Water Plan included the following measures that will reduce PCB loads to the Spokane River:

- The Cochran basin project "focuses on reducing the discharge of stormwater through infiltration, potentially using centralized bioinfiltration facilities located either near the TJ Meenach Bridge and/or near the existing Downriver Disc Golf Course. Estimated to cost $34 million, it will include an infiltration pond, piping, disc golf infiltration, near river biofiltration, 1.25 MG storage tank. Estimated average load of PCBs removed in the treatment layer of the facility is 4.688 g/yr and estimated PCB load diverted (pollutants that aren't removed in the facility and enter the vadose zone) is 0.29 g/yr. (City of Spokane, 2014)
- Section 6.2 of the plan describes the City's "Long-Term Approach to Reduce Stormwater Pollution" and focuses on the implementation of green infrastructure (GI) to intercept stormwater before

reaching the combined sewer system. "Because of the multiple benefits provided by GI, the City of Spokane has adopted a long-term approach to implementing GI by coupling these improvements with other public infrastructure projects, and by encouraging use of its LID ordinance on private projects" (City of Spokane 2014).

- The City is also working to reduce or eliminate CSOs for their 20 NPDES-permitted outfalls. Of those, six have been addressed through implementation of CSO storage facilities. Additional efforts to control CSOs include elimination of one outfall 20 and construction of storage tanks at three other outfalls. Additional CSO construction activities are scheduled for 2017 (City of Spokane 2014).

5.3.3 Schedule and Monitoring Program

Because this is a Category A Control Action (maintain existing activities), this Comprehensive Plan is not specifying additional scheduling or monitoring requirements beyond the long-term implementation effectiveness monitoring discussed in Section 6 of this Plan.

5.4 Category A: Low Impact Development Ordinance

Low-impact development (LID) describes a land planning and engineering design approach to manage stormwater runoff. LID uses on-site natural features to replicate the pre-development hydrologic regime of watersheds through infiltrating, filtering, storing, evaporating, and detaining runoff close to its source. By reducing runoff volume, implementation of LID will ultimately lead to reduction in stormwater PCB load. The City of Spokane enacted a low impact development ordinance in 2013 as part of the requirements of a consent decree entered into with the Spokane Riverkeeper as part of commitments made to improve water quality. It does not have any firm requirements, but simply encourages the use of these stormwater practices: "Low impact development is encouraged for site development and redevelopment" (ORD C35021 Section 11). The ordinance also officially adopts the Eastern Washington Low Impact Development Guidance Manual as a technical reference for developers. There is a financial incentive for developers as they will be granted a 10% discount on their stormwater fee for implementing LID practices into new or re-developed projects.

5.4.1 Schedule and Monitoring Program

Because this is a Category A Control Action (maintain existing activities), this Comprehensive Plan is not specifying additional scheduling or monitoring requirements beyond the long-term implementation effectiveness monitoring discussed in Section 6 of this Plan.

5.5 Category A: Street Sweeping

Street sweeping is designed to remove debris and particulate matter from street surfaces for subsequent disposal, thus preventing these materials from being washed into the stormwater system during wet weather and delivered to the river. Because PCBs are strongly associated with particulate material, street sweeping can reduce PCB loading from stormwater. Several communities in the Spokane River watershed conduct regular street sweeping.

The City of Spokane primarily conducts street sweeping during summer through fall with a priority on arterial roads, followed by residential areas. The downtown business district is swept every other Thursday morning. To pick up the heavy and fine debris and dust, each crew has a mechanical broom, regenerative air broom, a street flusher and a hauling truck. Street sweeping in Spokane Valley is done by a contractor with frequency determined by specified priority areas. Highest priority areas are authorized to be swept twice a month. Priority two areas are authorized to be swept once during the month. All other areas will be authorized by the City as determined necessary. The Contractor uses regenerative air type

sweepers for arterial sweeping. Sweeping along curbs is done using a high-efficiency vacuum sweeper. Residential streets in Coeur d'Alene are swept an average of four times yearly and all arterials are swept twice monthly. Two sweepers are employed at a time and they work from spring to fall. Street sweeping in Post Falls is accomplished by rotating the sections of city four days a week from May through September.

5.5.1 Schedule and Monitoring Program

Because this is a Category A Control Action (maintain existing activities), this Comprehensive Plan is not specifying additional scheduling or monitoring requirements beyond the long-term implementation effectiveness monitoring discussed in Section 6 of this Plan.

5.6 Category A: Purchasing Standards

The State of Washington enacted legislation in 2014 that directed the Washington Department of Enterprise Services to "establish purchasing and procurement policies that provide a preference for products and products in packaging that does not contain polychlorinated biphenyls." RCW 39.26.280. The legislation also precluded other State agencies from knowingly purchasing "products or products in packaging containing polychlorinated biphenyls above the practical quantification limit except when it is not cost-effective or technically feasible to do so." Id. This legislation was adopted, in part, as a result of Task Force efforts to discourage use of products containing PCBs. In June of 2014, the City of Spokane enacted a similar municipal ordinance providing a preference in City purchases for products and products in packaging that do not contain PCBs. Spokane County passed an almost identical resolution (#2014-1022) in December 2014. Implementation of the municipal ordinances should not only reduce the introduction materials containing PCBs, but also facilitate the development of an economic market with reduced amounts of PCBs (EPA, 2015).

5.6.1 Schedule and Monitoring Program

Because this is a Category A Control Action (maintain existing activities), this Comprehensive Plan is not specifying additional scheduling or monitoring requirements beyond the long-term implementation effectiveness monitoring discussed in Section 6 of this Plan.

5.7 Category B: Support of Green Chemistry

The Control Action Green Chemistry is designed to reduce inadvertent PCB production through the development of alternative (non-chlorinated) products or products with reduced levels of PCBs.

5.7.1 Existing Actions

Washington State Department of Ecology provides a range of technical support and expertise to educators (http://www.ecy.wa.gov/greenchemistry/edumain.html) looking to incorporate green chemistry into teaching materials, manufacturers looking to understand the potential impacts of the ingredients (http://www.ecy.wa.gov/greenchemistry/chazassess.html) in their products, and to the general public who want to know which are safer choices (http://www.ecy.wa.gov/greenchemistry/saferchoice.html) for products such as the "Safer Choice" label. Ecology also provides training and other educational resources about safer chemical alternatives and green chemistry (http://www.ecy.wa.gov/programs/hwtr/shoptalkonline/current_issue/story_three.html).

Ecology has partnered with Northwest Green Chemistry (http://www.northwestgreenchemistry.org/) on some of these information resources and tools, including organization of a session called "Green

Chemistry Design for a Rainbow of Colorants," at the Green Chemistry and Engineering Conference held in Portland (OR) in June, 2016.

5.7.2 New Actions

The Task Force will provide additional support to existing Green Chemistry efforts as follows:

- Provide guidance and feedback to Ecology related to current and potential ongoing Green Chemistry efforts
- Contact other parties, including EPA and universities, to provide feedback on existing efforts and/or solicit participation in future Green Chemistry efforts.

5.7.3 Schedule and Monitoring Program

The effectiveness of SRRTTF's implementation of Category B and C Control Actions will be assessed, in part, via annual preparation of an Implementation Review report. This report will compare actions conducted over the prior year to the timelines spelled out in the implementation plan. Specific milestones, timelines and effectiveness metrics are listed in Table 6 for the Green Chemistry Control Action. The first milestone consists of demonstrated tangible outreach to Ecology, EPA, and/or universities. Initial outreach will be conducted within one year of issuance of Comprehensive Plan, and future schedules assessed as part of the Implementation Review report. The second milestone consists of tangible improvement in Green Chemistry efforts due to SRRTTF actions, to be attained with two years of issuance of the Comprehensive Plan.

Table 6. Milestones, Timelines and Effectiveness Metrics for Green Chemistry

Milestone	Timeline	Effectiveness Metric
Demonstrated outreach efforts to Ecology, EPA, and/or universities	Within one year of issuance of Comprehensive Plan	Outreach conducted
Accelerated Green Chemistry efforts	Within two years of issuance of Comprehensive Plan	Tangible improvement in Green Chemistry efforts due to SRRTTF actions

5.8 Category B: PCB Product Testing Information

This Control Action consists of further study of the extent to which commercial products contain inadvertently produced PCBs, as well as creation of a database to store the collected information. This Control Action also includes public education on products containing PCBs, providing consumers the opportunity to select products with lower PCB content.

5.8.1 Existing Actions

As discussed above in the section on Available Data, many project have been conducted and/or are ongoing related to testing of PCBs in commercial or consumer products. The City of Spokane (2015a) collected and analyzed nearly 50 product samples to determine PCB content in various municipal products. The SRRTTF (2015) Hydroseed Pilot Project analyzed identify specific component(s) of hydroseed that may be contributing to elevated PCB levels. Ecology (2014b) evaluated the presence of PCBs in 68 general consumer products and is preparing a forthcoming PCB product testing report analyzing 201 consumer products.

5.8.2 New Actions

The Task Force will provide additional support to existing Green Chemistry efforts as follows:

- Provide guidance and feedback to Ecology, including comments on the forthcoming PCB product testing report
- Support development of a centralized clearinghouse containing PCB product testing information.
- Conduct public education on products containing PCBs

5.8.3 Schedule and Monitoring Program

Specific milestones, timelines and effectiveness metrics are listed in Table 7 for the Control Action PCB Product Testing Information. The first milestone consists of the provision of comments on Ecology's PCB product testing report within three months of issuance of the draft report. The second milestone consists of demonstrated tangible outreach to Ecology, regarding development of a PCB product testing clearinghouse. Initial outreach will be conducted within one year of issuance of Comprehensive Plan, and future schedules assessed as part of the Implementation Review report. The third milestone is development of a clearinghouse within two years of issuance of the Comprehensive Plan. Public education will be evaluated annually, with an expectation of a measurable change in public behavior within five years of issuance of the Comprehensive Plan.

Table 7. Milestones, Timelines and Effectiveness Metrics for PCB Product Testing Information

Milestone	Timeline	Effectiveness Metric
Provide comments on the PCB product testing report	Within three months of issuance of draft report	Comments provided
Support Ecology efforts towards development of a clearinghouse	Within one year of issuance of Comprehensive Plan	Demonstrated support, reassessed annually
Development of clearinghouse	Within two years of issuance of Comprehensive Plan	Has clearinghouse been developed?
Public education	Ongoing annual assessment	Has outreach been conducted?
Public education	Within five years of issuance of Comprehensive Plan	Measurable change in public behavior

5.9 Category B: Waste Disposal Assistance

This Control Action consists of programs (targeted at household consumers and businesses that generate small quantities of PCBs) designed to accept and properly dispose of PCB-containing items, thus preventing legacy non-fixed building sources such as small appliances and lamp ballasts from potentially being disposed of improperly.

5.9.1 Existing Actions

Several voluntary programs currently exist to assist consumers and businesses in properly disposing waste materials. The Spokane River Forum sponsors a Waste Directory (http://spokaneriver.net/wastedirectory/) that provides information describing which waste products may contain PCBs, as well providing information on proper methods for disposing these materials. Spokane EnviroStars (http://spokaneenvirostars.org/) is a voluntary program businesses that certifies local small businesses having practices and policies in place demonstrating proper management and reduction of hazardous and other waste.

In addition, the State of Washington has established a Mercury-Containing Lights Product Stewardship Program (Chapter 173-910 WAC) to collect and properly dispose of mercury-containing lights. While this program is currently targeted towards control of mercury, it could be adapted to also consider PCB-containing wastes.

5.9.2 New Actions

The Task Force will provide additional support to existing Waste Disposal Assistance efforts as follows:

- Provide recommendation to implementing organizations as to how they can better control PCB-containing wastes
- Raise public awareness on how to identify and dispose of PCB-containing items

5.9.3 Schedule and Monitoring Program

Specific milestones, timelines and effectiveness metrics are listed in Table 8 for the Control Action Waste Disposal Assistance. The first milestone consists of providing specific recommendations to implementing organizations. Initial recommendations will be provided within one year of issuance of the Comprehensive Plan, and the effectiveness of these recommendations and need for continued support will be evaluated annually. The final milestones consist of raised public awareness on how to identify and dispose of PCB-containing items. Initial outreach in this regard will be conducted within one year of issuance of the Comprehensive Plan, and one effectiveness metric will be whether outreach has been conducted. Future schedules for outreach will be assessed as part of the Implementation Review report. The final effectiveness metric will be a measurable change in public behavior in terms of disposal of PCB-containing wastes, to be achieved within five years of issuance of the Comprehensive Plan.

Table 8. Milestones, Timelines and Effectiveness Metrics for Waste Disposal Assistance

Milestone	Timeline	Effectiveness Metric
Recommendations to implementing organizations	Within one year of issuance of Comprehensive Plan	Recommendations provided, reassessed annually
Raised public awareness on how to identify and dispose of PCB-containing items	Ongoing annual assessment	Has outreach been conducted?
Raised awareness on how to identify and dispose of PCB-containing items	Within five years of issuance of Comprehensive Plan	Measurable change in public behavior

5.10 Category B: Regulatory Rulemaking

This Control Action consists of regulatory reform of Federal TSCA and FDA's food packaging regulations to: 1) re-visit currently allowed concentration of PCBs in chemical processes; 2) eliminate or reduce the creation of inadvertently generated PCB; and 3) reassess the current use authorizations for PCBs.

5.10.1 Existing Actions

The SRRTTF and individual members have had continuing engagement with State and federal agencies to lobby for reform of existing regulations, including providing evaluation and comment on rulemaking activities.

5.10.2 New Actions

Paint manufacturers providing road paint to transportation agencies are currently required to use pigments compliant with a strictly-controlled "color box". These color box requirements can only be met

through the use of PCB-containing diarylide pigments. The Task Force will seek to attain State/federal level changes to color box requirements for road paints, allowing the use of PCB-free (or essentially PCB-free) pigments in these paints.

5.10.3 Schedule and Monitoring Program

Specific milestones, timelines and effectiveness metrics are listed in Table 9 for the Control Action Regulatory Rulemaking. The first milestone consists of continuing the existing ongoing dialogue with EPA and legislators regarding reform of TSCA and FDA's food packaging regulations. The effectiveness of this dialog and need for continued dialogue will be evaluated annually in the Implementation Review report. The remaining milestones relate to State/Federal-level changes to color box requirements for road paints. The first milestone consists of outreach to governmental agencies and paint manufactures, and will be conducted within one year of issuance of the Comprehensive Plan. The effectiveness of this outreach recommendations and feasibility of getting changes enacted will be evaluated annually. The long-term goal, with a timeline of ten years, is to have the color box requirement changed to allow the use of PCB-free pigments.

Table 9. Milestones, Timelines and Effectiveness Metrics for Regulatory Rulemaking

Milestone	Timeline	Effectiveness Metric
Dialogue/letters with EPA and legislators on TSCA reform	Ongoing annual assessment	Dialogue continuing to be conducted
State/Federal-level changes to color box requirements for road paints	Within one year of issuance of Comprehensive Plan	Has outreach been conducted?
State/Federal-level changes to color box requirements for road paints	Within ten years of issuance of Comprehensive Plan	Evidence of changed regulations

5.11 Category B: Compliance with PCB Regulations

This Control Action consists of requiring stricter accountability for compliance with existing rules. Potential activities include enforcement of existing TSCA rules to ensure imported and manufactured products are complying with allowable PCB levels, and enforcement of rules related to oil burning.

5.11.1 Existing Actions

The SRRTTF and individual members have had continuing engagement with State and federal agencies providing comments related to draft NPDES permits (e.g. the recent general hatchery permit), Clean Water Act compliance activities, and waterbody assessments such as 303(d) lists.

5.11.2 New Actions

Ecology's Environmental Assessment Program (Ecology, 2016b) is currently undertaking a study that will provide information on atmospheric transport of PCBs. The Task Force will review results of this study when it becomes available to assess the need for regulatory control of oil burning.

5.11.3 Schedule and Monitoring Program

Specific milestones, timelines and effectiveness metrics are listed in Table 10 for the Control Action Compliance with PCB Regulations. The first milestone consists of maintaining existing activity in terms of providing comments on recurring regulatory issues. Comments will be provided on an ongoing as-needed

basis, and assessed as part of the Implementation Review report. The second milestone consists of review of the Ecology atmospheric transport study, and a determination made regarding the need for more regulatory control of oil burning. Should oil burning be identified as a significant contributor of PCBs, the final milestone consists of a measurable change in regulatory control over this practice.

Table 10. Milestones, Timelines and Effectiveness Metrics for Compliance with PCB Regulations

Milestone	Timeline	Effectiveness Metric
Comments on recurring regulatory issues	Ongoing annual assessment	Recommendations provided, reassessed annually
Review of Ecology atmospheric transport study	Within one year of issuance of study	Determination of need for more regulatory control of oil burning
Changes in oil burning control (if appropriate)	Within five years of issuance of Comprehensive Plan	Measurable change in regulatory control

5.12 Category B: Emerging End of Pipe Stormwater Technologies

While many options currently exist for controlling stormwater PCB loads, they typically focus on activities to capture PCBs, but not destroy them. Newer technologies, such as mycoremediation, are being investigated that could lead to actual PCB destruction.

5.12.1 Existing Actions:

The Lands Council has begun an innovative mycology project which uses a native species of fungi, called white rot fungi, to break down persistent PCBs from stormwater. Because PCBs are chemically similar to the wood that these fungi naturally eat, the fungi can break down these chemicals without experiencing toxic effects. White rot fungi have been shown to break down PCBs under laboratory conditions, and The Lands Council is seeking to test this utility on a much larger scale in the field in order to identify the potential for WRF to be used to prevent PCBs from entering the Spokane River. If successful, this novel method could have broad implications for cost-effective cleanup at contaminated sites. The Lands Council currently has a contract with the City of Spokane for an initial mycoremediation experiment, which is looking at 'fungal treatment' of vactor waste on a small scale. This experiment is ongoing, with results expected in early spring of 2017.

5.12.2 New Actions:

The existing experiment could be considered Phase 1 of a larger study. Specific activities to be conducted in upcoming phases will depend upon results of Phase 1. The Task Force will review Phase 1 findings and identify and/or support additional phases of research projects that meet Task Force goals. The specific nature of this support will be determined after Phase 1, and could include identification of grant opportunities, support to the Lands Council of pursuit of these grant opportunities, and/or direct funding.

5.12.3 Schedule and Monitoring Program

Specific milestones, timelines and effectiveness metrics are listed in Table 11 for the Control Action Emerging End of Pipe Stormwater Technologies. The first milestone consists of the SRTTF reviewing the Phase 1 results of the Lands Council works and providing feedback on next steps. The second milestone consists of identification of the appropriate level of Phase 2 support, and provision of that support. Both of these milestones will be accomplished within one year of completion of the Phase 1 report.

Table 11. Milestones, Timelines and Effectiveness Metrics for Emerging End of Pipe Stormwater Technologies

Milestone	Timeline	Effectiveness Metric
Assessment of Phase 1 results	Within one year of completion of Phase 1 report	Feedback provided
Phase 2 support	Within one year of completion of Phase 1 report	Level of support defined and provided

5.13 Category C: Building Demolition and Renovation Control

Fixed building sources have been identified as one of the largest source areas of PCBs in the Spokane watershed. Building demolition and renovation activities provide the potential to mobilize these fixed PCBs, making them more amenable to transport to the Spokane River. This Control Action consists of providing educational materials that inform contractors of proper methods of management of PCB-containing materials and waste during building demolition and renovation.

The San Francisco Estuary Institute (SFEI) conducted a study to estimate the total content of PCBs in caulk in buildings throughout the Bay Area and the potential load of PCBs from demolition and remodeling sources to San Francisco Bay (Klosterhaus et al., 2011). A companion project was led by the San Francisco Estuary Project (SFEP) and focused on how to reduce this load of PCBs (SFEP, 2011). They developed descriptions of several different management practices for managing PCBs in caulk during building demolition or remodeling, related to:

- Building Occupant Notification: communication of health and safety goals prior to beginning a project
- Worker Training: proper identification, handling and disposal of PCB-contaminated materials
- Personal Protective Equipment (PPE): protection of human health and limit the spread of contaminated materials
- Work Area Containment: prevention of the spread of contaminated dust
- Tools and Equipment: selection of appropriate tools that minimize dust generation
- Demolition: includes dust management, discharge of wastewater, and removal of other hazardous materials
- Site Erosion and Sediment Controls
- Work Area Housekeeping and End of Project
- Transport and Disposal

5.13.1 Actions

The specific actions to be implemented by the SRRTTF relative to Building Demolition and Renovation Control are:

1. Adapt the SFEP document to make it suitable for use as a guidance document for Spokane-area building contractors
2. Work with relevant local government agencies responsible for permitting to ensure that the guidance document be distributed as part of all building permits related to building demolition and renovation

5.13.2 Schedule and Monitoring Program

Specific milestones, timelines and effectiveness metrics are listed in Table 12 for the Control Action Building Demolition and Renovation Control. The first milestone consists of adaptation of the SFEP

report, which will be completed within one year of issuance of the Comprehensive Plan. The second milestone consists of coordination with local governments to have the guidance document routinely distributed with relevant permits, to be completed within two years of issuance of the Comprehensive Plan. The final milestone is a demonstrated change in contractor behavior in response to the guidance provided, to be attained within five years of issuance of the Comprehensive Plan.

Table 12. Milestones, Timelines and Effectiveness Metrics for Building Demolition and Renovation Control

Milestone	Timeline	Effectiveness Metric
Adaptation of SFEP report	Within one year of issuance of Comprehensive Plan	Guidance document produced
Distribution of guidance document	Within two years of issuance of Comprehensive Plan	Guidance document routinely distributed with permits
Utilization of guidance document	Within five years of issuance of Comprehensive Plan	Measurable change in contractor behavior

5.14 Category C: Identification of Sites of Concern for Contaminated Groundwater

As discussed above in the section Remediate Known Contaminated Sites, Ecology has identified and initiated remediation activities on several sites believed to be contributing PCBs to the Spokane River. Activities conducted on behalf of the Task Force have identified the potential for additional sites of potential concern; specifically:

- Assessment of groundwater PCB data collected up-gradient of the known Kaiser groundwater contamination indicates the potential for a significant groundwater loading source independent of the Kaiser remediation (LimnoTech, 2016f)
- Homolog-specific mass balance analyses conducted with the 2015 and 2016 synoptic river survey data indicate the potential presence of a significant groundwater PCB loading source entering the river downstream of the Trent Avenue Bridge (LimnoTech, 2016d).
- Cleanup targets for many TCP sites are based on levels necessary to protect groundwater as a drinking water supply (adjusted for the Practical Quantitation Limit), and are not necessarily protective of river water quality standards. For example, the groundwater cleanup target concentration at the City Parcel site (0.1 ug/l) is approximately 600 times higher than the river water quality standard of 170 pg/l. Given that sites that have received No Further Action (NFA) designation may still contain groundwater PCB concentrations orders of magnitude higher than safe river concentrations, these sites have the potential to contribute to water quality standard violations in the Spokane River. Marti and Maggi (2015) identified 23 TCP sites with confirmed releases of PCBs to soil and/or groundwater that may merit further investigation in terms of potential to contribute problematic levels of PCBs to the Spokane River.

Because these additional sites have the potential to cause or contribute to PCB impairment of the Spokane River, it is important to: 1) Determine whether they have the potential to be significant contributors of PCBs, and 2) Develop a plan for remediation for any source determined to be a potential contributor.

5.14.1 Actions

The Task Force will implement the following three-step process to identify of sites of concern for contaminated groundwater:

1. Mine existing data

2. Consult with TCP
3. Determine next action (e.g. targeted monitoring)

Mine existing data

Initial activities will consist of compiling and reviewing available data to assess the potential significance of new groundwater sites to contributing PCBs to the Spokane River. Separate activities will be conducted for each of the three categories of sites described immediately above.

With respect to the potential source up-gradient of Kaiser, existing data have largely been mined to the extent necessary to define that a source exists and that its magnitude is potentially of concern. Recent evaluations of hydrogeological and groundwater quality information collected by Kaiser show that there likely is an up-gradient source of PCBs via venting groundwater within the gaining portion of the river from approximately the Pentzer WWTP to Kaiser monitoring well MW-15 (approximately 1.1. miles). This conclusion is based on available PCB homolog data collected from Kaiser monitoring wells, which show a difference between the PCB homolog patterns between the Kaiser plume monitoring well data and up-gradient and cross-gradient monitoring well data collected outside these areas (LimnoTech, 2016f). The Kaiser plume data are dominated by the tri- and tetra- homolog groups, while the up-gradient/cross-gradient PCB data are dominated by the tetra-, penta- and hexa- homolog groups (Figure 6).

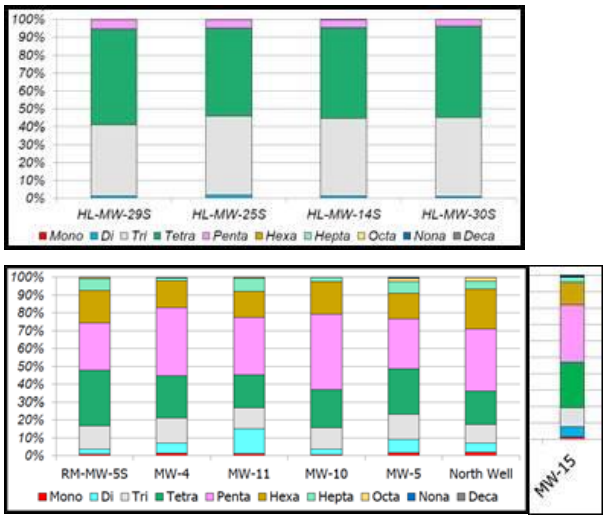

Figure 6. Homolog Distribution of Groundwater Monitoring Data Collected form Kaiser Plume (top) and Up-Gradient/Cross-Gradient Wells (bottom)

For this stretch of the river, an initial up-gradient PCB loading estimate of 14 to 55 mg/day was calculated, assuming a representative seepage rate of 0.01 cfs per linear foot of river (Kahle and Bartolina, 2007), and representative average up-gradient PCB concentrations ranging from 0.1 to 0.384 ng/l. Although this analysis is not rigorous enough to prove that a significant up-gradient source exists, it is rigorous enough to show that up-gradient sources merit additional consideration.

The source of the up-gradient PCB groundwater loads is unknown, but the Spokane Industrial Park area may be one contributor. This observation is based on:

- The up-gradient location of the Industrial Park relative to the Kaiser boundary monitoring wells. These wells historically have shown detectable concentrations of PCBs up to 6 ng/l (median = 0.1 ng/l).
- Ecology's Urban Waters Initiative has identified the Industrial Park as a likely source of PCBs prior to 1994 (http://www.ecy.wa.gov/urbanwaters/spokaneriver.html)
- Past use of the area as a Naval Supply Depot
- The presence of approximately 500 Underground Injection Control (UIC) wells which are registered in the UIC database as non-municipal stormwater wells that generally are 7 to 10 feet deep (EAP, September 16, 2015).

With respect to the suspected source downstream of the Trent Avenue Bridge, data mining activities will consist of more detailed homolog-specific mass balance assessments to estimate the magnitude of the load. The mass balance assessments conducted to date at this site have only considered river concentration data and stream flow to determine that a net loading of penta- through hepta- chloro PCB homologs occurs. The specific magnitude of this potential loading source was not assessed further due to the confounding effects of groundwater exchange mechanisms which are more complex than assumed in the original mass balance assessment. Data mining activities conducted under the Comprehensive Plan will consist of:

- Estimating groundwater gains and losses for the stream reach from available hydrogeologic data
- Conducting a mass balance analysis for 2014 and 2015 synoptic survey data, using the gross gaining and losing flow estimates, to update the prior analyses which only considered net groundwater flow.
- Calculate estimated loading rate and congener distribution of the potential source.
- Review existing TCP site information to identify potential contributing sites.

With respect to other TCP sites, data mining activities will consist of estimating the potential magnitude of loading from the 23 TCP sites with confirmed releases of PCBs identified by Marti and Maggi (2015). This will be done by:

- Calculating the amount of area potentially containing PCB concentrations at cleanup target concentration.
- Reviewing existing hydrogeologic information to estimate groundwater seepage rates for each site.
- Merging areal extent, seepage rate and concentration estimates to calculate a potential loading contribution for each site

Package information for and consult with TCP

The results of the above data mining activities will be documented in a technical report, and shared with Ecology TCP staff. The Task Force will schedule a meeting (or meetings) with TCP to present and discuss results. Findings will be compared to those obtained by TCP (e.g. TCP will be conducting a separate assessment of the magnitude of the loading up-gradient of the Kaiser site). Result of the meeting(s) will feed directly in to the next step, determining subsequent actions.

Determine next action

Based on the above findings and discussions, the Task Force will work with TCP to determine appropriate next steps, and the party (or parties) responsible for conducting them. Depending on findings from the data mining, next steps could include:

- Determining that certain sites are contributing to the impairment of the river, and identifying potential remediation actions
- Targeted monitoring to better define the contribution of sites determined to be potentially important

- Exclusion of certain sites that are determined to be insignificant contributors to the impairment of the river

5.14.2 Schedule and Monitoring Program

Specific milestones, timelines and effectiveness metrics are listed in Table 13 for the Control Action Identification of Sites of Concern for Contaminated Groundwater. The first milestone consists of data mining activities, which will generate an assessment document within one year of issuance of the Comprehensive Plan. The second milestone consists of coordination with TCP, which will result in a consensus plan for future action within two years of issuance of the Comprehensive Plan. The final milestone will be a determination of whether each site under consideration is a sufficient enough contributor of PCBs to the Spokane River to merit remediation activities, and initiation of remedial activities on sites determined to be significant. This final milestone will be accomplished within five years of issuance of the Comprehensive Plan.

Table 13. Milestones, Timelines and Effectiveness Metrics for Identification of Sites of Concern for Contaminated Groundwater

Milestone	Timeline	Effectiveness Metric
Initial data mining	Within one year of issuance of Comprehensive Plan	Assessment document produced
TCP coordination	Within two years of issuance of Comprehensive Plan	Study plan adopted
Identification, remediation (as appropriate)	Within five years of issuance of Comprehensive Plan	Conclusive identification of significance of sites. Initiation of remedial activities on sites determined to be significant.

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6 Future Activities

In addition to the Implementation Activities described above, the SRRTTF intends to conduct additional activities in the future to assess implementation effectiveness, and to consider additional Control Actions and studies to fill identified data gaps.

6.1 Implementation Effectiveness Assessment

The Implementation Plan section above contains effectiveness metrics specific to each Control Action, designed to assess whether each action is being implemented and performing as planned. The Task Force will also conduct a broader implementation effectiveness assessment within five years, designed to review all available data to assess:

- PCB loading to the Spokane River from the primary delivery mechanisms, and changes in loading over the evaluation period
- Spokane River PCB concentrations, and changes in concentration over the evaluation period

PCB loading will be assessed for the primary delivery mechanisms described previously, as follows. PCB loading from wastewater treatment plants will be assessed via review of all effluent monitoring data collected by each plant as part of their NPDES permit requirements. Groundwater loading near Kaiser will be assessed via review of data collected by Kaiser as part of their ongoing remediation efforts. Stormwater/CSO loading will be assessed via review of post-implementation performance data to be collected by the City of Spokane as part of their Integrated Clean Water Plan. Changes in loading from Lake Coeur d'Alene will be assessed via review of observed Spokane River PCB concentrations in Idaho being collected as a requirement of NPDES permits in Idaho.

In-river concentrations will be assessed via review of long-term river monitoring data to be collected by the Task Force and/or Ecology. Statistical tests will be applied as appropriate to determine if statistically significant reductions have occurred in loads and in-river concentrations. In addition to assessment of the change in River concentrations, river concentrations will also be compared to existing water quality standards.

The above assessment will be conducted five years after the issuance of this Comprehensive Plan. If PCB loads and/or concentrations are not decreasing, the Task Force will identify, evaluate, and select new Control Actions (or modify existing Control Actions) in an adaptive manner to ensure that reductions occur in the future. It is expected that the implementation effectiveness assessment will be repeated on a five year basis.

6.2 Consideration of Additional Control Actions

As discussed above, numerous Control Actions were placed in Category D, defined as "Include in Comprehensive Plan as an activity worth exploring in the future." The commitment to these actions is to give them future consideration, but with no specific commitment towards implementation at this time. This section describes the following Control Actions identified as Category D:

- Survey Schools and Public Buildings
- Accelerated Sewer Construction

- Emerging Wastewater Technology
- Survey Electrical Equipment
- Leak Prevention/ Detection
- Regulation of Waste Disposal
- Removal of Carp from Lake Spokane
- PCB Identification during Inspections
- Compliance with PCB Regulations for Imported Products

Each are described below. The Task Force will consider the need to implement any of these Control Actions as part of their annual implementation effectiveness assessment.

6.2.1 Education on Septic Disposal

This Control Action is designed to educate on-site septic system owners located over the aquifer recharge area on proper disposal of wastes (e.g., not "down the drain") and on the environmental and functional benefits of regular tank pumping.

6.2.2 Survey Schools and Public Buildings

This action consists of programs designed to survey PCB-containing materials in schools/public buildings and enact a program to dispose of them properly or implement encapsulation.

6.2.3 Accelerated Sewer Construction

This action consists of acceleration of sewer construction to replace septic systems. Spokane County has completed its mandatory septic tank elimination program for septic tanks within the Urban Growth Area (UGA) in areas that have sewer available, requiring connection within a year of notification and enforcement through the Prosecutor's office. There is some overlap between the UGA and the Critical Aquifer Recharge Area (CARA), but still a large amount of area where sewer construction could help eliminate discharge to the CARA. There is currently no planned effort to eliminate every septic system within the UGA, due to reasons such as:

- Installation of sewers in low density areas is not cost effective
- Certain land uses are exempt by state law from the requirement to connect to sewer, even when available (e.g. manufactured home parks)

6.2.4 Emerging Wastewater Technology

This action consists of regular outreach to researchers/contractors in the field of wastewater treatment in order to stay abreast of potential new technologies for PCB removal.

6.2.5 Survey Electrical Equipment

This action would conduct a survey of local utilities and other owners of electrical equipment to document the presence/amount of PCBs in transformers. Identify PCB-containing equipment (nominal 1 ppm concentration) that has a reasonable pathway to the river, if spilled, and target for removal.

6.2.6 Leak Prevention/ Detection

This action consists of implementation of state and/or local ordinance to require a leak prevention/detection system in any PCB-containing transformer or capacitor.

6.2.7 Regulation of Waste Disposal

This action consists of programs designed to review local/regional laws regulating waste disposal (including oil burning) and illegal dumping, and revise as necessary (e.g. enforcing fines/other penalties for improperly disposing of PCBs.)

6.2.8 Stormwater Source Tracing

Through Ecology's Urban Waters Initiative, a team of Ecology staff and specialists from the Spokane Regional Health District have sampled water and visited businesses along the river to identify sources of toxic chemicals, including PCBs. These studies are designed to identify potential hot spots (i.e. areas contributing an inordinately high amount of PCBs) that could be controlled in the future. This action consists of considering these source tracing activities to identify significant sources of PCBs to the Spokane stormwater system.

6.2.9 Removal of Carp from Lake Spokane

This action involves removing carp from Lake Spokane. Carp in the lake are known to be contaminated with PCBs, and removing them would prevent further cycling in the watershed. This Control Action was suggested as a complement to existing studies conducted by Avista regarding removal of carp from Lake Spokane for the purposes of phosphorus removal.

6.2.10 PCB Identification during Inspections

This action consists of identifying PCB-containing materials as part of other regular inspections (e.g., building permits, IDDE, facility inspections). It involves training inspectors to identify materials and what to do next (safe disposal, encapsulation, etc.).

6.2.11 Compliance with PCB Regulations for Imported Products

This control action consists requiring stricter accountability for compliance with existing rules, specifically enforcement of existing TSCA rules to ensure imported and manufactured products are complying with allowable PCB levels.

6.3 Studies to Address Data Gaps

Due to the diffuse nature of PCB source area, poorly defined pathways between source areas and delivery mechanisms, and uncertain environmental response, the Task Force will contemplate addition studies to address some key data gaps. The Task Force will consider the need to conduct any of these studies as part of their routine implementation effectiveness assessment. It is noted that some of these studies may be conducted by Ecology's Environmental Assessment Program, in which case the Task Force will provide review and comment. Two potential studies are provided below, related to bioaccumulation of PCBs in fish and assessment of sediment PCB concentrations.

6.3.1 Bioaccumulation of PCBs in Fish

Measured water column PCB concentrations in the Spokane River are currently at levels similar to, and typically below, the listed water quality standard. Fish tissue concentrations, however, remain well above target levels. This study would collect the necessary data and perform the associated analyses to better understand the site-specific factors that drive fish tissue concentrations in the Spokane River. This work could also review past fish studies to see if historically observed PCB concentrations are unduly influenced by specific age of the fish collected.

6.3.2 Sediment PCB Concentrations

There is a commonly-held assumption that legacy bottom sediments are not a significant contributor to PCB impairment of the Spokane River, because: 1) The River is viewed as sediment-poor, with many non-depositional zones, and 2) Remediation activities have been conducted at areas of known legacy sediment contamination. This assumption may not be accurate, however, as there are known areas of sediment deposition in impounded sections of the river that have not been sufficiently sampled to provide a clear understanding of sediment PCB contributions. Available recent data currently consist of sediment trap measurements conducted near Ninemile and Upriver Dam in 2013 (Era-Miller, 2014), and sediment data collected as part of reassessment of the Upriver Dam and Donkey Island PCB sediment sites. Some additional sediment PCB concentration data exist (Johnson. and Norton, 2001), but are much older.

This study, if undertaken, would be designed to:

- conduct sediment PCB measurements in known depositional areas (such as behind Ninemile Dam and Upriver Dam);
- provide an assessment of the extent to which existing sediment concentrations reflect existing loads versus legacy sources; and
- provide a better-informed understanding of the contribution of sediments to PCB impairment of the Spokane River.

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Appendix A: Sources and Pathways of PCBs in the Spokane River Watershed

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Memorandum

From: Dave Dilks **Date:** March 16, 2016
Project: SRRTTF

To: SRRTTF

SUBJECT: Sources and Pathways of PCBs in the Spokane River Watershed

Summary

The Spokane River Regional Toxics Task Force (SRRTTF) is developing a comprehensive plan to reduce polychlorinated biphenyls (PCBs) in the Spokane River, and has contracted with LimnoTech to assist in development of the plan. Development of the comprehensive plan will benefit from an understanding of the sources of PCBs in the Spokane River watershed and how they are delivered to the river. This memorandum describes the key sources and transport mechanisms affecting PCBs in the Spokane River and its contributing watershed. Sources are broadly characterized as:

- Legacy sources of PCBs currently present in the Spokane watershed study area
- New sources of PCBs continuing to be introduced to the watershed via inadvertent production in commercial products
- Environmental transport (e.g. via the atmosphere) of PCBs into the study area, which may either be legacy or continuing sources

A network of transport processes exists that deliver PCBs from their current location to the Spokane River, including erosion of contaminated surface soil and delivery to storm sewer systems, delivery to wastewater treatment plants, and transmission via groundwater.
The magnitude of these sources and transport mechanisms will be quantified in subsequent project work. Those sources and pathways of the greatest magnitude will be targeted for control in the comprehensive plan.

Introduction

The SRRTTF is developing a comprehensive plan to reduce PCBs in the Spokane River, designed to identify specific management actions that can be undertaken to control PCB loads to the river. Work on Comprehensive Plan will be conducted through five tasks:

1. Develop Inventory of PCB Sources and Pathways
2. Evaluate Best Management Practices to address PCB Sources and Pathways
3. Attain Consensus on Alternatives to Be Included in Plan
4. Develop Comprehensive Plan
5. Project Management and Coordination

This memorandum corresponds to the first task: Develop Inventory of PCB Sources and Pathways. PCBs are introduced to the watershed from many different sources, and delivered to the river via many different pathways. The magnitude of individual sources can vary widely, as can the magnitude of individual pathways. Selection of the most appropriate management actions will be facilitated by an understanding of the magnitude of the various sources and pathways.

Sources and pathways will be represented in this memorandum through the use of conceptual models. A conceptual model is a graphic depiction of all of the processes believed to be potentially significant in effecting pollutant concentrations. Conceptual models provide a means to convey complicated processes and relationships in a simplified manner to a wide audience, and allows non-technical reviewers to understand and provide input on the sources and pathways to be considered. An example conceptual model of PCB sources and pathways for San Francisco Bay is shown in Figure 1.

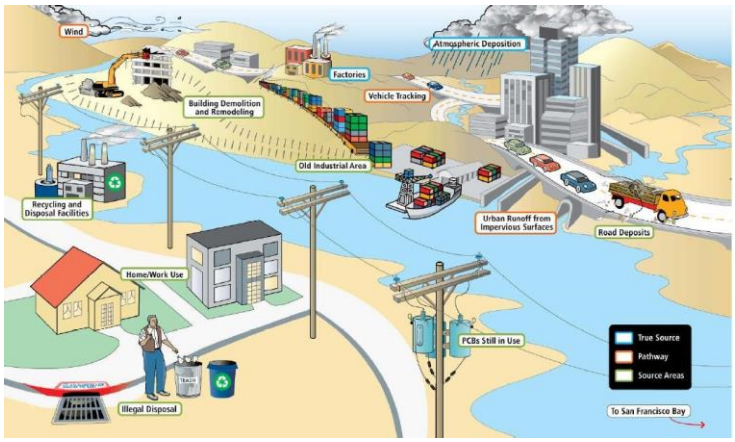

Figure 1. Example Conceptual Model of PCB Sources and Pathways (from SFEI, 2010)

Conceptual models can also be drawn as "box and arrow" diagrams, with boxes representing environmental compartments and arrows representing processes that transfer PCBs between compartments. An example box and arrow diagram summarizing PCB fate processes in the Spokane River and its sediments is shown in Figure 2.

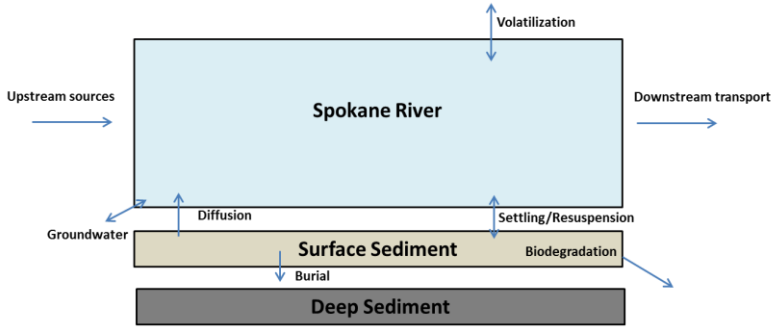

Figure 2. Example Box and Arrow Conceptual Model

This memorandum is intended to describe the sources of PCBs in the Spokane River watershed and the pathways by which these PCBs are delivered to the river, in support of subsequent steps to define the magnitude of these sources and pathways. It is divided into sections of:

- Sources of PCBs

- Delivery mechanisms of PCBs to the Spokane River
- Transport pathways between sources and delivery

Sources of PCBs

Sources of PCBs are divided into three broad categories, based on refinement of earlier PCB source characterization done for San Francisco Bay (SFEI, 2010) and Spokane (LimnoTech, 2013).

- Legacy sources of PCBs currently present in the Spokane watershed
- Ongoing sources of PCBs continuing to be introduced to the watershed via inadvertent production in commercial products
- Environmental transport of non-local PCBs into the watershed study area, which may either be legacy or continuing sources

Legacy Sources

Legacy sources correspond to PCBs that were brought into the Spokane watershed in the past, but are not continuing to be produced. These were produced by Monsanto and marketed as Aroclors which were used in machine oils, transformers, etc. As shown in Table 1, legacy sources are divided into categories of buildings, environmental, and industrial equipment. Building sources can either be fixed to the building itself (e.g., paint, caulk) or non-fixed and removable (e.g., light ballasts). Legacy environmental sources of PCBs correspond to contaminated surface soils, contaminated subsurface soils/groundwater, and in-place aquatic sediments in the Spokane River and Lake Spokane. Historically produced PCBs are also still contained in various forms of electrical equipment such as transformers, and hydraulic equipment.

Buildings	Environmental	Industrial Equipment
• Fixed • NonFixed	• Surface soils • Subsurface soil/ groundwater • Aquatic Sediments	• Electrical Equipment • Hydraulic Equipment

Table 1. Categories of Legacy Sources of PCBs in the Spokane Watershed

Ongoing Sources

Despite the ban on the intentional production of PCBs instituted in 1979, PCBs still continue to be inadvertently produced in the chemical synthesis of many commercial products. These sources are divided into categories in Table 2. Characterization of PCB loads from inadvertent sources have identified pigments in printed materials/fabrics (Guo et al, 2013) and paints (Hu and Hornbuckle, 2010) as two primary categories of inadvertent production. Combustion of chemicals can also be an inadvertent source. It is recognized that inadvertent PCB production occurs in other categories of products as well, although the magnitude of these other sources is largely unknown and/or considered to be much smaller than sources in the first two categories.

Pigments in Printed Materials/Fabrics	Paints	Other
• Newsprint • Commercial Packaging • Colored Clothing	• Architectural paint • Road paint	• Motor oil • Agricultural chemicals

Table 2. Categories of Ongoing Sources of PCB Production

Non-Local Environmental Sources

PCBs also enter the Spokane watershed study area (presently defined as having an upstream boundary at Lake Coeur d'Alene) via non-local environmental sources. Non-local sources can either be delivered via the atmosphere or enter the river from Lake Coeur d'Alene. The term "non-local" is used to distinguish sources that originate outside of the watershed from atmospheric sources that originate from the volatilization of PCBs in the Spokane watershed. It is recognized that these non-local environmental sources can originate from either legacy PCB sources or ongoing inadvertently produced sources.

Delivery Mechanisms of PCBs to the Spokane River

PCBs can be delivered to the Spokane River study area via a number of mechanisms, as depicted in Figure 3. Categories of delivery include:

- Transport of PCBs from upstream sources through Lake Coeur d'Alene
- Atmospheric deposition
- Groundwater loading
- Stormwater runoff, either as part of an MS4 stormwater system or via direct drainage
- Combined sewer overflows (CSOs)
- Tributaries
- Discharge from municipal and industrial wastewater treatment plants
- Discharge of waste water and stocking of fish from fish hatcheries
- Diffusion or resuspension of PCBs from bedded sediments in the Spokane River and Lake Spokane

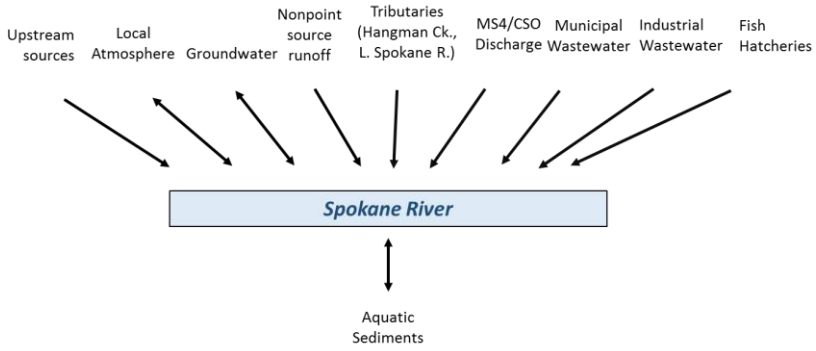

Figure 3. Categories of Delivery of PCBs to the Spokane River

Intermediate Transport Pathways

It is recognized that there are a number of intermediate pathways by which the pollutant sources listed above get transported to the delivery mechanisms shown in Figure 3. The pathways are depicted in Figure 4 under the broad categories of:

- Mobilization in the watershed
- Volatilization to the atmosphere
- Delivery to sewer infrastructure
- Contribution to groundwater

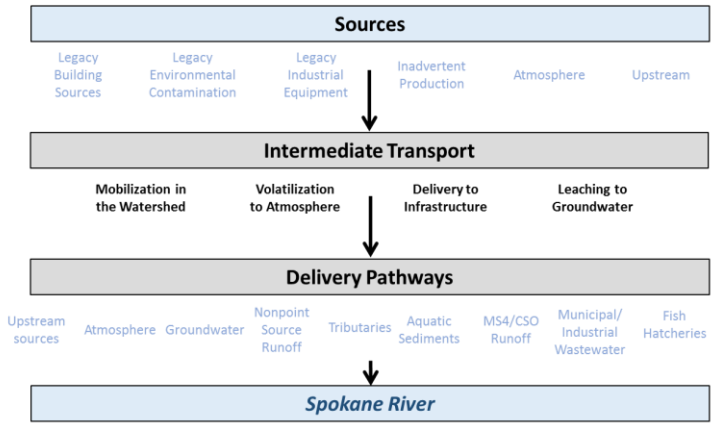

Figure 4. Intermediate Transport Pathways for Delivery of PCBs

Each of these pathways contains multiple components, which are described in subsequent subsections of this memorandum.

Mobilization in the Watershed

Many of the sources of PCBs are contained within products of some kind. They are not immediately available for transport from the watershed to the river, and must first undergo a mobilization step. These sources, and the routes in which they are mobilized, are depicted in Figure 5. Fixed building sources can either be released to surface soil during building demolition, or transferred to recycling facilities[4]. The primary routes of watershed mobilization for non-fixed building sources are transfer to recycling facilities. PCBs contained in industrial sources can be mobilized via spills to surrounding soils, or through delivery to recycling facilities. PCBs in consumer products can be mobilized in surface soils via littering or processing at recycling facilities. Local atmospheric sources can contribute to watershed contamination via deposition and gas transfer. Finally, inadvertently produced PCBs can be directly applied to watershed soils via hydro-seed, de-icer, herbicides and pesticides, and biosolids or fertilizer applications.

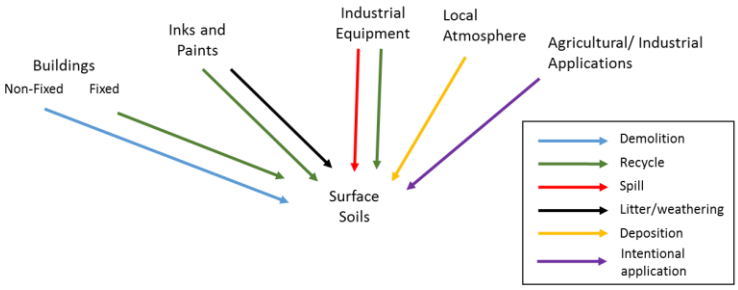

Figure 5. Mobilization of Sources in the Watershed

Mobilization to the Atmosphere

Numerous sources contribute to local atmospheric concentrations of PCBs via volatilization, i.e. conversion into a gas phase. Most of these pathways consist of volatilization directly from one of the previously listed source categories (i.e., buildings, surface soils, industrial equipment). Combustion sources include internal combustion engines, incinerators, used oil burning and residential burning. Shanahan, et al. (2015) also identified volatilization of PCBs from sludge drying at wastewater treatment plants as an important source of atmospheric PCBs. The final source of local atmospheric sources is transport of PCBs generated outside of the watershed (Figure 6).

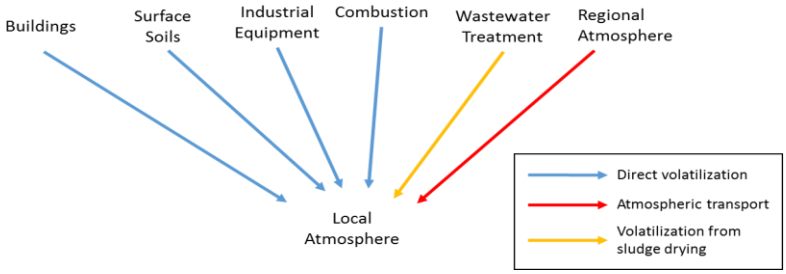

Figure 6. Mobilization of Sources to the Atmosphere

[4] Transfer to landfills is discussed in the "Contribution to Groundwater" section.

Delivery to Sewer Infrastructure

The Spokane watershed contains a range of sewer infrastructure capable of delivering PCBs, either directly or indirectly, to the river. This infrastructure can be broadly divided into categories of stormwater and wastewater. Stormwater infrastructure can be further divided into categories of systems that directly discharge to the river and those that do not directly discharge (e.g., dry wells). Wastewater infrastructure can be divided into categories of municipal wastewater and industrial/other (i.e., Kaiser Aluminum, Inland Empire Paper, and the Spokane fish hatchery) and private septic systems. The mechanisms by which PCBs are delivered to the infrastructure are depicted in Figure 7.

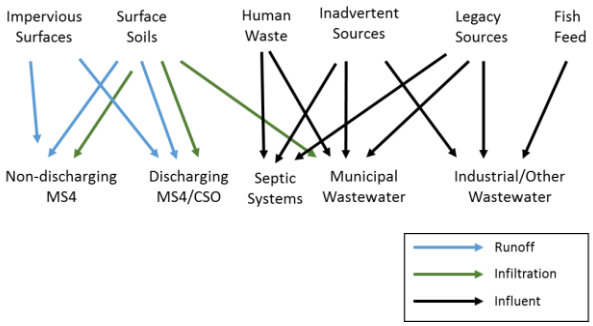

Figure 7. Delivery of Sources to Sewer Infrastructure

Potential sources of PCBs to the stormwater network are erosion of contaminated surface soils and infiltration of contaminated subsurface flow. Municipal wastewater treatment plants can get PCBs from human waste, infiltration of contaminated surface soils, as well as from printed materials/fabrics and legacy sources in their influent. Septic systems can receive PCBs from human waste, infiltration of contaminated surface soils, printed materials/fabrics and legacy sources. The industrial/other wastewater treatment plants receive PCBs in their influent, with the specific nature of the PCB source depending upon the facility.

Contribution to Groundwater

The final intermediate transport pathway is contribution to groundwater, with specific transport mechanisms shown in Figure 8. Subsurface soils can contribute to groundwater either via legacy contamination, landfill disposal of PCB-containing products or private septic systems. Surface soils can also contribute to groundwater contamination via infiltration. A special case is included in Figure 8 to consider detention of stormwater in the non-discharging system such as drywells, as this mechanism has the potential to be a larger source of PCBs than infiltration from other soil areas.

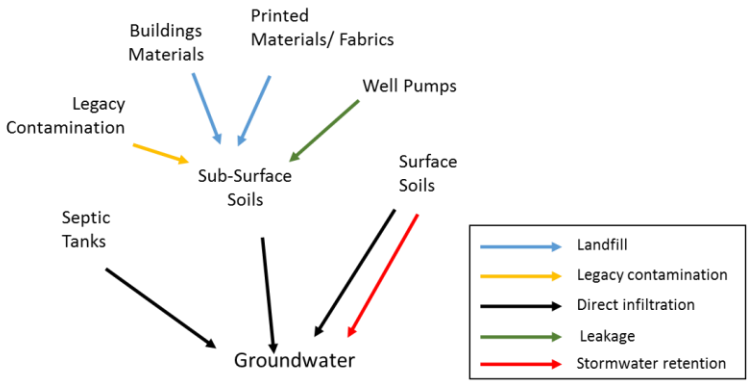

Figure 8. Delivery of Sources to Groundwater

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Appendix B: Magnitude of Sources and Pathways of PCBs in the Spokane River Watershed

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Memorandum

From: Dave Dilks

Date: June 22, 2016
Project: SRRTTF

To: Spokane River Regional Toxics Task Force

SUBJECT: DRAFT: Magnitude of Source Areas and Pathways of PCBs in the Spokane River Watershed

Summary

The Spokane River Regional Toxics Task Force (SRRTTF) is developing a comprehensive plan to bring the Spokane River into compliance with applicable water quality standards for polychlorinated biphenyls (PCBs). Development of the comprehensive plan will benefit from an understanding of the sources and pathways of PCBs in the Spokane River watershed, allowing the plan to target control of the most important sources and pathways. A prior memorandum (LimnoTech, 2015a, http://srrttf.org/wp-content/uploads/2016/03/SRRTTF_SourcesPathways_2016_0309_draft.pdf) qualitatively described potential source areas and transport mechanisms affecting PCBs in the Spokane River and its contributing watershed. This memorandum estimates the magnitude of those source areas and pathways to the extent possible, using site-specific data when available and literature sources otherwise. The estimates are specified as ranges, sometimes covering an order (or orders) of magnitude, because of the extensive reliance on literature values. Although uncertain, these estimates are still worthwhile in distinguishing between source areas and pathways as likely significant or relatively unimportant in developing the Comprehensive Plan.

Legacy PCBs in buildings (e.g. small capacitors, caulks) and legacy soil contamination are estimated to be the largest source areas of PCBs in the watershed. Cumulative loading across all wastewater treatment plants, contaminated groundwater, stormwater/combined sewer overflows, and Lake Coeur d'Alene and tributaries are estimated to be the primary delivery mechanisms of PCBs to the Spokane River. PCB loading from Lake Coeur d'Alene and tributaries are of similar magnitude to the other primary delivery mechanisms, due to much higher flow rates with lower concentrations of PCBs. Although quantitative estimates have been generated for the PCB mass currently residing in the watershed and for the magnitude of different delivery mechanisms to the Spokane River, much less information is available to quantify the transport pathways between these source areas and delivery mechanisms. This lack of information will pose a significant challenge when developing the Comprehensive Plan. This issue is not unique to Spokane, as PCB control plans for other watersheds have been developed facing similar types of uncertainty regarding transport mechanisms.

Introduction

This memorandum quantifies, to the extent possible, the magnitude of source areas and pathways of PCBs to the Spokane River using a combination of site-specific data and literature sources. LimnoTech (2015a) previously qualitatively described potential key source areas and transport mechanisms affecting PCBs in the Spokane River watershed. That memorandum showed that PCBs originate from many different source areas, and are delivered to the river via many different pathways. This memorandum is divided into sections discussing:

- Magnitude of source areas of PCBs
- Magnitude of delivery mechanisms of PCBs to the Spokane River
- Magnitude of intermediate transport pathways

Magnitude of Source Areas of PCBs

There is the potential for confusion when discussing PCB sources, as the term "sources" commonly refers to the true origin of the contaminant. In the case of PCBs, the dominant source was intentional production by Monsanto through 1979. Although this source no longer exists, those legacy PCBs now exist throughout the environment. This memorandum follows the nomenclature of SFEI (2010) and used the term "source areas" to represent those environmental compartments containing PCBs. Source areas are defined as the places where PCBs were used, inadvertently released, systematically discarded or accumulated. Source areas of PCBs are divided into three broad categories in this memorandum, based on refinement of earlier PCB source characterization done for San Francisco Bay (SFEI, 2010) and Spokane (LimnoTech, 2013).

- Legacy sources of PCBs currently present in the Spokane watershed
- Ongoing sources of PCBs continuing to be introduced to the watershed via inadvertent production
- Environmental transport of non-local PCBs into the watershed study area, which may either be legacy or ongoing sources

The mass of PCB estimated in each source area category is listed in Table 1 and depicted in Figure 1. Note that each entry is described using a range, rather than a single value, in order to clearly depict the uncertainty in each estimate.

Table 1. Mass of PCB Estimated in each Source Area Category

Source Area Category	PCB Mass (kg)
Legacy	
Building sources	
Non-fixed[5]	50 – 40,000
Fixed[6]	60 - 130,000
Environmental	
Watershed soils	550 - 55,000
Sub-surface soils – cleanup sites	Unknown
Spokane R. deep sediments	4 -100
L. Spokane deep sediments	8 - 200
L. Spokane shallow sediments	0.4 - 10
Spokane R. shallow sediments	0.06 – 0.15
Industrial equipment	6.4 - 25
Ongoing	
Inadvertent production	0.2 – 450
Non-Local Environmental	
Lake Coeur d'Alene	~0 – 0.047
Atmospheric	Unknown

[5] PCBs in small capacitors in items such as appliances and lamp ballasts.
[6] Building materials such as paints and sealants (e.g. caulks).

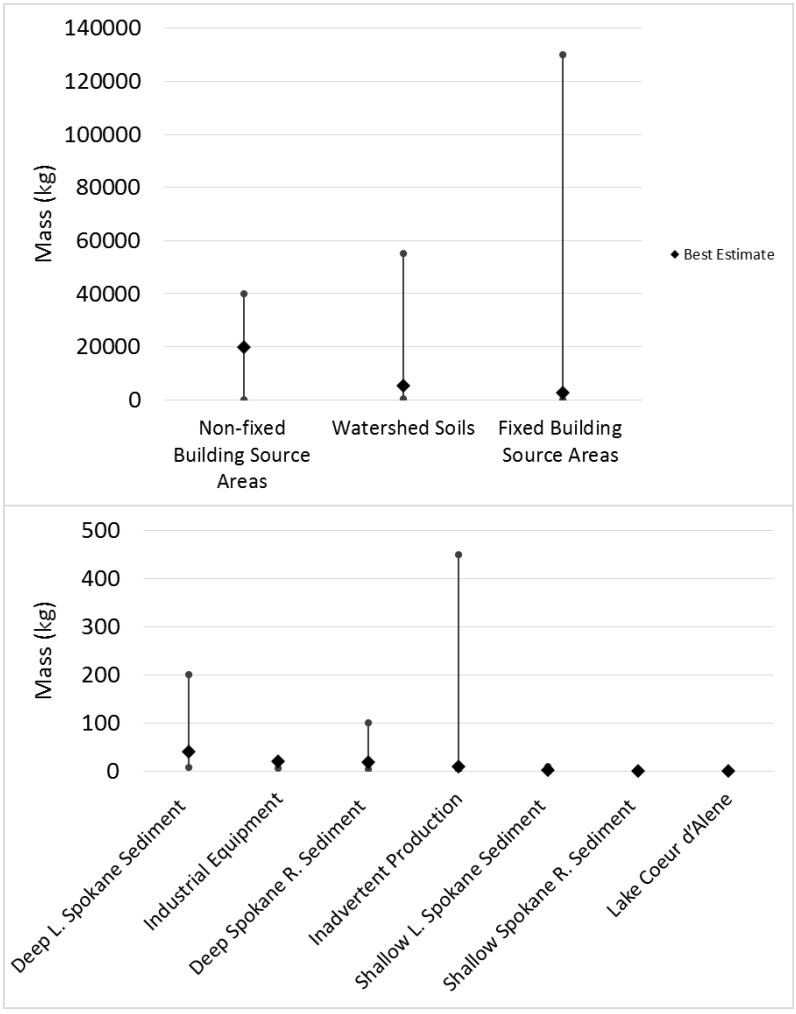

Figure 1. Estimated Range of Mass of PCB in each Source Area Category (Note the large difference in scale between the two embedded graphs)

The remainder of this section describes how each of these estimates was determined.

Legacy Sources

Legacy sources are defined as PCBs that were brought into the Spokane watershed in the past, but are not continuing to be produced. These were produced by Monsanto and marketed as Aroclors which were used in machine oils, transformers, building materials, and many other products. LimnoTech (2015a) divided legacy sources into source area categories of:

- Building sources areas: These source areas were sub-categorized as either fixed to the building itself (e.g., paint, caulk), or non-fixed and removable (e.g., light ballasts)
- Environmental: These source areas consist of contaminated surface soils, contaminated subsurface soils/groundwater, and the re-suspendable portion of in-place aquatic sediments in the Spokane River and Lake Spokane.
- Industrial equipment: These source areas consist of PCBs contained in various forms of electrical equipment such as large transformers, and hydraulic equipment.

Building source areas

Building source areas are sub-categorized as either fixed to the building itself (e.g., paint, caulk), or non-fixed and removable (e.g. lamp ballasts).

Fixed Building Source Areas

PCBs were commonly used in building sealants such as caulks from the 1950s to the 1970s (Robson et al. 2010), to improve the flexibility of the material, increase the resistance to mechanical erosion, and improve adherence to other building materials (Andersson et al., 2004). As such, building constructed from the 1950s to the 1970s may still contain caulks with elevated levels of PCBs. No Spokane-specific data exists defining the quantity of PCBs still present in fixed building source areas. However, many studies have been conducted estimating this magnitude for other communities, and these studies can provide a template for Spokane estimates. The methods used vary in terms of complexity, as demonstrated below. Shanahan et al (2015) used the most rigorous approach, estimating the mass of PCBs present in Chicago-area building source areas by:

- Examining the building footprint, age, number of stories for each individual land parcel
- Calculating the volume of all buildings constructed between 1940 and 1979 from the building footprint and height data
- Assuming the mass of sealants per unit building volume from literature sources
- Assuming the PCB concentrations in caulk for buildings built between 1940 and 1979 from literature sources
- Assuming the percentage of buildings constructed from 1940 to 1979 contained PCB sealants from literature sources

Ecology (2011) estimated the quantity of PCBs in building sealants in in the Puget Sound Basin based upon:

- Reviewing the available literature for information on the types and ages of buildings most likely to contain caulking with PCBs.
- Sampling available county assessor's information to estimate the volume of candidate buildings and develop an inventory of caulking material likely to contain PCBs within the Study Area.
- Reviewing the available literature for data on PCB concentrations in caulking material.
- Applying literature values to estimate the mass of PCBs contained in caulk.

Diamond et al (2011), used a range of calculation methodologies, including providing estimates for PCBs in caulk on a per capita basis, calculated as 5.2 metric tons per million people of population. Lacking readily available information on volume of structures in the Spokane watershed built during the time of PCB use, the Diamond et al (2011) per capita will be used in conjunction with the Spokane watershed population. Population in census block groups was obtained in GIS data format from the U.S. Census Bureau estimates for 2011 (https://www.census.gov/geo/maps-data/data/tiger-data.html). Population per acre was calculated for each block group, and this information merged with watershed boundary

delineations obtained from the Watershed Boundary Dataset (WBD). This results in a population estimate for the contributing watershed of 571,045, leading to an estimate of PCBs in caulk throughout the watershed of 2969 kg. This number should be considered very uncertain. The literature sources used to support this calculation cited a factor of ten uncertainty in their calculations. Because the Spokane calculation in based on a per capita estimate rather than actual building age, it is likely that this estimate is only accurate with a factor of fifty, resulting in an uncertainty range of 60 to 130,000 kg.

Non-Fixed Building Source Areas

Non-fixed and removable PCBs are contained in small capacitors in a number of non-fixed building related items, such as appliances and lamp ballasts. PCB-containing ballasts were commonly used in public schools, and EPA (2001) recommends removal of all pre-1979 fluorescent light ballasts in schools to prevent accidental exposure of students, teachers, and other school personnel to PCBs. No Spokane-specific data are available defining the mass of PCBs in this category, but the method applied by Ecology (2011) to estimate the mass of PCBs contained in small capacitors in the Puget Sound watershed can be applied to Spokane. Ecology (2011) described their approach as follows:

> A typical small capacitor unit contains 0.1-0.6 pounds (45 - 270 grams) of PCB oil, with lamp ballasts typically containing about 45 - 70 grams per ballast (EPA, 1982). Globally, one-third of all PCB production may have gone into lamp ballasts (Panero et al., 2005). In 1992 the University of Illinois estimated that 10-25% of U.S. household white goods (major appliances) contained capacitors with PCBs (Panero et al., 2005). Though it is known that many small PCB capacitors were manufactured prior to 1978, estimates of the number still in use vary. EPA (1982) estimated that historically there were 870 million small capacitors in use throughout the U.S. in 1977 in industrial machines and small appliances. EPA (1987) also estimated a 10% annual disposal rate in 1982.
>
> Estimates for PCB lamp ballasts currently in use are an order of magnitude higher than the 1982 EPA estimate for small capacitors. These estimates place the number of ballast units remaining in use nationally between roughly 300 million (U.S. Army, 2001) and 500 million (Missoula County, 2010). In 1998, the EPA cited an unnamed industry source that estimated one billion ballasts were currently in use (EPA, 1998). The EPA (1998) reference suggests that the current number of PCB-containing ballasts in use nationally would be somewhere between 280 million, assuming a mean annual disposal rate of 10% from 1998 to 2010, and 69 million, assuming a mean annual disposal rate of 20% from 1998 to 2010.

Applying annual disposal rates of 10 and 20% to the national estimates and scaling to the Spokane study area by local population yields a range of 1,000 to 500,000 total small capacitors (including ballasts) remaining in use. This information, combined with an assumed PCB concentration of 45 – 75 g PCB per capacitor, results in total PCB mass in the Spokane watershed of 50 – 40,000 kg.

Environmental

Environmental source areas consist of contaminated surface soils, contaminated subsurface soils/groundwater, and in-place aquatic sediments in the Spokane River and Lake Spokane.

Contaminated Surface Soils

Meijer et al (2003) concluded that soil may be one of the largest global PCB repositories, due to deposition from manufacturing, leaching from building materials or landfills, and the application of wastewater treatment plant biosolids. Insufficient site-specific data are available defining PCB concentrations in soils throughout the Spokane River watershed. An estimate of the total stock of PCBs in Spokane-area soils was made following the approach used by Shanahan et al (2015), who estimated the soil PCB mass reservoir in the Chicago area from:

- the amount of urban area, based upon parcel data

- a literature based soil:air exchange depth of 0.12 m.
- an average PCB concentration in urban soils estimated from 15 cities of 50 ng/g dry weight (from a range of 3–220 ng/g)
- the average bulk density of urban soils

Applying that approach to the Spokane watershed results in an estimate of the PCB mass reservoir of 5,500 kg. Given that the range of observed PCB concentration in urban soils varies by approximately a factor of plus or minus ten, it is reasonable to assume that the Spokane-specific mass estimate is also only accurate to a factor of ten, resulting in an estimated rand of 550 to 55,000 kg.

Contaminated Sub-Surface Soils

Marti and Maggi (2015) searched Ecology databases for sites that could be contributing PCB contamination to the Spokane River via groundwater, and identified 31 cleanup sites. Soils at 27 of the sites had been analyzed for PCBs using method SW8082, with 23 of these sites having had confirmed releases to soils. Of these 23 sites, 13 have undergone cleanups and received No Further Action (NFA) designation although they may still have detectable PCB concentrations using method 1668. Contaminated soils were removed at twelve of the sites. On-site containment was used at one site. Of the ten remaining sites with confirmed releases of PCB, six are undergoing cleanups, two are in performance monitoring status, and two are awaiting cleanups. Marti and Maggi (2015) prioritized these sites in terms of: 1) confirmed or suspected release of PCBs to the environment, and 2) site status with regard to cleanup activities. While an extensive data base exists defining soil PCB concentrations at these sites, this information has not been compiled in a manner that provided a quantitative estimate of the total mass of PCBs across the sites.

River and Lake Sediment

The bottom sediments of the Spokane River and Lake Spokane provide another potential reservoir of PCB contamination. An estimate of the total mass associated with this category was made using data from Ecology (2011), Ecology (2015a), Golder (2005), Ecology (2005), Johnson and Norton, (2001) and Era-Miller (2014). Separate estimates were made for the Spokane River and Lake Spokane, further sub-divided into estimates for surface and deep sediments in each system.

Ecology (2011) discussed the general lack of bottom sediments in the Spokane River:

> One particular macro characteristic of the Spokane River is the general lack of fine depositional sediments in most of the river. Lake Coeur d'Alene acts as a settling basin for sediments transported in the upper watershed, and there are no tributaries to the river between the outlet of the lake and Latah Creek. Spokane River is essentially a free-stone stream environment. Although the dams break the river into a series of pools, there are few areas of placid water above Lake Spokane. The river velocities are high enough and the sediment load low enough to scour the bed or prevent settling of significant fine particulate matter, even immediately behind the dams. As a result, almost the entire riverbed upstream of Lake Spokane (the largest reservoir) is composed of gravel, cobble, and boulders with the finer sediment reserved for limited locations behind the dams, interstitial spaces within the river bed, isolated shoreline deposits, and certain fluvial bar features. One notable exception is the narrow band of fine, organic carbon rich sediments found near the Upriver Dam reservoir.

Calculation of surface sediment PCB mass in the Spokane River was based upon measured PCB and sediment concentrations, and modeled fraction of river containing depositional sediment. Ecology (2011) reported surface sediment PCB concentrations above Monroe St. of 6.7 ng/g. Era-Miller (2014) reported PCB concentrations from sediment traps at Upriver Dam of 25.4 to 28.5 ng/g and 13.7 to 17.2 ng/g at Ninemile Dam. Ecology (2015b) reported surface sediment PCB concentrations at undetectable levels (detection limit ~10 ng/g) in their reassessment of the Upriver Dam and Donkey Island PCB sediment

site. The solids concentrations of the bed sediments were taken from measurement reported by Johnson and Norton (2001), and an assumed sediment solids density of 2.6. Golder (2005) reports that approximately 20% of the Spokane River above Ninemile Dam is considered depositional. The Spokane River is unique in this regard, as most systems with known PCB contamination (e.g. Delaware River, San Francisco Bay) are dominated by depositional areas. Combining the above information and assuming an average of the observed PCB concentrations (15 ng/g) results in a mass estimate of 0.032 kg.

The Spokane River also contains historical PCB contamination in deep sediments at the Upriver Dam and Donkey Island PCB Sediment Site. The mass of PCB buried in deep sediments was calculated from the PCB concentration depth profiles provided in Ecology (2005), surface area provided in Ecology (2015b), and bed sediment solids concentrations provided in Johnson and Norton, (2001). Combining the above information and assuming an average of the observed PCB concentrations (6587.5 ng/g) results in a mass estimate of 19.2 kg. Ecology (2011) also reported sediment PCB concentrations at two locations in Lake Spokane. Concentrations in the upper 10 cm ranged from 8 to 33 ng/g in the upper portion of the Lake to 28 to 75 ng/g in the lower portion of the lake. Johnson and Norton, (2001) provided solids concentrations of the bed sediments and three locations in the lake, upper mid-lake, and lower. Combining the observed concentration data at each location (18 ng/g in the upper lake, 41 ng/g in the lower lake), an assumed concentration at mid-lake as the average of the upper and lower lake concentrations 29 ng/g), and an assumed sediment solids density of 2.6 results in a mass estimate of 2.24 kg in surficial Lake Spokane sediments.

The mass of PCB buried in deep Lake Spokane sediments was calculated from the PCB concentration depth profiles provided in Ecology (2011), and bed sediment solids concentrations provided in Johnson and Norton (2001). Combining the observed concentration data at each location (37 ng/g in the upper lake, 4442 ng/g in the lower lake), assumed concentration at mid-lake as the average of the upper and lower lake concentrations (240 ng/g), and an assumed sediment solids density of 2.6, results in a mass estimate of 40.6 kg. Because estimates of the system-wide mass reservoir is being based on a relatively small number of discrete measurements, it is reasonable to assume that these estimate are only accurate within a factor of five, resulting in an uncertainty range of 8 to 200 kg.

Industrial equipment

The primary source areas of legacy PCBs contained in industrial equipment correspond to transformers and large (over three pounds total) capacitors. In addition, hydroelectric dams have been identified as a potential ongoing source of PCBs in the Columbia River, due to historical leaks and spills of PCB-contaminated oils. Information on the presence and PCB content of these sources was gained by direct contact with the utilities who are responsible for the generation and transmission of electricity in the Spokane region. These consisted of Avista Utilities, Inland Power and Light Company, Modern Electric Water Company, Vera Water and Power, Kootenai Electric Cooperative, and Bonneville Power Administration. Avista operates approximately 24,754 overhead transformers within the Spokane region, with a total oil content of approximately 117,000 gallons. By the end of 2016, Avista will have no detectable levels (EPA method 8082) of PCBs in their overhead transformers. Using an assumed PCB concentration of 0.5 ppm (half the detection limit of 1 ppm), this corresponds to a total PCB mass of 0.20 kg. Inland Power and Light Company operates approximately 30,000 transformers, and has replaced all transformers that had 45 ppm or more PCBs. Using 22.5 ppm (half the replacement concentration), this corresponds to a PCB mass of 10.8 kg. Vera Water and Power operates 137 transformers containing PCB concentration between 2 ppm and 43 ppm, with an average concentration of 8 ppm. These transformers contain approximately 3430 gallons of oil. This corresponds to a total PCB mass of 0.09 kg. Kootenai Electric Cooperative has 1,926 transformers in their system that potentially contain PCBs. They do not have an estimate of PCB content, but do have a two year plan to remove all transformers with PCBs. in them. Using average values for quantity of oil and PCB content results in a total mass of 1.7 kg. Modern

Electric Water Company operates 2,665 transformers and in the past 20 years has replaced all transformers with PCB concentrations greater than 10 ppm. They estimate roughly 10% of the transformers contain PCBs at a concentration less than 10 ppm. Using an average of 25 gallons oil/transformer and 5 ppm to provide an average PCB concentration, this corresponds to a mass of 0.11 kg. Bonneville Power Administration (BPA) has no high voltage PCB capacitors in their system. No other information is available from them.

The sum of transformer PCB mass across all utilities is approximately 12.8 kg. This estimate should be accurate within a factor of two, as the volume of oil is well known and the concentration values are specified as a midpoint between zero and the maximum possible value. This results in an uncertainty range of 6.4 to 25 kg, which is specified in Table 1.

None of the utilities continue to use PCB-containing capacitors over three pounds, so the estimated PCB content for this source area category is zero.

Hydroelectric facilities were identified as another potential source of PCBs to the Spokane River, based on past releases of PCB-containing electric oil from Army Corps of Engineers' hydroelectric facilities in the Columbia River basin. With the exception of Upriver Dam (which is operated by the City of Spokane), Avista Utilities operates all hydroelectric facilities in the Spokane River study area. Neither Avista nor the City of Spokane use PCB containing oil in these facilities. The PCB mass contained in hydropower facilities was therefore considered negligible.

Ongoing Sources

Despite the ban on the intentional production of PCBs instituted in 1979, PCBs still continue to be inadvertently produced in the chemical synthesis of many commercial products. EPA promulgated a rule under the Toxics Substance Control Act for inadvertent generation of PCBs that are not in closed or controlled manufacturing processes. The annual average concentration of inadvertently generated PCBs in products must be less than 25 ppm, with a maximum concentration of 50 ppm (40 CFR Section 761.3). LimnoTech (2015a) divided ongoing sources into source area categories of:

- Pigments in printed materials/fabrics: Newsprint, commercial packaging, colored clothing
- Paints: Architectural paint, road paint
- Other: Many products, including agricultural chemicals

Studies have been conducted that test the levels of PCBs in a wide range of products (e.g. City of Spokane, 2015; Ecology, 2014; Hu and Hornbuckle, 2010.) The number of products tested, however, in conjunction with a lack of information on the quantity of goods being imported into the watershed by category, prevent calculation of category-specific magnitude estimates. Work conducted as part of the Ecology and DOH (2015) PCB Chemical Action Plan provides a template for estimating of the overall magnitude of all inadvertent sources being imported into the watershed:

> The US market consumes approximately 20% of global organic pigments (Guo et al. 2014). Washington is approximately 2% of the US population, which leads to an estimate for Washington's share of PCB-11 from yellow pigment of 0.02 and 31 kg per year. This is the amount of PCB-11 in products, with an unknown amount entering the environment. The Color Pigments Manufacturers Association (CPMA) estimated that the total annual amount of these pigments (phthalocyanine and diarylide) imported or manufactured in the US is about 90 million lbs (41,000 metric tons). They further estimated inadvertently generated PCBs in these pigments with an upper bound of 1.1 tons per year and a more reasonable estimate of 1000 lbs per year (CPMA 2010). Using the lower annual estimate of 1000 lbs (450 kb), leads to an estimate of 9 kg per year in Washington, that is within the range of the estimate above.

Scaling the above estimate to the population of the Spokane watershed leads to a loading estimate for Spokane of 0.86 kg/yr. In order to convert this rate into a mass, assumption need to be made regarding how long these inadvertently-produced remain in the watershed before leaving either via the atmosphere or being transported downstream by the Spokane River. A lower-bound estimate of a residence time one year results in a mass estimate of 0.86 kg, while an upper-bound estimate of a residence time 20 years results in a mass estimate 17.2 kg. The mid-point of these values is 9 kg/yr. The overall uncertainty in this estimate reflects uncertainty in both the rate of PCBs being imported to the watershed as well as their residence time, such that this value is likely accurate only within a factor of fifty, resulting in a range from 0.2 – 450 kg.

Non-Local Environmental Source Areas

PCBs also enter the Spokane watershed study area (presently defined as having an upstream boundary at Lake Coeur d'Alene) via non-local environmental sources. LimnoTech (2015a) divided non-local environmental source areas into categories of:

- Atmospheric: Atmospheric sources originating outside of the watershed
- Up-watershed: Entering the river from Lake Coeur d'Alene.

Atmospheric

No definitive information exists on the specific amount of PCBs delivered to the Spokane area from atmospheric sources, regardless of origin. Era-Miller (2011) in a literature review of toxics atmospheric deposition in Eastern Washington State, found no data available for atmospheric PCBs in eastern Washington. The closest relevant reference site with atmospheric PCB data was from Summerland, British Columbia, with a measured annual PCB concentration of 4.4 ng/PAS (Passive Air Sampler). Era-Miller's review showed a range of reported significance of non-local sources compared to local sources. An atmospheric deposition model of PCBs in the Willamette River Basin suggested that PCBs came primarily from non-local sources and local soil sources, while a second source in that review (Simonich, cited as personal communication) suggested that the contribution of trans-Pacific sources to PCB, PBDE, and PCDD/F deposition in Eastern Washington was less than 2%. Ecology's Environmental Assessment Program is currently undertaking a study that will provide information on this source area category.

Up-Watershed

PCB loading from Lake Coeur d'Alene represents the aggregate contributions of PCBs from the upper watersheds after travelling through the lake. An estimate of PCB load currently present in Lake Coeur d'Alene was calculated by multiplying the volume of the lake (2.79 km^3) by the average PCB concentration in the lake, represented by data collected by the SRRTTF during confidence testing and synoptic surveys. It is recognized, however, that the analytical results utilized to estimate this concentration are below concentrations at which PCBs can be measured with confidence in the environment. The average total PCB concentration of 17 pg/l is less than the average of field blanks from the same confidence testing and synoptic survey, corrected in the same manner (27 pg/l). In addition, available PCB concentration data are dominated by summer measurements, although no significant difference in concentrations were observed between seasons. To account for this uncertainty in lake concentrations, the mass calculation was conducted for a range of PCB concentrations from near zero to 17 pg/l. The resulting load estimate is near zero to 0.047 kg.

Magnitude of Delivery Mechanisms of PCBs to the Spokane River

The mechanisms that can deliver PCBs to the Spokane River study area were defined by LimnoTech (2015a) as:

- Transport of PCBs from upstream sources through Lake Coeur d'Alene

- Atmospheric deposition directly to water bodies
- Groundwater loading
- MS4 stormwater/combined sewer overflows (CSOs)
- Tributaries
- Discharge from municipal and industrial wastewater treatment plants
- Discharge of waste water and stocking of fish from fish hatcheries
- Diffusion or resuspension of PCBs from bedded sediments in the Spokane River and Lake Spokane

Consistent with the assumptions of Ecology (2011), direct stormwater runoff draining to the Spokane River from areas other than the City of Spokane's MS4 system is assumed to be small. It is noted, however, that one percent (28.6 acres) of Post Falls' impervious surface area contributes to MS4 discharges to the Spokane River, and the City of Coeur d'Alene has five MS4 outfalls to the Spokane River and seven to Lake Coeur d'Alene. Stormwater runoff drainage to tributaries will be reflected in the tributary loading estimates for Latah Creek and the Little Spokane River.

The mass loading rate for PCBs estimated in each source category is provided in Table 2 and Figure 2.

Table 2. PCB Loading Rates Estimated for each Delivery Mechanism

Delivery Mechanism	PCB Loading Rate (mg/day)
WWTPs	
Total Municipal	6 - 2652
Total Industrial	48 - 271
Groundwater loading	60 - 300
Upstream sources	~0 - 260
Tributaries	
Latah Creek	~0 - 215
Little Spokane River	15-200
MS4 stormwater/CSOs	15 - 94
Bottom sediments	0.2 - 20
Fish hatcheries	Unknown
Atmospheric deposition to surface water	<0

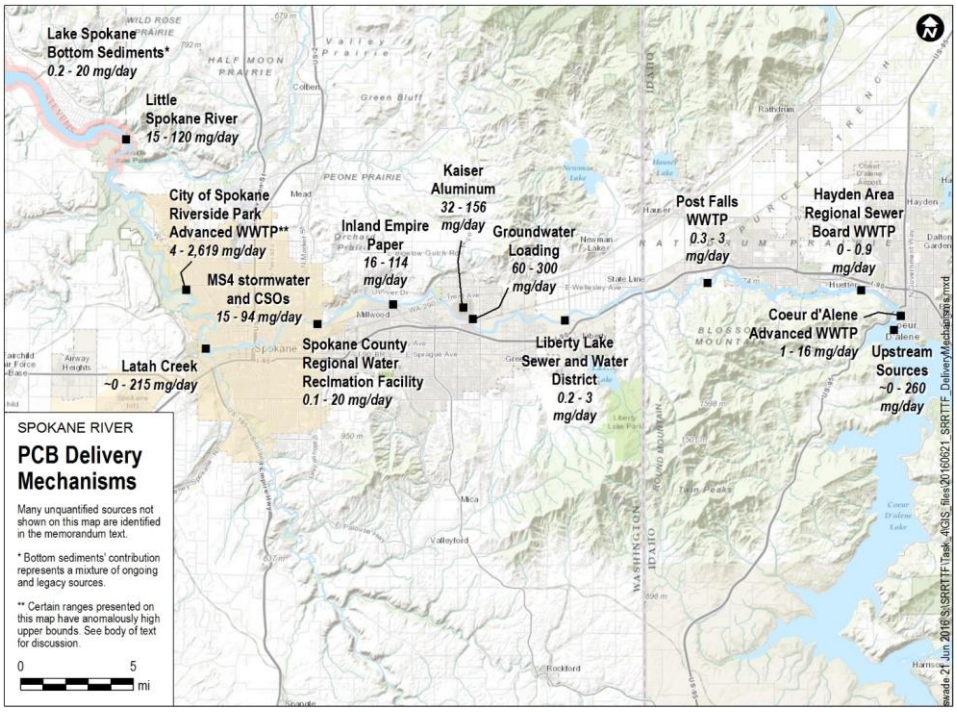

Figure 2. Estimated Range of PCB Loading Rates (mg/day) for each Delivery Mechanism

The remainder of this section describes how each of these estimates was determined.

Transport of PCBs from Upstream Sources through Lake Coeur d'Alene

Transport of PCBs from upstream sources through Lake Coeur d'Alene was estimated using the assumed range of PCB concentrations (near zero to 17 pg/l) discussed in the previous section, in conjunction with the annual average flow out of the lake (175 m^3/sec) to produce an estimated loading rate range from near zero to 260 mg/day.

Atmospheric Deposition Directly to Water Bodies

PCBs can be delivered directly to surface waters from atmospheric sources via three mechanisms: wet deposition, dry deposition, and gas deposition. Wet deposition consists of PCBs contained in precipitation. Dry deposition consists of PCBs attached to airborne particulate matter that settle onto the surface water. Gas deposition occurs as a transfer across the air-water interface when atmospheric gas-phase PCB concentrations exceed the equivalent dissolved phase PCB concentrations in the water column. Research (Miller et al, 2001) has shown that the primary mechanism for atmospheric PCBs to enter surface waters is through gas-phase exchange, so the calculations that follow focus solely on gas deposition as the dominant component of atmospheric PCB loading.

The magnitude of gas deposition is determined by three primary factors, the atmospheric gas phase PCB concentration, the water column PCB concentration and the mass transfer coefficients that control the

rate at which PCB concentrations pass through the air-water interface. Screening-level calculations of gas phase PCB exchange for Spokane focused on Lake Spokane itself, which provides the large majority of overall surface area. Gas-phase atmospheric PCB concentrations were estimated from a population-based regression of Venier and Hites (2010) as 0.121 ng/m^3. The water column PCB concentration was specified as 163.2 pg/L, based upon the average concentration observed at Nine Mile Dam during the 2014 synoptic survey. Representative mass transfer coefficients were taken from Chapra (1996). These values lead to a net movement of PCBs out of the water column and into the atmosphere, i.e. no net loading of PCBs from the atmosphere to the water column.

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Table 3. Inputs Used in Calculating Gas Phase Deposition

Description	Value	Units
Molecular Weight	288	g/mol
Henry's Constant	5.60E-04	atm m3/mol
Gas Law Constant	8.206E-05	atm m3/(K mol)
Air Temperature	4.11	Celsius
Oxygen Transfer Coefficient	0.8655	m/day
Wind Speed	10	mph

These values were input into Equation 1 (where the net transfer velocity is a function of air temperature, the oxygen transfer coefficient, the ratio of PCB molecular weight to oxygen molecular weight, the ratio of PCB molecular weight to water molecular weight, and wind speed):

Mass Flux = Net Transfer Velocity x (Partial Pressure in air / Henry's Constant – Concentration in water) (1)

Application of Equation 1 results in a net movement of PCBs out of the water column and into the atmosphere, i.e. no net loading of PCBs from the atmosphere to the water column.

Groundwater Loading

The synoptic water quality survey conducted by the SRRTTF in August, 2014 identified a significant groundwater loading source entering the river between Greenacres (Barker Rd.) and the Trent Avenue Bridge, with an estimated loading rate of 170 mg/day. A second synoptic survey conducted in August, 2015 confirmed the presence of this load, and estimated its magnitude at 130 mg/day. Uncertainty analyses conducted in conjunction with the loading assessment (LimnoTech, 2015b, http://srrttf.org/wp-content/uploads/2015/08/SRRTTF_Phase_2_Final_Report_2015_08_12_without-appendices.pdf) indicate that this loading estimate can range between 60 and 300 mg/day.

MS4 Stormwater Runoff/Combined Sewer Overflows (CSOs)

Stormwater/CSO loading estimates are based solely on available data for the City of Spokane. It is recognized that Post Falls and Coeur d'Alene also contribute stormwater to the Spokane River, but this load has not been quantified and the area of drainage is small relative to that of Spokane. Initial sampling of the City of Spokane stormwater/CSO discharges for PCBs first occurred for single event in 2004 by the City of Spokane, followed in 2007 by more extensive sampling by Ecology and Parsons (Parsons, 2007). Ecology (2011) used these concentration data in conjunction with average annual stormwater flow predicted by the Simple Method to generate an annual average loading estimate of 691 mg/day.

From 2012 through 2014, the City of Spokane monitored three MS4 stormwater basins (Cochran, Union, Washington) and two CSO basins (CSO34 and CSO06) on a near-monthly basis. Hobbs (2015) reviewed the available data and calculated mass loading of PCBs to the river for individual storms.

Donovan (2015) generated annual loading estimates for MS4 and CSO sources, based upon:

- Annual rainfall of 18 inches
- Site-specific regression of discharge from the Cochran basin to rainfall
- Ratio of impervious area in other basins to impervious area in Cochran basin
- Average stormwater PCB concentration observed in Cochran basin to represent all basins except Union and Washington
- Average stormwater PCB concentration observed in Union basin
- Average stormwater PCB concentration observed in Washington basin
- 2005 actual CSO flow
- Average CSO 6 PCB concentration to represent CSO 6
- Average CSO 34 PCB concentration to represent CSO 34
- Average of CSO 34 and CSO 6 PCB concentration to represent all other CSOs

The above information resulted in an annual loading rate of 29.9 mg/day for MS4 stormwater, 7.6 mg/day for CSO, and a total of 37.6 mg/day. The estimate of Donovan (2015) is believed to be the most accurate value available. There is still uncertainty in this estimate, due primarily to uncertainty in stormwater flow. Based on best professional judgement, the loading estimate is accurate within a factor of 2.5. This results in an estimated loading rate range of 15 to 94 mg/day.

Tributaries

Two tributaries enter the Spokane River within the study area, Latah Creek and the Little Spokane River. Each are discussed below.

Latah Creek

An annual PCB loading estimate for Latah Creek was obtained using long-term average observed creek flow (6.5 m^3/sec) and the average concentration observed during the 2014 SRRTTF synoptic survey (89 pg/l), resulting in an annual loading estimate of 50 mg/day). This loading estimate was calculated by excluding one observed concentration measurement of 2444 pg/l observed during the 2014 Synoptic Survey, due to the fact no indication of concentrations of that magnitude were seen in the composite sample taken during that same synoptic period. Repeating the analysis with that one potentially unrepresentative sample from the calculation results in an average concentration of 383 pg/l and a loading estimate of 215 mg/day. Serdar et al (2011), based upon the absence of detectable levels of PCBs in Latah Creek sediments, assumed that the PCB contribution to the Creek was negligible. The range of estimated loading is based upon the range of these reported and calculated values, and is set as being from near zero to 215 mg/day.

Little Spokane River

A PCB loading estimate for the Little Spokane was originally provided by Serdar et al (2011), based upon and average Little Spokane PCB concentration data from 2003-2004 (199 pg/l) and harmonic mean at the USGS Station 12431000 at Dartford. Their concentration was derived from sampling with a semi-permeable membrane device (SPMD), which is an indirect measurement of water column PCB concentrations. Data collected in 2013-2014 reported by Friese and Coots (2016) suggest much lower river concentrations, with all observed River concentrations being less than 30 pg/l. Blank contamination issues prevented Friese and Coots (2016) from providing a quantitative estimate of concentration. Assuming an concentration of 114 pg/l, representing the average of the observed Serdar et al (2011) concentrations and Friese and Coots (2016) reported concentrations for the Painted Rocks station, in conjunction with the reported long term average flow (11.8 m^3/sec) results in a loading estimate of 116 mg/day. Because the average flow from the river is much better understood than average river concentration, the uncertainty in this estimate is likely driven by the uncertainty in the average river concentration estimated above. Using 15 pg/l as a lower bound and 200 pg/l as an upper bound results in a load range of 15 to 120 mg/day.

Discharge from Municipal and Industrial Wastewater Treatment Plants

Loading estimates for municipal and industrial wastewater treatment plants were calculated from effluent data collected by the plants during routine monitoring, along with data obtained during the SRRTTF synoptic surveys to assist in source identification. Results are summarized in Tables 4 through 6, and Figures 3 through 5. These concentrations and loading estimates are presented in multiple formats due to differences in objectives, blank correction methodology, and monitoring design between the SRRTTF synoptic surveys and routine discharger effluent monitoring. The SRRTTF recognizes that the selection of blank correction methodology is dependent on the use of the data and conducted synoptic effluent monitoring with the objective of collecting the necessary data to conduct a semi-quantitative PCB mass balance assessment in the Spokane River. For the purposes of calculating total PCB concentrations for this study, the SRRTTF did not use any individual congener in a field sample that was less than three times the concentration of that congener in the method blank associated with the field sample (LimnoTech 2014, http://srrttf.org/wp-content/uploads/2013/05/QAPP_FINAL_081114.pdf). This is commonly referred to as "3x blank correction." For routine effluent monitoring, the majority of dischargers currently exclude any individual congener in a sample that is less than ten times the concentration of that congener in the method blank associated with the sample (i.e. 10x correction). Differences in reported concentrations between the synoptic surveys and routing monitoring may also be explained by the sampling methods used, as routine monitoring is primarily conducted with composite samples while the synoptic surveys used grab samples. The number of samples available also differ between routine monitoring and the synoptic surveys.

Table 4 and Figure 3 present PCB concentrations and loading rates from municipal and industrial WWTPs calculated from synoptic survey data, which used a 3x blank correction. Table 4 presents minimum, median and maximum values. Figure 3 also shows interquartile (i.e. 25th and 75th percentile) values. This presentation is useful in identifying the influence of anomalously high individual concentrations, such as a single concentration from the City of Spokane that is an order of magnitude higher than all other measurement. The uncertainty in loading rate is estimated from the minimum and maximum load calculated for each discharge. The estimated total loading rate ranges from 140 to 271 mg/day for the industrial discharges and 100 to 2652 mg/day for the municipal discharges. The maximum municipal loading rate of 2652 mg/day is inflated by the single anomalous City of Spokane measurement mentioned above; the median municipal loading rate is only 132 mg/day.

Table 4. PCB Concentrations and Loading Rates from Municipal and Industrial WWTPs Calculated from Synoptic Survey Data

			PCB Concentration (pg/l)				PCB Loading Rate (mg/day)		
	No. of Samples	Sample Type	Minimum	Median	Maximum		Minimum	Median	Maximum
Industrial									
Kaiser	7	Grab	2226	3179	4625		69.4	98.4	156.1
Inland Empire Paper	7	Grab	2629	2958	4449		70.7	78.6	114.4
Municipal									
City of Spokane	4	Grab	771	1066	23404		82.2	112.8	2619.0
Spokane County	7	Grab	290	330	490		8.2	9.4	14.1
Coeur d'Alene	3	Grab	531	534	1227		7.0	7.0	16.0
Post Falls	3	Grab	200	219	221		1.9	2.0	2.1
Liberty lake	3	Grab	193	200	260		0.5	0.5	0.7
HARSB	0	-	-	-	-		-	-	-
Total							240.0	308.7	2922.5

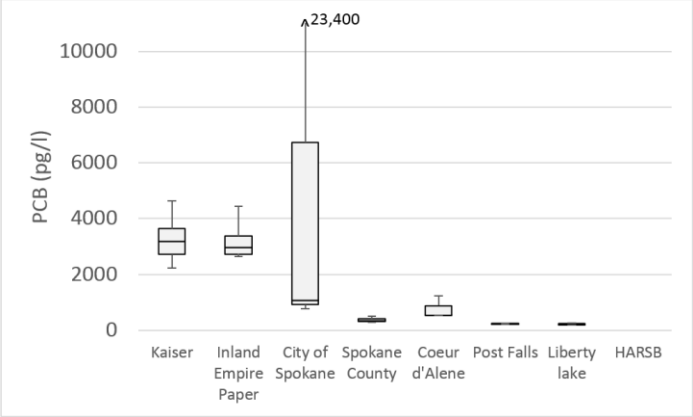

Figure 3. PCB Concentrations from Municipal and Industrial WWTPs Calculated from Synoptic Survey Data, Using 3x Blank Correction

Table 5 and Figures 4 and 5 present PCB concentrations from municipal and industrial WWTPs calculated from routine monitoring data, and are shown using both a 3x blank and 10x blank correction. Table 6 presents loading rates associated with the concentrations in Table 5. The uncertainty in loading rate is estimated from the minimum and maximum load calculated for each discharge. The estimated total loading rate ranges from 48 to 226 mg/day for the industrial discharges and from 6 to 244 mg/day for the municipal discharges.

Table 5. PCB Concentrations (pg/l) from Municipal and Industrial WWTPs Calculated from Routine Monitoring Data Using Two Different Blank Correction Methods

			3x Blank Correction				10x Blank Correction		
	No. of Samples	Sample Type	Minimum	Median	Maximum		Minimum	Median	Maximum
Industrial									
Kaiser	52	Composite	1205	1982	4405		973	1757	4291
Inland Empire Paper	5	Composite	1212	2978	3159		610	2024	3065
Municipal									
City of Spokane	22	Composite	93.5	609	1680		40.7	469	1654
Spokane County	13	Composite	4.31	109	792		4.31	31.2	226
Coeur d'Alene	1	Composite	435	435	435		105	105	105
Post Falls	4	Composite	101	111	315		26	39	65
Liberty lake	17	Composite	66	220	1085		66	188	971
HARSB	4	Composite	58.7	152	212		37	96.6	201

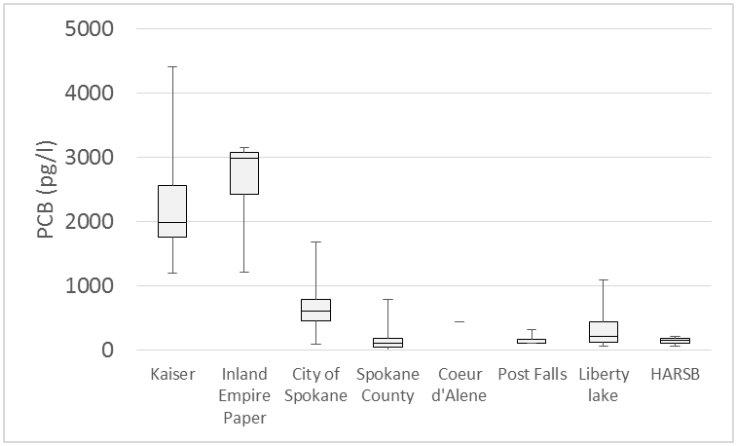

Figure 4. PCB Concentrations from Municipal and Industrial WWTPs Calculated from Routine Monitoring Data, Using 3x Blank Correction

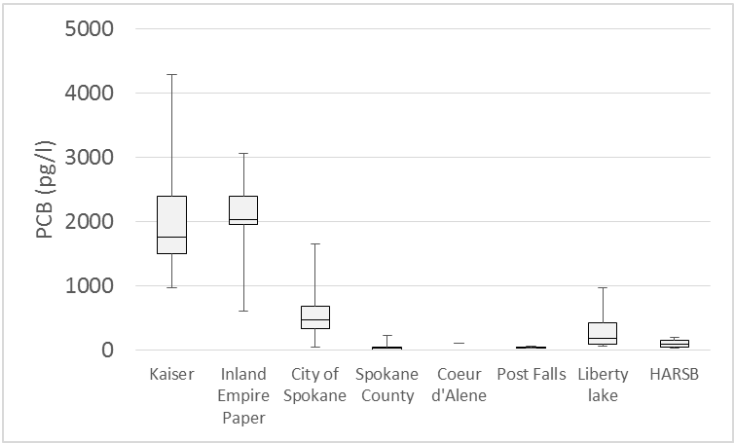

Figure 5. PCB Concentrations from Municipal and Industrial WWTPs Calculated from Routine Monitoring Data, Using 10x Blank Correction

Table 6. PCB Loads (mg/day) from Municipal and Industrial WWTPs Calculated from Routine Monitoring Data Using Two Different Blank Correction Methods

			3x Blank Correction				10x Blank Correction		
	No. of Samples	Sample Type	Minimum	Median	Maximum		Minimum	Median	Maximum
Industrial									
Kaiser	52	Composite	39	65	144		32	57	140
Inland Empire Paper	5	Composite	32	72	82		16	52	70
Municipal									
City of Spokane	22	Composite	10.4	64.6	211.8		3.9	48.4	208.5
Spokane County	13	Composite	0.12	2.85	20.1		0.12	0.8	6.1
Coeur d'Alene	1	Composite	5.6	5.6	5.6		1.3	1.3	1.3
Post Falls	4	Composite	0.98	1.04	2.97		0.25	0.37	0.61
Liberty lake	17	Composite	0.20	0.61	2.76		0.20	0.52	2.47
HARSB	4	Composite	0.24	0.63	0.9		0.15	0.4	0.86
Total			**88.5**	**212.3**	**470.1**		**54.0**	**160.8**	**429.9**

Discharge of Waste Water and Stocking of Fish from Fish Hatcheries

PCB contributions to Spokane River from fish hatcheries can arise from the stocking of PCB-contaminated fish and discharge of effluent from the Washington Department of Fish and Wildlife's

Spokane Fish Hatchery to the Little Spokane River. Approximately 170,000 rainbow trout are planted annually to Lake Spokane and the Spokane River. The fish raised are in two different hatcheries, Troutlodge in Soap Lake, and the Spokane Fish Hatchery. Serdar et al (2006) found PCB concentrations of 6.5 ug/kg in hatchery trout from the Spokane Fish Hatchery and 14.4 ug/kg in fish fillets from the Troutlodge facility. Fish feed from the Spokane hatchery was analyzed by Serdar et al (2006) with a result of 16.4 ug/kg. No quantitative data exists for PCB loading from discharge of waste water and stocking of fish from these hatcheries. Ecology (2016) is conducting a study to provide specific estimates of loading from fish hatcheries.

Diffusion or Resuspension of PCBs from Bedded Sediments in the Spokane River and Lake Spokane

No site-specific data were available to define the magnitude of pore water diffusion and/or resuspension of PCBs into the study areas from bed sediments. Given that the calculations above show that the mass of PCB in lake sediments is more than 100x greater than river sediments, it can be reasonably assumed that overall flux from bedded sediments is dominated by flux from lake sediments. The magnitude of pore water diffusion from lake bed sediments was estimated based on a combination of physical-chemical properties taken from the development of the MICHTOX Lake Michigan Mass Balance Project (USEPA, 2006; Endicott, 2005; and Endicott et al., 2005) with study area-specific measurements of sediment PCB concentrations. The resulting gross PCB diffusive flux from the lake sediments was estimated at 1.01 mg/day. Lake Spokane is known to have a significant carp population (Avista and Golder, 2012), and carp feeding mechanisms are known to churn bottom sediments and increase the flux of sediment-bound pollutants such as PCBs from via bioturbation (Canfield and Farquhar, 2009.) No quantitative data exists describing the effect of carp bioturbation on sediment flux, such that the actual rate of flux could be significantly higher than typical literature values. Conversely, much of the carp bioturbation activities occur in the shallower headwaters of Lake Spokane (Avista, 2015), where sediment PCB concentrations are lower than the sediments near the dam. Given this uncertainty, the estimate of the flux rate from Lake Spokane sediments is assumed to be accurate only within a factor of twenty, resulting in a range of 0.05 to 20 mg/day.

Magnitude of Intermediate Transport Pathways

It is recognized that there are a number of intermediate pathways by which PCBs from the source areas get transported to the delivery mechanisms described above. LimnoTech (2015a) divided these pathways under the categories of:

- Mobilization in the watershed
- Volatilization to the atmosphere
- Delivery to sewer infrastructure
- Contribution to groundwater

Mobilization in the Watershed

Many of the PCBs in source areas are contained within products of some kind and must first undergo a mobilization step to allow them to be transported through the watershed and/or to the Spokane River. Watershed mobilization pathways defined in LimnoTech (2015a) consist of:

- Demolition from fixed building source areas
- Transfer of non-fixed building source areas to recycling facilities
- Spills/leaks of PCBs contained in industrial source areas
- Littering/recycling of PCBs in consumer products
- Deposition and gas transfer of atmospheric sources

- Application of PCB-containing materials to watershed

Figure 6 depicts estimated magnitudes for these pathways, and shows that magnitudes for many of these pathways cannot currently be estimated.

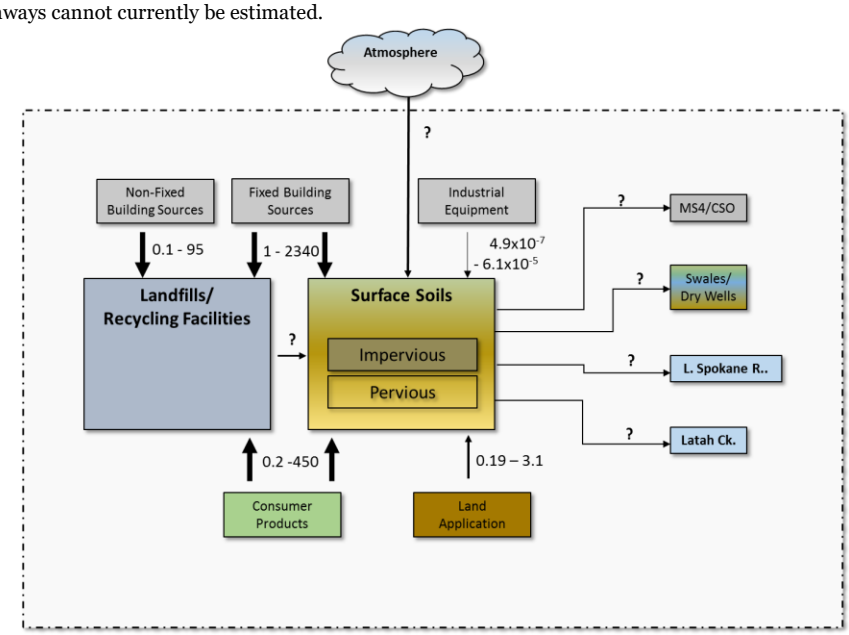

Figure 6. Estimated Magnitudes (kg/yr) for Watershed Mobilization Pathways

Fixed Building Source Areas: Demolition/Volatilization

Little information is available regarding the mobilization of PCBs from fixed building source areas, with many studies assuming that volatilization is the dominant mobilization method (e.g. Shanahan et al, 2015). Ecology (2011) notes, however, that volatilized PCBs may quickly attach to other media include adjoining materials, or dust and films. Weathering of caulk through fragmentation and abrasion may also release PCBs directly in particle form. For these reasons, mobilization from fixed building source areas has been combined into a lumped demolition/ volatilization category. Robson et al. (2010) calculated a long-term gross mean regional sealant PCB loss rate of 9% over 50 years of exposure, i.e. 0.018/yr. Combining this loss rate of PCBs with the total PCB mass estimated above of 60 to 130,000 kg results in a release rate of 1 to 2340 kg/yr.

Transfer of Non-Fixed Building Source Areas to Recycling Facilities

No site-specific data are available describing the transfer of non-fixed building source areas to recycling facilities. Assumptions used for the Puget Sound Source Assessment (Ecology, 2011) were applied here. They estimated a release rate from small capacitors of approximately 1 to 1,000 kg/yr, with a mid-point of is 500 kg. Scaling that estimate by population to the Spokane watershed results in range of 0.1 to 95 kg/yr.

Spills/Leaks of PCBs Contained in Industrial Source Areas

The prior section on magnitude of source areas concluded that the primary remaining reservoir of industrial PCB in the Spokane watershed was in the capacitors of some of the small utilities. Ecology

(2015a) cited a USWAG/EEI (1982) study reporting that about 2% of all transformers had moderate leaks or spills each year, with an average amount of PCBs leaked/spilled per event of 18 mg – 2.27 g for mineral oil transformers. Avista maintains all large transformers in the watershed in controlled areas, and implements immediate remediation activities in the event of leakage that prevents the release of PCBs to the outside environment. The combination of above leakage rate and range of amount spilled results in an annual release estimate of 4.86×10^{-7} to 6.13×10^{-5} kg/year.

Littering/Recycling of PCBs in Pigments in Consumer Products

No quantitative information is available for this pathway. An upper bound estimate can be made assuming that all inadvertently produced PCBs imported into the watershed over the course of the year become available through this pathway. As described above in the Magnitude of Source Areas section, this results in a range of release rates for Spokane of 0.2 to 450 kg/yr.

Deposition and Gas Transfer of Atmospheric Source Areas

As discussed in the Ongoing Source Areas section above, no definitive information exists on the specific amount of PCBs delivered to the Spokane area from atmospheric source areas. Ecology is currently undertaking a PCB atmospheric deposition study in Spokane to address this need.

Application of PCB-Containing Materials to Watershed

LimnoTech (2015a) identified that produced PCBs can be directly applied to the watershed via hydro-seed, de-icer, herbicides and pesticides, and biosolids or fertilizer applications. No quantitative data are available to estimate the overall magnitude of this pathway, although the application of biosolids may be an important component. Shanahan et al (2015) estimated the average concentration of PCBs in municipal sewage sludge at 1.0 mg/kg dry weight, based on the work of Rodenburg and Meng (2007) and Norstro¨m et al (2010), while the City of Spokane has reported biosolids PCB concentrations in the 0.08 – 0.25 mg/kg dry weight range. An upper bound estimate for PCB transport via sludge application can be made by assuming that all PCBs removed from municipal influents are land applied as sludge. As described below, the influent PCB load to municipal plants was estimated at 2108 mg/day (0.77 kg/year). Influent PCB concentration estimates are likely accurate within a factor of two, with a similar level of uncertainty on the assumption that the mass of PCB exported via biosolids is equivalent to the mass of PCB in the plant influent, resulting in a range of application rates of 0.19 – 3.1 kg/year.

Mobilization to the Atmosphere

Numerous source areas contribute to local atmospheric concentrations of PCBs via volatilization, i.e. conversion into a gas phase. Atmospheric mobilization pathways defined in LimnoTech (2015a) consist of:

- Volatilization directly from previously defined source area categories.
- Combustion sources
- Volatilization of PCBs from wastewater treatment sludge
- Atmospheric transport of PCBs generated outside of the watershed

Volatilization Directly from Previously Defined Source Area Categories

Shanahan et al (2015) showed that volatilization from contaminated surface soils was the dominant source of atmospheric PCB load in the Chicago area. They estimated that a soil PCB mass of 2,200 kg resulted in a volatilization load of 64 kg/yr. Scaling their results to the mass load of 5,500 kg estimated above for the Spokane watershed results in a volatilization load of 160 kg/yr. Given that that the PCB mass estimate was considered to only by accurate to a factor of 10, it is assumed that this release rate estimate has a similarly large range of uncertainty.

Combustion Sources

Potential combustion sources include internal combustion engines, incinerators, used oil burning and residential burning. Of these, quantitative estimates were found in Ecology and DOH (2015) for residential trash burning and the Spokane Waste to Energy Plant. According to the most recent NEI for 2008, there were 199 kg of PCBs released to the air in Washington State from residential waste burning. Scaling this estimate by population results in a Spokane watershed estimate of 16.9 kg/yr. Ecology and DOH (2015), citing the Spokane Regional Clean Air Agency, reported about 1 lb of PCB emitted from the Spokane Waste to Energy Plant in 2011 (0.45 kg/yr). The upcoming Ecology PCB atmospheric deposition study in Spokane will provide more information on the significance of this source.

Volatilization of PCBs from Wastewater Treatment Sludge

Shanahan et al (2015) estimated that volatilization of wastewater treatment sludge was the second largest source of PCB release in the Chicago area. This estimate was determined to be inapplicable to the Spokane area, because biosolids from all municipal wastewater treatment plants are either: 1) incorporated into compost, or 2) land applied and directly incorporated (i.e. plowed) into the soil. Because neither of the above mechanisms are readily amenable to volatilization, it assumed that PCB release from this pathway is negligible.

Atmospheric Transport of PCBs Generated Outside of the Watershed

This category is the same as the non-local atmospheric source areas category discussed above in the section on Ongoing Source Areas. As discussed there, little definitive information exists on the specific amount of PCBs delivered to the Spokane area from atmospheric source areas. Ecology's Environmental Assessment Program is currently undertaking a study that will provide information on this source area category.

Delivery to Sewer Infrastructure

The Spokane watershed contains a range of sewer infrastructure capable of delivering PCBs, either directly or indirectly, to the river. This infrastructure can be broadly divided into categories of stormwater and wastewater.

Stormwater

No quantitative estimate exists defining the quantity of PCBs being delivered to the stormwater system. A lower bound estimate of loading to the City of Spokane's MS4 system can be obtained from the stormwater loading estimate provided above of 29.9 mg/day (0.01 kg/year). No information exists to estimate PCB loading to non-discharging stormwater systems.

Wastewater

An estimate of PCBs delivered to municipal wastewater systems can be obtained from observed influent PCB concentrations. Review of influent PCB data provided by the City of Spokane, Spokane County, and Post Falls show an average influent concentration of 13,000 pg/l. Multiplying this influent concentration by cumulative municipal discharge flow results in a loading rate of 2107.8 mg/day (0.77 kg/yr).

Contribution to Groundwater

The final intermediate transport pathway defined in LimnoTech (2015a) is contribution to groundwater, divided into categories of:

- Legacy contamination
- Landfill disposal of PCB-containing products
- Leaking well pumps
- Private septic systems

- UIC wells (referred to as Dry Wells in LimnoTech, 2015a)

Legacy contamination

The Magnitude of Source Areas section above concluded that insufficient data exist to estimate the total mass of legacy subsurface PCB contamination; correspondingly, insufficient data are available to estimate the rate at which this legacy subsurface contamination contributes to groundwater. A lower bound estimate can be gained from the groundwater loading calculation presented above in the Magnitude of Delivery Mechanisms section, which estimated the groundwater loading in the river section directly below Mirabeau Park at 148.7 mg/day (0.054 kg/year). This is considered a lower bound estimate because it only considers legacy contamination loading to a portion of the aquifer.

Landfill disposal of PCB-containing products

Similarly, no data were found describing groundwater PCB loading from landfills. Modern landfills are designed and operated to prevent any adverse effects to groundwater. Older landfills still exist in the watershed that were not designed or operated to modern standards. However, many of these older landfills suspected of contributing toxic materials to local groundwater have been named as National Priorities List (NPL) sites under the Comprehensive Environmental Response, Compensation and Liability Act, and have undergone remedial actions to address potential groundwater contamination (SCS, Engineers, 2015.)

Leaking well pumps

The Wisconsin Department of Natural Resources and Division of Health (WDNR, 2008) determined that certain submersible pumps used to draw water from wells may leak PCBs into ground water. The dielectric fluid in capacitors used in certain pump motors manufactured before 1979 was made of PCBs, with each capacitor containing up to five ounces of PCBs. These PCBs can gradually leak during normal wear-and-tear. No quantitative information was available describing the rate of leakage.

Private septic systems

There are over 45,000 private septic systems in Spokane County, with 200 to 300 new systems are added annually and 50 to 150 systems removed due to connection to sewer or abandonment. At least 10,000 systems are likely located over the aquifer contributing to the Spokane River (S. Phillips, personal communication). Furthermore, the USGS calculated an average hydraulic input to the entire aquifer of 23 cubic feet per second for the period 1990 to 2005 (USGS, 2007). Given observed PCB concentrations greater than 10,000 pg/l in municipal wastewater influent as discussed above, it is reasonable to assume that similarly high PCB concentrations are delivered to septic tanks. No quantitative information exists defining the rate at which these PCBs may be delivered to the groundwater contributing to the Spokane River.

UIC wells

Underground Injection Control (UIC) wells are manmade structures used to discharge fluids into the subsurface. Examples of UIC wells include dry wells, infiltration trenches with perforated pipe, and any structure deeper than the widest surface dimension (http://www.ecy.wa.gov/PROgrams/wq/grndwtr/uic/index.html). Marti and Maggi (2015) reviewed the abundance and use of UIC wells in Washington. Ecology's Underground Injection Control (UIC) Program protects groundwater quality by regulating the disposal of fluids through UIC wells. Approximately 14,000 UICs have been registered in Spokane County, with an unknown number of unregistered wells. These wells receive stormwater runoff from paved areas, such as parking lots, streets, residential subdivisions, building roofs, and highways. USGS (2007) cited the work of Contor (Idaho State University, written communication), who used aerial photography and GIS coverages of precipitation and

dry well locations to estimate recharge from impermeable surfaces to the Spokane Valley-Rathdrum Prairie aquifer. The estimated mean annual areal recharge (inflow) for 1990–2005 to the aquifer from permeable and impermeable surfaces was 233 cubic feet per second.

Marti and Maggi (2015) note that the potential for groundwater contamination from UICs depends upon the UIC wells' construction and location, the type and quality of fluids being injected, and the geographic and subsurface setting in which the injection occurs. UICs used along roads and parking areas are not typically considered a high threat to groundwater if they have been built to meet the requirements of the Guidance for UIC Wells that Manage Stormwater (Ecology, 2006). UICs constructed before 2006 and used to manage stormwater are required to have a well assessment to determine if they pose a risk to groundwater. A well assessment evaluates the land use around the UIC, which may affect the quality of the discharge, and whether the UIC is located in a groundwater protection area. If a UIC well is considered a high threat to groundwater, the assessment may also include information on the local geology and depth to groundwater in relation to the UIC well. Beyond the control measures discussed immediately above, no quantitative information exists on the rate at which PCBs may be delivered to Spokane area groundwater from UIC wells.

Conclusions

This assessment of the magnitude of source areas and pathways of PCBs in the Spokane River watershed provides some useful information to support development of a Comprehensive Plan, but also identifies some important data gaps. Key conclusions can be summarized as follows:

- The source areas containing the largest mass of PCBs residing in the watershed have been identified
- Prior estimates of the magnitude of delivery mechanisms provided in Serdar et al (2011) have been updated
- The transport pathways between source areas and delivery mechanisms are poorly understood

The bulk of the PCB mass currently present in the Spokane River watershed corresponds to legacy PCBs contained in: 1) non-fixed building materials (such as appliances and light ballasts) built prior to 1978, 2) fixed building materials (paints, caulks), and 3) watershed soils. Although the specific mass of PCBs in each compartment may not be able to be estimated more accurately than by a factor of 50, the magnitude of PCBs in the above compartments are orders of magnitudes greater than the other compartments considered.

This memorandum generates estimates of the magnitude of delivery mechanisms of PCBs to the Spokane River that can be compared to similar estimates made by Serdar et al (2011) in their Spokane River PCB Source Assessment. This study estimates cumulative loading from Idaho sources ranging between 10 and 280 mg/day, compared to an estimate of 477 mg/day from Serdar et al. The cumulative loading from Washington wastewater treatment plants of 310 mg/day in Serdar et al falls within the 52 to 2904 mg/day range estimated in this study. This study generates much lower estimates for stormwater/CSO contribution, with the currently estimated range of 10 to 90 mg/day being much less than the previously estimated 691 mg/day. This study did identify two loading pathways that were not quantified by Serdar et al.: 1) a groundwater loading with a magnitude of between 60 and 300 mg/day, and 2) loading from Latah Creek with a potential magnitude of up to 215 mg/day.

Although quantitative estimates have been generated for the PCB mass currently residing in the watershed and for the magnitude of different delivery mechanisms to the Spokane River, much less information is available to quantify the intermediate transport pathways between these source areas and delivery mechanisms. This lack of understanding will pose a significant challenge when developing the

Comprehensive Plan. As a hypothetical example, knowledge that a large amount of PCBs reside in home appliances does not necessarily mean that they should be a primary target for control; if there is no transport process by which those PCBs will reach the Spokane River, controls on them may not be effective in reducing PCB loads to the river. This issue of unquantified intermediate control pathways is not unique to Spokane, as PCB control plans for other watersheds have been developed facing similar types of uncertainty.

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Appendix C: Inventory of Control Actions to Be Evaluated for the Spokane River

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Memorandum

From: Kat Ridolfi, Dave Dilks

Date: September 15, 2016
Project: SRRTTF4

To: SRRTTF

SUBJECT: DRAFT: Inventory of Control Actions to Be Evaluated for the Spokane River

Summary

The Spokane River Regional Toxics Task Force (SRRTTF) was created with the goal of developing a comprehensive plan to bring the Spokane River into compliance with applicable water quality standards for the toxic chemical polychlorinated biphenyls (PCBs). To accomplish that goal, the functions of the SRRTTF include preparing recommendations for controlling and reducing the sources of listed toxics in the Spokane River and review of proposed Toxic Management Plans, Source Control Plans and Control Actions (referred to in earlier documents as Best Management Practices). This memorandum provides an inventory of control actions that have the potential to reduce PCB loads, divided into four categories:

- Institutional
- Stormwater Treatment
- Wastewater Treatment
- Site Remediation

A total of 41 control actions (or groups of control actions) were identified and are summarized in Table 1.

The intent of this memorandum is not to evaluate the feasibility of any control action for application in the Spokane region; it is solely intended to identify the range of control actions to be evaluated. Subsequent project tasks will assess the cost and reduction efficiency of these control actions in order to help identify those that may be most effective at reducing PCB loads to the Spokane River. In addition, it is noted that many of these control actions are already being implemented in the watershed. For example, all wastewater treatment plants discharging to the Spokane River are required to prepare Toxics Management Action Plans, detailing specific control actions they are taking to reduce PCB loading to the Spokane River.

Table 1. Menu of Control Actions Described in this Memorandum Potentially Applicable for Reducing PCB Loads to the Spokane River and Lake Spokane

Category	Sub-	Control Action
Institutional	**Government Practices**	Take-back programs
		Leaf removal
		Street sweeping
		Catch basin/pipe cleanout
		Purchasing standards/product testing
		Survey of PCB-containing materials
		Review laws regulating waste disposal and illegal dumping
		Removal of carp from Lake Spokane
		Expand monitoring
		PCB-product labeling law
		Leak prevention/detection system ordinance for transformers and capacitors
		Accelerate sewer construction to replace septic systems
		PCBs identification during inspections
		TSCA and food packaging law reform
		Support green chemistry alternatives
	Educational	Survey of electrical equipment containing PCBs
		Education/outreach re: PCB sources
		Education about discharge through septic systems in aquifer recharge area
		PCB product information
Stormwater Treatment	**Pipe Entrance**	Infiltration control actions
		Retention and reuse control actions
		Bioretention control actions
		Filters
		Screens
		Wet vault
		Hydrodynamic separator
	End of Pipe	Constructed wetlands
		Sedimentation basin
		Discharge to ground/dry well
		Diversion to treatment plant
		Fungi (mycoremedation) or biochar incorporated into stormwater treatment
Wastewater Treatment		Development of a Toxics Management Action Plan
		Implementation of a source tracking program
		Chemical fingerprinting or pattern analysis
		Remediation and/or mitigation of individual sources
		Elimination of PCB-containing equipment
		Public outreach and communications
		Review of procurement ordinances
		Pretreatment regulations
Site Remediation		Identification of contaminated sites
		Clean up of contaminated sites

Introduction

The SRRTTF is developing a comprehensive plan to bring the Spokane River into compliance with applicable water quality standards for PCBs. An initial step in development of the comprehensive plan is to identify the universe of control actions that have the potential to reduce PCB loading to the river.

These control actions were previously referred to as Best Management Practices (BMPs) in earlier Task Force documents. The term Best Management Practice is no longer being used in Comprehensive Plan documents, because it has a specific legal meaning that varies between Washington and Idaho. In the context of the Spokane River Comprehensive Plan, control actions are defined consistent with SFEI (2010) as "any activity, technology, process, operational method or measure, or engineered system, which when implemented prevents, controls, removes or reduces pollution."

The control actions identified in this memorandum were obtained from several sources:

- BMP Toolbox for the San Francisco Bay Area (SFEI 2010)
- Stormwater Management Manual for Eastern Washington (Washington Department of Ecology 2004)
- Spokane Regional Stormwater Manual (Spokane County, City of Spokane, and City of Spokane Valley 2008)
- Spokane River Regional Toxics Task Force February 6-8, 2016 Workshop
- PCB Chemical Action Plan (Washington Department of Ecology, 2015)
- Discussions within the SRRTTF BMP subgroup

For purposes of this memorandum, control actions were divided into the following four categories based upon discussions of the Spokane River Regional Toxics Task Force Workshop BMP planning group.

- Institutional
- Stormwater Treatment
- Wastewater Treatment
- Site Remediation

The intent of this memorandum is not to evaluate the feasibility of any control action for application in Spokane, it is solely intended to identify control actions to be evaluated. Subsequent deliverables will assess the cost and reduction efficiency of these control actions in order to help identify those that may be most effective at reducing PCB loads to the Spokane River.

Institutional

Institutional control actions include information sharing (educational campaigns) and governmental practices to help businesses and the general public identify, avoid, clean up and/or properly dispose of products containing PCBs. These control actions require the least amount of infrastructure, engineering work, maintenance, and disturbance of existing land because their intent is to avoid the continued use, inadvertent production, or release of PCBs. The control actions listed below will help reduce PCB loads through reduction of existing production and use; clean-up of existing source areas; and proper disposal of PCB-containing products and waste. Institutional control actions can be further broken down into two categories, government practices and educational control actions.

Government Practices

This sub-category of Institutional control actions consists of actions that government agencies can take which will directly reduce source areas of PCBs. Specific control actions under this category consist of:

- Implement take-back programs, which are government or non-profit run

programs to accept and properly dispose of PCB-containing items

- Create and implement land use/development ordinances or standards that encourage Low Impact Development and decrease impervious surfaces.
- Identify businesses that are likely to contribute PCBs to the MS4 and to follow up with such businesses and appropriate regulatory agencies to develop and implement appropriate control actions.
- Enhance current municipal leaf removal programs since foliage is a receptor of atmospheric PCB loadings. Removal of leaf litter prior to it being discharged to the river could reduce loading PCB associated with this source area. Care will also need to be taken to ensure that where leaves are disposed does not create an additional load of PCBs to the River. The opportunity for expanded implementation for this control action within the watershed is limited, however, because leaf removal is already a government-provided service in the city of Spokane (seasonal), Spokane county (leaves can go in green bins collected by Waste Management), and Post Falls, ID (last two weekends in April and September), but not Coeur d'Alene, ID).
- Modify current street sweeping frequency and area covered to specifically target source areas of PCBs, or when/where more material is washing down streets to prevent it from entering storm drains
- Increase frequency of catch basin and pipe cleanout to specifically remove PCB-contaminated sediment
- Pass local laws to reduce or totally eliminate the purchase of products that contain PCBs. Further implementation of this control action primarily pertains to the Idaho communities, since most of the Washington jurisdictions in the watershed have already implemented purchasing standards. However, product testing by the manufacturers of alternative products under consideration for purchase at the state level could support the implementation of PCB free product purchasing laws. Current examples include the three below:
  - Washington State Senate Bill 6086 (passed in 2014) requires State agencies to establish a purchasing and procurement policy that provides a preference for products that do not contain PCBs. (http://apps.leg.wa.gov/billinfo/summary.aspx?bill=6086&year=2013).
  - Spokane County passed Resolution #2014-1022 in December 2014
  - The City of Spokane's ordinance requires City departments to purchase PCB-free items (defined as less than the practical quantification limit using EPA Method 1668) if a feasible alternative is available at less than a 25% cost increase (Spokane Municipal code 07.06.172).
- Survey PCB-containing materials in schools/public buildings and enact a program to dispose of them properly or implement encapsulation[7]. See BASMAA (2014) and Ecology's (2014) PCB Chemical Action Plan as example guidance for inspections to identify PCBs.
- Review local/regional laws regulating waste disposal (including oil burning) and illegal dumping, and revise as necessary (e.g. enforcing fines/other penalties for improperly disposing of PCBs, sharing information on safer alternatives for lighting, paint, caulk, etc.)
- Expand environmental monitoring to identify any new areas requiring

[7] Encapsulation is accomplished by painting a contaminated surface(s) with a coating material that serves as a barrier to prevent the release of a contaminant from a source (USEPA 2015a).

cleanup and investigate air deposition. This in and of itself will not have immediate impacts on PCB loads but will be a step towards better source area identification and targeted BMP implementation

- Implement state/local ordinance to require a leak prevention/detection system in any PCB-containing transformer or capacitor.
- Identify PCB-containing materials as part of other regular inspections (e.g., building permits, IDDE, facility inspections). See BASMAA (2014) as example guidance for inspections to identify PCBs.
- Implement controls, incentives (e.g. tax incentives), or credits to encourage safe containment, proper disposal, and safer replacement products for those products used for building remodeling and demolition that may contain PCBs.
- Implement statutory reform of TSCA and FDA's food packaging law (21 CFR 109) and animal/human food laws on products such as dyes/pigments (regulated by TSCA) or food packaging (regulated by FDA) (See Washington Department of Ecology 2015, Appendix D for full list of processes that inadvertently generate PCBs)to:
  - re-visit current allowed concentration of PCBs (50 ppm) in chemical processes,
  - reduce the creation of inadvertently generated PCBs, and
  - limit or otherwise control use of products to reduce exposure of humans to PCBs. For example, the type of ink used in newspaper, which lasts about a day on the average is different than what is needed for an archive quality publication.
- Implement regulatory reform of TSCA to:
  - increase inspections for more rigorous enforcement of allowed PCB concentrations of imported products
  - work with manufacturers that have PCBs in their products to reduce/eliminate them
- Support green chemistry alternatives to replace products that contain or could inadvertently release PCBs. Green chemistry is defined by EPA as "chemical products and processes that reduce or eliminate the use or generation of hazardous substances" (USEPA 2015b).
- Remove carp from Lake Spokane (0.023 – 0.062 grams of PCBs per carp)
- Implement labeling ordinance for products containing PCBs, similar to 2014 law for labeling construction materials that contain asbestos (RCW 70.310.030)
- Encourage acceleration of sewer construction to replace septic systems over the aquifer recharge area (prioritizing commercial properties)

Educational

This sub-category of Institutional control actions consists of actions that will indirectly reduce loading of PCBs, by providing information to help direct future PCB reduction efforts. Specific control actions under this category consist of:

- Conduct a survey of local utilities and other owners of electrical equipment to document the presence/amount of PCBs in transformers. This survey was recently completed for several local utilities (Avista Utilities, Inland Power and Light Company, Modern Electric Water Company, Vera Water and Power,

Kootenai Electric Cooperative, and Bonneville Power Administration), and they all have (or are in the process of) removed PCB-containing equipment. Follow up steps after identifying this information could include providing technical assistance where requested for disposal and replacement of the contaminated fluid.

- Conduct public education and outreach campaigns to spread information about the potential sources of PCBs, what to do with them if discovered (e.g., avoid pouring paint down the drain), and safer alternatives. Information should be shared with buyers and suppliers of industrial equipment, consumers, as well as with residents who fish for recreation or subsistence to increase their awareness of fish advisories and the fish species that contain the highest concentrations of PCBs. Pathways of PCB sources should also be discussed in such campaigns. There are several existing programs such as "Fix Leaks", "Go natural in your yard", "Puget Sound Starts Here", Boat pump out station, Washington Waters pledge, LEAN techniques and "Toxics free tips" that could potentially be leveraged for additional information on PCBs. Shared media and branding materials could be developed with these programs.
- Conduct studies to better define which products contain PCBs, test new products, and maintain a database that is publicly available. Products identified by the City of Spokane (2015) as potentially containing significant levels of PCBs included (but not limited to):
  - Road Oil
  - Hydroseed additives
  - Deicer
- Educate on-site septic system owners located over the aquifer recharge area (there are approximately 10,000 systems in the Spokane area) on proper disposal of wastes (e.g., not "down the drain") and on the environmental and functional benefits of regular tank pumping.

Stormwater Treatment

Stormwater Treatment control actions are engineered options to be installed or built with the existing storm sewer infrastructure to capture soil and water containing PCBs and prevent it from being discharged to the Spokane River. Since PCBs adsorb to soil/sediment, reducing solids will in turn reduce PCBs. They can be implemented anywhere, but the limiting factor is access because they require regular inspection and maintenance and specialized knowledge for installation. These control actions are effective at treating a range of contaminants, and are not limited to controlling PCB loads. They are organized by their placement relative to storm sewer pipes, and divided into sub- categories of:

- Pipe entrance
- Pipe system
- End of pipe

Pipe Entrance

This sub-category of control actions is designed to capture/treat stormwater onsite before it enters storm pipes or travel through the street where more PCB contamination can be picked up, and includes:

- Infiltration control actions such as trenches, basins, dry wells which are designed to

infiltrate stormwater quickly through gravel or similar material so that the contamination is dissipated/filtered through the soil or groundwater and not directly discharged to surface waters or the MS4.

- Retention and reuse control actions, including rain barrels, underground tanks, ponds, detention basins, and green roofs. These control actions are designed to retain stormwater to slow down peak discharges to the MS4 system, and potential reuse of the effluent for practices such as watering gardens and playing fields.
- Bioretention control actions such as swales, buffer strips which are designed to provide some infiltration/trapping of solids before discharge to the MS4 or a drywell.
- Isolation of contaminated source areas from the stormwater system. A contaminated discharge could either be routed to a wastewater treatment plant for proper treatment (and avoid direct discharge to the Spokane River), or ideally be cleaned up prior to discharge to the river.

Pipe System

This sub-category of control actions is installed in the MS4 infrastructure (e.g., pipes, storm drain inlets). These actions usually have higher maintenance requirements (compared to other stormwater control actions) and can sometimes impede flow when not maintained properly. Options include:

- Screens that trap contaminated solids and larger debris to prevent discharge of that material to receiving waterbodies
- Filters or "socks", like screens, that trap contaminated solids and prevent discharge of that material to receiving waterbodies
- Wet vaults, consisting of a permanent pool of water in a vault that rises and falls with storms and has a constricted opening to let runoff out. Its main treatment mechanism is settling of solids that are contaminated.
- Hydrodynamic separators that use cyclonic separation to trap solids and debris as stormwater flows through them before being discharged to receiving waterbodies.

End of pipe

This sub-category of control actions is installed at the end of MS4 pipes, but before the discharge will reach receiving waters (the Spokane River, Lake Spokane, or their tributaries). They can have high maintenance requirements or require significant areas of land to implement. Options include:

- Constructed wetlands, that work to slow peak stormwater flows to prevent erosion and also help to trap contaminated solids and debris from entering receiving waterbodies
- Sedimentation basins, which are similar to a wetland in their purpose and trapping mechanism but allow for a large volume of detained stormwater to be ponded prior to discharge
- Discharge to ground/dry wells, which works to infiltrate stormwater into the ground prior to discharge. The issue of whether the discharge to dry wells would contribute PCBs to groundwater is unknown at this time and should be explored further before implementation.
- Diversion to treatment plant, which involves a separation of a stream of stormwater from the rest in order to have it routed to a wastewater treatment plant instead of being discharged untreated to receiving waterbodies
- New technologies such as fungi and biochar, which are being investigated for effectiveness of their ability to break down PCBs when incorporated into bioretention or

other green infrastructure design features.

Wastewater Treatment

The Washington and Idaho (EPA) NPDES permits require each wastewater facility discharging to the Spokane River to develop and install treatment systems to reduce nutrient loading that will concurrently result in reductions of PCB loading. In addition, each facility has developed a Toxics Management Action Plan that includes a PCB source identification study and control actions. Control actions that are contained in the majority of these plans include:

- Preparation of an Annual Toxics Management Report
- Elimination of all known PCB-containing equipment under control of permittee
- Public outreach and communications
- Review of procurement ordinances
- Application of pretreatment regulations to industrial users

Other control actions appear in a limited number of Toxics Management Action Plans. These actions include:

- Implementation of a source tracking program
- Chemical fingerprinting or congener or homolog pattern analysis
- Remediation and/or mitigation of individual sources, conducted in the event that track-down sampling or chemical fingerprinting identifies potential individual sources

These Toxics Management Action Plans have been submitted to Ecology or to EPA under the terms of their respective NPDES permits. The Comprehensive Plan shall reference and incorporate these plans as submitted to the respective agencies. The SRTTFF shall evaluate the extent to which the plans should be further reviewed in the Comprehensive Plan.

Site Remediation

Site remediation control actions involve: 1) identifying, and 2) cleaning up soil that has been contaminated from past use of PCBs, before they can be mobilized and transported to the river. Marti and Maggi (2015) conducted preliminary research on existing soil and groundwater PCB data to assess contaminated sites that could be contributing PCBs to the Spokane River, and identified thirty one Toxic Control Program cleanup sites. These sites have either undergone cleanups and received No Further Action designation, are in the process of undergoing cleanups, or are awaiting cleanups.

Marti and Maggi (2015) note that PCB analytical data for the cleanup sites were primarily generated using method SW8082, with a standard reporting limit range of 0.5 to 100 ug/kg for soil and 0.0033 to 0.1 ug/l for water. Because of these higher detection limits, residual PCB contamination likely still exists at some of the sites that are currently designated for No Further Action. As such, continued identification of sites that could contribute PCBs to the Spokane River may be a worthwhile control action.

Remediation is the primary control action for identified contaminated sites. In Washington, remediation activities fall under the jurisdiction of the Model Toxics Control Act (MTCA), which will take precedence over Task Force activities. Four contaminated sites with potential to contribute PCBs to the Spokane River are in various stages of remediation:

- Spokane River Upriver Dam and Donkey Island
- General Electric Co.
- City Parcel
- Kaiser Aluminum

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Appendix D: Cost/Effectiveness of PCB Control Actions for the Spokane River

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Memorandum

From: Kat Ridolfi, Dave Dilks

Date: September 15, 2016
Project: SRRTTF4

To: SRRTTF

SUBJECT: DRAFT: Cost/Effectiveness of PCB Control Actions for the Spokane River

Summary

The Spokane River Regional Toxics Task Force (SRRTTF) was created with the goal of developing a comprehensive plan to bring the Spokane River into compliance with applicable water quality standards for the toxic chemical polychlorinated biphenyls (PCBs). To accomplish that goal, the functions of the SRRTTF include preparing recommendations for controlling and reducing the sources of listed toxics in the Spokane River and review of proposed Toxic Management Plans, Source Control Plans and Control Actions. A previous memorandum (LimnoTech, 2016b) originally identified a total of 41 control actions. The intent of this memorandum is to provide information to assess these control actions in order to help identify those that may be most appropriate in making measurable progress in controlling PCBs in the Spokane River Watershed. It is divided into sections describing:

- Control Actions Considered
- Review of Control Actions
- Prioritizing Control Actions for the Comprehensive Plan
- Future Steps

Fact sheets are provided for each Control Action under consideration. Each Control Action is reviewed in terms of expected removal efficiency, the significance of the PCB source area or pathway it addresses, cost, presence of an agency willing to implement the action, location in the Pollution Prevention hierarchy, relationship to existing control efforts, implementation/effectiveness time frames, and ancillary benefits provided.

While it is recognized that it is solely up to the discretion of the Task Force regarding which Control Actions to recommend for inclusion in the Comprehensive Plan, this review can provide some guiding principles to contribute to the discussion. They are, in order of priority:

1. **Maintain existing Control Actions:** Numerous Control Actions are already being implemented, and are targeted to control the largest delivery mechanisms of PCBs. These Control Actions are expected to significantly reduce PCB loads to the River and Lake Spokane. Primary consideration should be given to maintaining and supporting these activities.
2. **Gain understanding of uncertain source areas and pathways:** The majority of the Control Actions under consideration act upon pathways of uncertain magnitude. Consistent with comprehensive PCB plans in other watersheds, initial efforts should focus on collecting data to better understand the magnitude of uncertain source areas and transport pathways, prior to

implementing specific Control Actions on them. The source areas and transport pathways to be investigated should be prioritized using the best current estimate of their magnitude.

3. **Assess if additional actions merit near-term consideration:** Other Control Actions can be considered for inclusion in the Comprehensive Plan, to the extent that they can be reasonably expected to achieve noticeable reductions in PCB loading to the river or lake.
4. **Understand the timeframes for implementation and effectiveness**: Control actions can be evaluated in terms of the timing of their success to help rank the practical application of a Control Action within five year windows.

Control Actions Considered

LimnoTech (2016b) originally identified a total of 41 Control Actions considered potentially applicable to address PCBs in the Spokane River. The control actions identified in that memorandum were obtained from several sources:

- BMP Toolbox for the San Francisco Bay Area (SFEI 2010)
- Stormwater Management Manual for Eastern Washington (Washington Department of Ecology 2004)
- Spokane Regional Stormwater Manual (Spokane County, City of Spokane, and City of Spokane Valley 2008)
- Spokane River Regional Toxics Task Force February 6-8, 2016 Workshop
- PCB Chemical Action Plan (Washington Department of Ecology, 2015)
- Discussions within the SRRTTF BMP subgroup

This list of Control Actions considered changed slightly in response to Task Force comments provided after the publication of LimnoTech (2016b), with some control actions added (e.g. land use/development ordinance that encourages Low Impact Development (LID), education about filtering of post-consumer paper products) and one deleted (expanded monitoring). Each control action considered is summarized by category in Table 1.

Review of Control Actions

Information on the potential suitability of the Control Actions identified above was gathered from a range of sources including: descriptions of application to other sites, internet searches, and phone interviews with Task Force members. While no clear precedent exists for evaluating PCB Control Actions, some guiding principles may be useful in evaluating them. The most desirable Control Actions will be ones that:

- **Affect qualitatively significant pathways:** Even though many intermediate transport pathways are uncertain or not quantified, sufficient information exists to allow at least a qualitative understanding of the importance of most pathways. Control Actions that affect larger pathways will be preferred over Control Actions that affect smaller pathways.
- **Are qualitatively cost effective:** Similar to above, a qualitative understanding likely exists regarding the cost effectiveness of many Control Actions, even in the absence of quantitative case examples. Control Actions that remove PCBs at lower costs will be preferred over Control Actions that remove similar amounts of PCBs at greater costs.
- **Have a responsible party capable of implementation:** Control Actions must be implemented in order to reduce PCB loads. The presence of a party capable of ensuring that the selected Control Action will be implemented is a necessary condition.
- **That are already occurring or are in process of implementation as a function of regulatory/voluntary programs.** Control Actions that are the result of permits are subject to refinement and upgrades as permit cycles revolve. Control Actions should be identified and understood as they are implemented under the NPDES program, MTCA program, or the MS4

programs, etc.

Table 1. Menu of Control Actions Identified as Potentially Applicable for Reducing PCB Loads to the Spokane River and Lake Spokane

Category	Sub-	Control Action
Institutional	Government Practices (Regulatory Actions and/or Incentivized Voluntary Programs)	Disposal assistance for PCB-containing items
		Land use/development ordinance that encourages LID
		Leaf removal
		Street sweeping
		Catch basin/pipe cleanout
		Purchasing standards
		Survey of local utilities for electrical equipment
		Regulation of waste disposal
		Removal of carp from Lake Spokane
		Building demolition control actions
		PCB-product labeling law
		Leak prevention/detection in electrical equipment
		Accelerated sewer construction
		PCB identification during inspections
		Regulatory rulemaking
		Compliance with PCB regulations
		Support green chemistry alternatives
	Educational	Survey of PCB-containing materials in schools/public buildings
		Education/outreach about PCB sources
		Education about discharge through septic systems in aquifer recharge area
		Education about filtering of post-consumer paper products
		PCB product information

Table 1 (continued). Menu of Control Actions Identified as Potentially Applicable for Reducing PCB Loads to the Spokane River and Lake Spokane

Category	Sub-	Control Action
Stormwater Treatment	**Pipe Entrance**	Infiltration control actions
		Retention and reuse control actions
		Bioretention control actions
		Isolation of contaminated source areas from the MS4
		Filters
		Screens
		Wet vault
		Hydrodynamic separator
	End of Pipe	Constructed wetlands
		Sedimentation basin
		Discharge to ground/dry well
		Diversion to treatment plant
		Fungi (mycoremedation) or biochar incorporated into stormwater treatment
Wastewater Treatment		Development of a Toxics Management Action Plan
		Implementation of a source tracking program
		Chemical fingerprinting or pattern analysis
		Remediation and/or mitigation of individual sources
		Elimination of PCB-containing equipment
		Public outreach and communications
		Review of procurement ordinances
		Pretreatment regulations
Site Remediation		Identification of contaminated sites
		Clean up of contaminated sites

- **Are Located Higher in the Pollution Prevention Hierarchy:** The Pollution Prevention Act of 1990 explicitly recognized that source reduction is fundamentally different and more desirable than waste management or pollution control. This hierarchy has been refined for PCBs as "Don't make it > Don't use it > Use less of it > Manage it properly > Dispose of it properly > Treat it." Control Actions that are located higher in the pollution prevention hierarchy are preferable to ones that are located lower.
- **Provide ancillary benefits:** Control Actions that provide benefits beyond PCB load reduction will be preferable to those that address only PCBs, all else being equal.
- **Are relevant and practical from a timeframe for effectiveness**. Control Actions will require practical investments in terms of making measurable progress within the timeframes set up both internally to the SRRTTF and externally for the demands of the regulatory agencies.

This section first describes the factors that were used to review each Control Action, then summarizes the findings of the review.

Review Factors

Each Control Action is reviewed with respect to several factors, consisting of: reduction efficiency, significance of pathway, cost, implementing entity, pollution prevention hierarchy, and ancillary benefit, as well as timeframes for implementation and results. In addition, because many significant Control Actions are currently being undertaken in Spokane, each action is assessed in terms of the extent that it overlaps with existing efforts.

The information gathered for this review indicates that many of the reviewed Control Actions have no quantitative information available on costs or effectiveness. In addition, the magnitude of the transport pathways between source areas and delivery mechanisms assessed in (LimnoTech, 2016a) were determined to be either highly uncertain, or unknown. Because quantitative information is lacking for many aspects of this review, a qualitative scoring system is used. The definition of each aspect of the review, as well as the qualitative scoring system used, is described below.

Significance of Pathway: Significance of Pathway describes the importance of the pathway in terms of delivering PCBs to the river or lake from the source area or pathway being targeted by the Control Action. Control actions that interrupt significant pathways may be very effective in preventing PCB sources from contributing PCBs to the system. Even though many intermediate transport pathways are uncertain or not quantified, sufficient information exists to allow at least a qualitative understanding of the importance of many pathways. As such, Control Actions will be rated as follows:

- Highly suitable: Pathway provides >1% of the total PCB load delivered to the system[8]
- Moderately suitable: Pathway provides 0.1- 1% of the total PCB load delivered to the system
- Less suitable: Pathway provides <0.1% of the total PCB load delivered to the system

Reduction Efficiency: Reduction Efficiency is a primary consideration in terms of prioritizing Control Actions, as it describes the extent to which a given action is expected to reduce PCB movement from its targeted source area or pathway. Although quantitative information defining reduction efficiency was not available for many Control Actions, sufficient information exists to allow the majority of Control Action to be rated as follows:

- Highly suitable: >50% reduction in targeted source area or pathway
- Moderately suitable: 10-50% reduction in targeted source area or pathway
- Less suitable: <10% reduction in targeted source area or pathway

Cost: Cost describes the expected long-term cost of implementing the Control Action, considering both capital and operating costs. Control Actions that remove PCBs at lower costs will be preferred over Control Actions that remove similar amounts of PCBs at greater costs. Even in the absence of quantitative data, a qualitative understanding exists regarding the costs of many Control Actions, and they are rated as follows:

- Highly suitable: <$100,000
- Moderately suitable: $100,000-$1,000,000
- Less suitable: >1,000,000

Implementing Entity: The success of a given Control Action depends upon the presence of some entity capable of, and willing to, taking responsibility for its implementation. Implementing Entity describes the extent to which there is a clearly identified responsible party for implementing the control action due to their enrollment in a regulatory or voluntary program, along with an assessment of their willingness to do so. It is rated as follows:

- Highly suitable: Entity identified and willing to implement

[8] Total PCB load to the system estimated as 800 mg/day, based on work conducted in LimnoTech(2016a)

- Moderately suitable: Entity identified, willingness uncertain
- Less suitable: No willing entity identified

Pollution Prevention Hierarchy: Experience with a wide range of pollutants has shown that preventing the creation or release of a pollutant is far more effective than controlling it once released. Pollution Prevention Hierarchy describes where the Control Action is located on the spectrum from limiting production and use of PCBs to treating PCBs prior to their release to the river or lake. It is rated as follows:

- Highly suitable: Controls production or use of PCBs
- Moderately suitable: Manages the mobility of PCBs in the environment
- Less suitable: Performs "end-of-pipe" treatment of PCBs prior to discharge

Existing Efforts under Regulatory and/or Voluntary Programs: This describes the extent to which a given Control Action relates with existing PCB control efforts that are required by state or federal law. It is rated as follows:

- Highly suitable: Addresses a source area or pathway that is not currently being addressed
- Moderately suitable: Expands upon existing controls of a source area or pathway
- Less suitable: Redundant with existing efforts

Ancillary Benefit: Some Control Actions provide benefits beyond removal of PCBs from the system. Ancillary Benefit describes the extent to which a given Control Action provides these benefits. It is rated as follows:

- Highly suitable: Provides significant additional benefits beyond reduction of PCB loads
- Moderately suitable: Provides some additional benefits beyond reduction of PCB loads
- Less suitable: Provides minimal additional benefit beyond reduction of PCB loads

Implementation Timeframes: Control Actions will ideally be implemented in timeframes that are meaningful and relevant to the actions and efforts of the SRRTTF and other entities involved in controlling PCB pollution. It is rated as follows:

- Highly suitable: Expected implementation within two year timeframe
- Moderately suitable: Expected implementation within five year timeframe
- Less suitable: Expected implementation within twenty year timeframe

Effectiveness Timeframes: The timeframe by which Control Actions provide a noticeable environmental response is also an important consideration. It is rated as follows:

- Highly suitable: Improvements observed within two year timeframe
- Moderately suitable: Improvements observed within five year timeframe
- Less suitable: Improvements observed within twenty year (or longer) timeframe

Review Findings

Appendix A summarizes the findings of the review for all candidate Control Actions, using a simple shading scheme to identify whether each aspect of each control action is:

- Highly suitable
- Moderately suitable
- Less suitable
- Unable to be evaluated, due to a lack of information

Individual Fact Sheets are provided in Appendix A, which describes each control action and briefly discusses how the ratings were obtained.

Some key observations can be made from this review. First and foremost, the most significant delivery mechanisms of PCBs all have existing Control Actions in various phases of development. Specific PCB-related Control Actions underway in Spokane are:

- Wastewater treatment plants discharging to the Spokane River are all required to develop and install treatment systems to reduce nutrient loading that will concurrently result in reductions of PCB loading. In addition, each wastewater facility has developed a Toxics Management Action Plan that includes a PCB source identification study and associated control actions. These treatment plants are operated by:
  - City of Coeur d'Alene
  - Hayden Area Regional Sewer Board
  - Kaiser Aluminum
  - Spokane County
  - City of Post Falls
  - Liberty Lake Sewer and Water District
  - Inland Empire Paper
  - City of Spokane
- Remediation activities for known contaminated sites in Washington are being implemented and managed under the jurisdiction of the Model Toxics Control Act (MTCA). Marti and Maggi (2015) searched for sites in Spokane that could be contributing PCB contamination to groundwater in the area of the Spokane River. They identified 31 clean-up sites, three of which have confirmed release of PCBs and subject to MTCA remediation. They are:
  - Spokane River Upriver Dam and Donkey Island
  - Kaiser Aluminum
  - General Electric Company, E. Mission Ave.
- The City of Spokane is actively addressing stormwater and CSO loading of PCBs as part of their Integrated Clean Water Plan. Other entities are also controlling their stormwater loads under NPDES permits, including:
  - Idaho Transportation Department
  - City of Post Falls
  - Spokane County
  - Washington Department of Transportation
  - City of Coeur d'Alene
  - Post Falls Highway Department
  - City of Spokane Valley
- The large majority of stormwater in the remainder of the watershed (including Spokane County and the City of Spokane Valley) is being diverted to groundwater, as opposed to direct surface discharge to the River. This activity is consistent with many of the PCB Control Actions discussed previously under the category of "Stormwater Treatment--Pipe Entrance," and is regulated under the State of Washington's Underground Injection Control Program.
- Local electric utilities have replaced their transformer with essentially PCB-free oils, and eliminated the use of large capacitors. The following utilities were surveyed in LimnoTech (2016a):
  - Avista Utilities
  - Modern Electric Water Company
  - Kootenai Electric Cooperative
  - Inland Power and Light Company
  - Vera Water and Power

PCB concentrations and estimated mass are provided in the above-referenced document.

The second observation is that many of the Control Actions initially identified as potentially applicable are already being implemented with existing efforts. For example, many Control Actions identified from other sites were specific to stormwater controls. Stormwater PCB loads are largely already undergoing control actions as a function of NPDES permits and MS4 permits.

The third observation is that many Control Actions either operate on pathways of highly uncertain magnitude, or are so uncertain in their effectiveness that they cannot be fully evaluated at this time. The final observation is that there are a class of Control Actions that are not intended to lead to immediate load reduction, but rather to collect information to better define pathways or reduction efficiencies and educate the public so as to effect a cultural changes that result in the long-term control of PCBs that are handled by the public.

Prioritizing Control Actions for the Comprehensive Plan

The ultimate goal of evaluating a range of Control Actions is to inform the Task Force in the prioritization and selection of specific actions to be included in the Comprehensive Plan. While it is recognized that it is solely up to the discretion of the Task Force regarding which Control Actions to recommend for implementation, this section describes lessons that could be learned from other watershed-based PCB Control Actions and provides some potential guiding principles to be considered for prioritizing Control Actions.

Lessons from Other Sites

The challenge discussed above regarding insufficient information of PCB transport pathways and cost/effectiveness of Control Actions is not unique to Spokane. Essentially all other watershed-based PCB Comprehensive Plans have dealt with the issues of incomplete information on costs and effectiveness and uncertain magnitudes of transport pathways. The examples that follow illustrate different approaches to selection and implementation of PCB Control Actions in the face of incomplete information:

- San Francisco Bay TMDL: Urban stormwater controls are being adaptively selected and implemented over 20 years, beginning with permittees selecting and pilot testing their own BMPs to assess effectiveness and technical feasibility. Based on lessons learned during the pilot testing, additional controls will be implemented in strategic locations and will inform development of a plan to that will attain desired PCB load reductions. This effort faced similar challenges to Spokane in terms of uncertainty of the magnitude of PCB transport pathways, but successfully addressed it by creating an implementation plan with specific timelines and schedules that still allowed for adaptive management.
- Delaware River PCB TMDL: The implementation plan adopted a non-numeric approach requiring pollutant minimization plans for point and nonpoint source dischargers to track down and reduce PCBs. Components of the pollutant minimization plans included source identification and reduction, monitoring and reporting, and remediation activities for known contaminated sites. One strength of this effort is the existence of the Delaware River Basin Commission, a long-standing agency which is responsible for oversight of contributing jurisdictions, and serves to coordinate all entities.
- Illinois Lake Michigan Nearshore PCB TMDL: Stormwater MS4 permittees were given a menu of BMPs to choose from, with no guidance provided regarding expected cost or effectiveness. Near-term permits will be process-based rather than performance based, i.e. permittees must demonstrate that BMPs will be implemented but will not be held to numeric PCB loading limits. The primary challenge facing this effort was that the primary source of PCBs is from the atmosphere; however, the developers of the plan (the TMDL program) only had responsibility for discharges to water. During development of this plan and responding to public comments, the Illinois Water Division communicated frequently with the Illinois Air Division. As a result of this increase communication (i.e., breaching of institutional silos), the plan includes a comprehensive discussion of air sources and programs.

- Lake Ontario Tributaries PCB TMDL: Affected dischargers are required to implement a PCB monitoring plan, establish an interim limit, and review monitoring data to determine where it would be appropriate to require a PCB minimization plan. NYSDEC's PCB Minimization Program (PCBMP) states that permittees shall develop, implement and maintain PCBMPs for those outfalls which have been shown through monitoring that concentrations of PCBs in their discharge have a reasonable potential for being reduced. Where it can be shown that the PCBs present in a dischargers effluent is attributable to atmospheric deposition, the discharger will not be responsible to take actions Management of Lake Ontario and its main tributary, the Niagara River, is under the jurisdiction of NYSDEC, USEPA, Ontario Ministry of the Environment, and Environment Canada. The multi-jurisdictional nature of the Lake Ontario watershed is a challenge because each jurisdiction has a different water quality standard for PCBs, and developer of this plan only had control over New York sources. An additional challenge is that the primary source of PCBs is from the Niagara River, which requires binational collaboration for restoration.

These implementation plans are varied, but all are based on adaptive management principles that provide flexibility in selecting and implementing controls, typically after additional data has been collected to better inform the decision.

Potential Guiding Principles for Prioritizing Control Actions

While it is recognized that it is up to the discretion of the Task Force regarding which Control Actions to recommend for inclusion in the Comprehensive Plan, this review can provide some guiding principles to contribute to the discussion. These principles are, in order of priority:

1. **Maintain existing Control Actions:** Numerous Control Actions are already being implemented, and are targeted to control the largest delivery mechanisms of PCBs. These Control Actions are expected to significantly reduce PCB loads to the River and Lake Spokane. Primary consideration should be given to maintaining, supporting and upgrading these activities. Because these efforts are being conducted under the auspices of many different regulatory programs, efforts to facilitate communication between these programs will be essential. Equally essential will be the need to craft NPDES permits and stormwater programs with consistent language, consistent programs and protocols and data collection procedures that will facilitate:
    a. The evaluation and monitoring of effectiveness in controlling PCB pollution
    b. Allowing data to be shared and compared in ways that are useful across the basin for understanding the transport, fate and control of PCBs
    c. Adaptive management in the face of ongoing data collection
2. **Gain understanding of uncertain source areas and pathways:** Consistent with comprehensive PCB plans in other watersheds, initial efforts should focus on collecting data to better understand the magnitude of uncertain source areas and transport pathways, prior to implementing specific Control Actions on them. The source areas and transport pathways to be investigated should be prioritized by the best current estimate of their magnitude, with preference given to those sources believed most likely to be contributing to elevated PCB concentrations in the Spokane River and Lake Spokane.
3. **Assess if additional actions merit near-term consideration:** Other Control Actions can be considered for inclusion in the Comprehensive Plan, but only after the above two priorities are met. Any additional Control Actions should be restricted to those that can be reasonably expected to achieve noticeable reductions in PCB loading to the river or lake.

Future Steps

It is worthwhile, when evaluating these Control Actions, to keep overall objectives in mind. The goal of the Task Force is to develop a comprehensive plan to bring the Spokane River into compliance with applicable water quality standards for PCBs. After Control Actions have been selected by the Task Force, additional steps will be needed to ensure that progress is being made. The details of implementing the Control Actions will be determined later in the Comprehensive Plan, but may include:

1. Milestones for control action efforts will be developed as a Task Force. These should be milestones that are developed as we understand the ability for the Control Actions to deliver measurable progress. These milestones could consist of environmental benchmarks (e.g. in-stream PCB concentration) and/or measurement of the extent/effectiveness of Control Action implementation. Such interim milestones should be assessed at scheduled intervals that make sense in order to adjust to our growing understanding of the issues. These interim milestones should be adopted into the Comprehensive Plan and used by Ecology with support from DEQ and EPA to determine whether the SRRTTTF is making measurable progress towards bringing the Spokane River into compliance with water quality standards for PCBs.
2. Timelines for implementation of Control Actions will be set at the Control Action level within the Comprehensive Plan. A schedule for implementation (or a rolling timeline if the process requires years) should be developed for each control action
3. Each control action or suites/combinations of control actions will have a schedule and program for effectiveness monitoring. This effectiveness monitoring should guide the management and provide room to adapt strategies, phase out actions that are not working, and phase in new control actions that are developed. Additionally, this effectiveness monitoring should help Ecology in their efforts to make Measurable Progress determinations at five year intervals.

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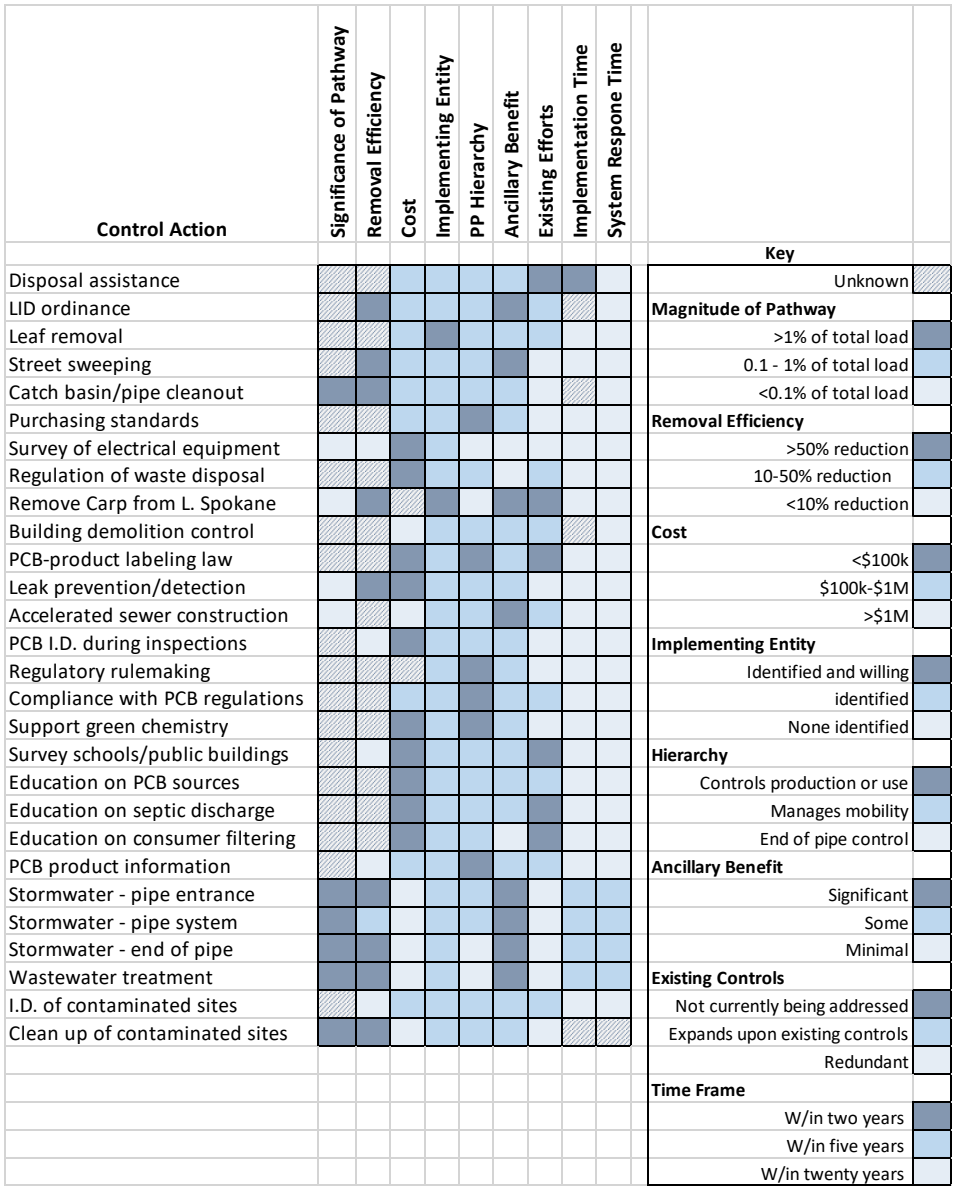
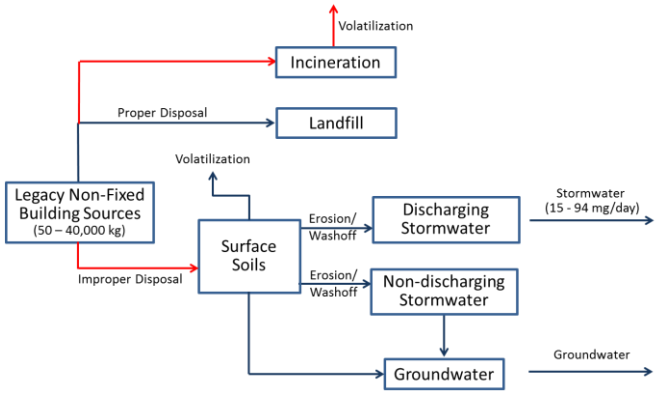
Appendix A. Summary of Control Action Review



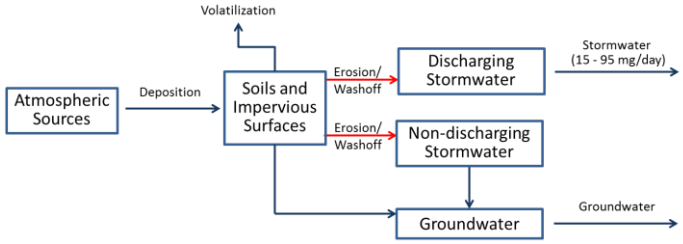
Appendix B. Control Action Fact Sheets

Disposal Assistance for PCB-Containing Items

Description:	This action consists of programs (targeted at household consumers and businesses that generate small quantity hazardous waste) designed to accept and properly dispose of PCB-containing items, preventing legacy non-fixed building sources such as small appliances and lamp ballasts from potentially being disposed of improperly.
Type:	Institutional -- government practices.
Significance of Pathway:	This control action targets legacy non-fixed building sources, which have been identified as one of the largest source areas of PCBs with an estimated mass range of 50 to 40,000 kg. The primary mechanisms delivering this source area to the river are stormwater and atmospheric deposition following waste incineration, both through improper disposal. The total stormwater load is 15 to 94 mg/day and the atmospheric load is not currently known. The specific portion of the total stormwater and atmospheric load contributed by legacy non-fixed building sources is also unknown, due to uncertainty in the number of appliances in the watershed, the percentage that may be improperly disposed, and the ultimate fate of those PCBs. 
Reduction Efficiency:	This control action is theoretically 100% effective in controlling the release of PCBs from items that would otherwise be improperly disposed. The overall efficiency is of this control action is unknown. However, increasing public education and awareness of existing recycling and household hazardous waste facilities would increase the number of PCB-containing items that are properly disposed.
Cost:	The infrastructure for this program largely exists in Washington via take-back programs for mercury-containing lights, such that costs to include PCB-containing products would consist largely of: 1) outreach and education programs for the general consumer and business community, and 2) additional costs associated with managing PCB wastes. Efforts to initiate such a program in Idaho would be greater. Because the cost of the statewide mercury take-back program was $8.7 million dollars for five years, the cost for application to the Spokane watershed (including Idaho) would be a fraction of that, likely more than $100,000 and less than $1 million.
Implementing Entity:	This action is currently being implemented by a number of organizations in Washington: Department of Ecology Hazardous Waste and Toxics Reduction program – Urban Waters Initiative; Spokane County Regional Health District; Spokane River Forum – Envirostars; local waste disposal vendors and local

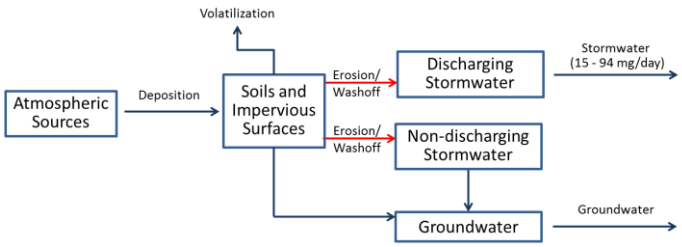
	businesses that accept fluorescent lamps for recycling. Specific activities that that the Task Force could undertake include: 1) Making recommendations to organizations currently providing waste disposal assistance as to how they can help achieve their goals, and 2) Raise public awareness on how to identify and dispose of PCB-containing items.
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	As discussed above, this action is available and could be better integrated with existing Control Actions targeted toward CFL lamp recycling and household hazardous waste collection.
Ancillary Benefit:	This action provides some ancillary benefits because PCB light ballasts and small capacitors are often associated with other items that have harmful materials in them (mercury containing lights). Outreach on this topic also promotes proper disposal of these items, and preventing environmental release of other harmful materials contained in them.
Time Frame:	Programs can likely be developed within two years, although it is not expected that measurable reductions in PCB loads will be observed with five years.

Low Impact Development (LID) Ordinance

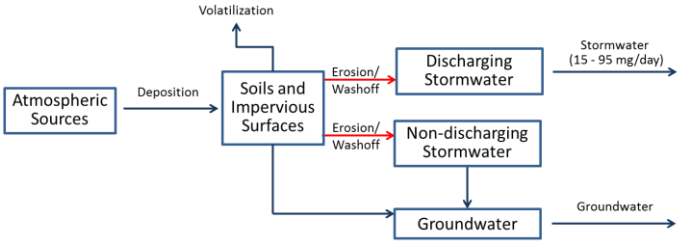
Description:	This action consists of creating and implementing land use/development ordinances or standards that encourage Low Impact Development (LID) and decrease impervious surfaces.
Type:	Institutional government practices
Significance of Pathway:	This control action is designed to prevent and minimize runoff from impervious surfaces and the PCBs that are contained in that runoff. The pathway for this action is primarily discharging stormwater systems, which delivers a total of 15 to 94 mg/day, This estimate is based upon loading from the City of Spokane, which contributes the majority of stormwater load to the river. This Control Action may be beneficial for other communities with stormwater discharges, although their contribution of PCBs to stormwater is not known. 
Reduction Efficiency:	Because PCBs in runoff are largely bound to soil particles, the efficiency of this control action can be estimated from the observed efficiency of LID on removing solids from runoff, which ranges from 40 to 88%. LID can also prevent stormwater from becoming contaminated by infiltrating it before it contacts contaminated surfaces such as roads. The portion of this load to the Spokane River that could be controlled by LID is unknown.
Cost:	Development and adoption of the ordinance in other communities (besides the City of Spokane which already has this type of ordinance) would likely be minimal (<$100,000) based on the information from the City of Spokane with their purchasing ordinance. However, related education and outreach efforts could be much more expensive ($100,000-$1million or more, depending on scope). Installation costs for Low Impact Development projects are project specific and would need to be evaluated with the ancillary benefits that offset the cost.
Implementing Entity:	This action is typically applied by the local agency responsible for managing land development (cities or counties). The City of Spokane LID program could serve as a model for implementation in other communities in the watershed.
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	A Low Impact Development ordinance has already been developed by the City of Spokane. Ecology has developed a guidance document to assist other jurisdictions with developing and implementing something similar. The Washington State Stormwater Center also has technical information and training resources for implementing low impact development projects in Eastern Washington.
Ancillary Benefit:	LID manages both stormwater and land use in a way that minimizes disturbance of the hydrologic processes, and uses on-site natural features that are integrated into an overall design so that stormwater practices include the use of natural processes such as transpiration, conservation, and infiltration. In addition to improved water quality, LID can reduce flooding, restore aquatic habitat, improve groundwater recharge, and enhance neighborhood beauty. This control action will provide other water quality benefits

	by reducing the loading of many other pollutants that are associated with solids and impervious surfaces (e.g. metals, bacteria).
Time Frame:	While LID ordinances can likely be developed within two years, the time frame for observing measurable reductions in PCBs is unknown.

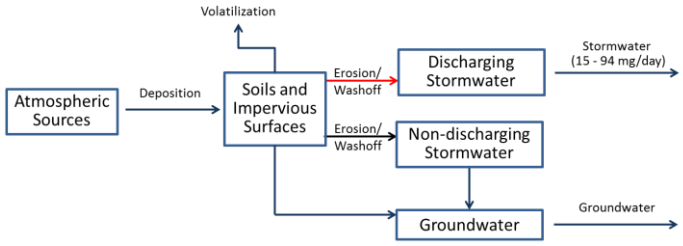
Leaf Removal

Description:	This action consists of programs designed to enhance current municipal leaf removal programs since foliage is a receptor of atmospheric PCB loadings, and the organic matter in leaves can adsorb PCBs from other sources in runoff. Removal of leaf litter prior to it being discharged to the river could reduce loading PCB associated with this source area.
Type:	Institutional - government practices
Significance of Pathway:	This control action is theoretically 100% effective in controlling the release of PCBs from collected leaf litter. The fraction of overall leaf litter that would be captured by improved removal and the overall efficiency is of this control action is not fully known. 
Reduction Efficiency:	The overall efficiency is of this control action is not fully known. While it is theoretically 100% effective in controlling the release of PCBs from collected leaf litter, the fraction of overall leaf litter that would be captured by improved removal is currently unknown.
Cost:	This control action is generally being implemented, such that costs would consist of further expansion of the program and/or evaluation to see if leaf removal can be more efficient or effective. Costs associated with public outreach that encourage local residents to collect leaf litter and dispose of it as green waste through existing solid waste system could mitigate current program expenses.
Implementing Entity:	Municipalities and other local governments.
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	Leaf removal is already a government-provided service in the City of Spokane (seasonal), Spokane county (leaves can go in green bins collected by Waste Management), and Coeur d'Alene (last two weekends in April and September).
Ancillary Benefit:	This action provides secondary benefits beyond PCB removal by reducing the loading to the Spokane River of nutrients and oxygen-demanding material contained in leaf litter.
Time Frame:	While programs can likely be developed within two years, it is expected that measurable reductions in PCB loads will not be observed within five years.

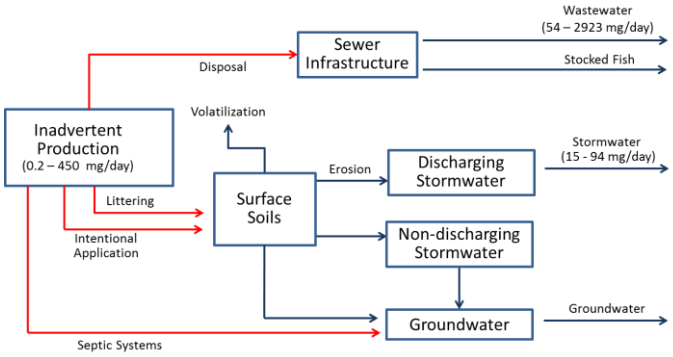
Street Sweeping

Description:	This action consists of programs designed to modify current street sweeping frequency and area covered to specifically target source areas of PCBs, or when/where more material is washing down streets to prevent it from entering storm drains.
Type:	Institutional - government practices
Significance of Pathway:	This control action is targeted towards the portion of PCB contamination in stormwater runoff that accumulates on street surfaces. The primary mechanism delivering this source area to the river is discharging stormwater, which totals 15 to 94 mg/day. Due to the uncertainty in the extent of the stormwater load arising from street surfaces, the significance of this pathway is not fully known, but is likely a moderate contributor. 
Reduction Efficiency:	Studies to assess the ability of street sweeping to improve concentrations of particle-bound pollutant in stormwater have reported widely varying effectiveness. Several studies showed no significant differences in stormwater concentration in response to street sweeping (e.g. USGS, 2007) while other (e.g. Sutherland, 2009) have reported decreases in concentration of more than 50% and Contra Costa County, CA reported removal of 1 kg of PCBs via street sweeping. Ecology (2007) reported an average of 74% removal efficiency for TSS for street sweeping based on two studies conducted outside of WA state. Although there is a wide range of reported reduction efficiencies, street sweeping is rated as a highly suitable in terms of reduction efficiency.
Cost:	Spokane Valley's 2016 estimated street sweeping costs are $490,000, however there are no known provisions in the contract that specify practices (e.g., area swept, equipment used, frequency) to target PCBs in addition to the usual objectives. Based on this cost, any modification to current sweeping practices in order to specifically target PCB source areas would likely be a fraction of this cost and certainly <$100,000. Long term costs are judged to be moderate. For example, purchasing a new, high efficiency sweeper could cost $200,000-$300,000.
Implementing Entity:	Municipal Public Works Departments, State Departments of Transportation
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	This control action is primarily applicable to the City of Spokane, as they are responsible for the large majority of watershed area contributing to discharging stormwater systems. The City is currently developing and implementing an Integrated Clean Water Plan designed to control PCB loading from their stormwater systems, which includes street sweeping. It may be beneficial for other communities with stormwater discharges, although the size of their service area is relatively small.
Ancillary Benefit:	This action provides significant secondary benefits by reducing the loading to the Spokane River of pollutants typically associated with impervious surfaces, such as phosphorus.
Time Frame:	This control action can likely be developed within two years. Because street sweeping is already being applied, it is unlikely that modification to existing practices will show measureable benefits within the next five years.

Catch Basin/Pipe Cleanout

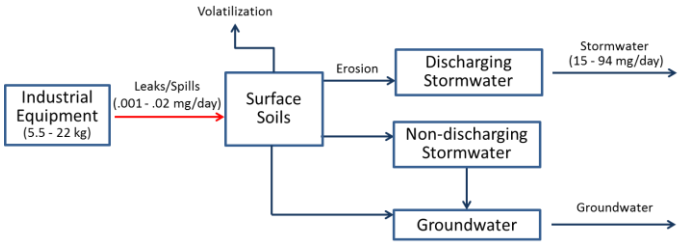
Description:	This action consists of programs designed to increase the efficiency or effectiveness of catch basin and pipe cleanout to specifically remove PCB-contaminated sediment.
Type:	Institutional - government practices
Significance of Pathway:	This control action is targeted towards all pathways that deliver PCBs to discharging stormwater systems. The overall magnitude of the stormwater delivery pathway is 15-94 mg/day. Because this Control Action has the potential to affect the majority of delivered stormwater loads, the action is rated as highly suitable in terms of pathway. 
Reduction Efficiency:	While the exact reduction efficiency on the PCB overall loading rate is uncertain, the Control Action is effective in removing PCBs that could otherwise be delivered to the system. The City of Spokane removed 32.4 grams PCBs removed from their catch basins between 2010 and 2012 (Schmidt, 2015). This action also assists in source identification if PCB concentrations of the removed sediments are measured, as catch basins with higher PCB concentrations indicated elevated source areas in their drainage basis. Given the amount of PCB mass removed relative to overall stomwater loading, this action is rated as highly suitable.
Cost:	The City of Spokane spent just over $1 million on routine catch basin pumping each year (including staff, administration, dumping fees, and equipment). Increasing the frequency or changing the type of cleaning administered to catch basins in order to more effectively target PCB reduction would likely be a fraction of the total cost, or <$100,000 per year. Other communities' costs can be estimated based on the size of the city and number of catch basins. In 2015 the City checked 15,716 catch basins (of a total over 21,000) and pumped 1,723. The area they inspect includes the CSO area and drywells.
Implementing Entity:	Municipal Public Works Departments, Department of Transportation
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	This control action is primarily applicable to the City of Spokane, as they are responsible for the large majority of watershed area contributing to discharging stormwater systems. The City is currently developing and implementing an Integrated Clean Water Plan designed to control PCB loading from their stormwater systems, so independent development of Control Actions by the Task Force is considered redundant to this effort.
Ancillary Benefit:	This action provides secondary benefits by reducing the loading to the Spokane River of pollutants typically associated with solids (e.g. metals, bacteria) that are captured be catch basins. More frequent catch basin cleanout can also prevent flooding.
Time Frame:	This control action is currently being implemented. The extent to which additional catch basin and pipe cleanout will result in observable near-term reductions in stormwater PCB loads is unknown.

Purchasing Standards

Description:	This action consists of using existing local and state regulations to reduce or eliminate the purchase of products that contain PCBs. When wholistically implemented, it would include: 1) gathering information about PCB content in purchased products; 2) working with manufacturers to identify products with preferentially low concentrations of PCB; 3) preparing contract specifications for government purchased products in accordance with State law; and 4) providing public access to information and specifications that encourage the purchase of products with no or minimal concentrations of PCB.
Type:	Institutional - government practices
Significance of Pathway:	This control action is targeted towards the source area of inadvertently produced PCBs, which are estimated as entering the watershed at a rate of 0.2 to 450 mg/day. This class of PCBs is essentially unregulated so that it has the potential to significantly affect the delivery pathways for wastewater (54-2923 mg/day) and stormwater (15-94 mg/day) loading, although the specific contribution of inadvertent sources to these pathways is unknown. 
Reduction Efficiency:	This control action can theoretically reduce the contribution of affected inadvertent sources by 100%, if products currently containing PCBs can be replaced with PCB-free products. For this reason, it is rated as highly suitable in terms of reduction efficiency.
Cost:	The costs associated with this control action include: 1) Product identification and sampling; 2) Manufacturer outreach, 3) Contract specifications development and 4) public outreach. These costs are expected to be shared by implementing entities, depending on needs and funding availability.
Implementing Entity:	State governments (Departments of Ecology, Environmental Protection, Enterprise Services, Transportation), local jurisdictions within the watershed.
PP Hierarchy:	This control action in high on the Pollution Prevention hierarchy, as it is designed to reduce the use of inadvertently produced PCBs.
Existing Efforts:	Washington State Senate Bill 6086 (passed in 2014) requires State agencies to establish a purchasing and procurement policy that provides a preference for products that do not contain PCBs. (http://apps.leg.wa.gov/billinfo/summary.aspx?bill=6086&year=2013). Spokane County passed Resolution #2014-1022 in December 2014.The City of Spokane's ordinance requires City departments to purchase PCB-free items (defined as less than the practical quantification limit using EPA Method 1668) if a feasible alternative is available at less than a 25% cost increase (Spokane Municipal code 07.06.172).
Ancillary Benefit:	This control action supports Governor Inslee's Reducing Toxic Pollution efforts http://www.ecy.wa.gov/toxics/docs/ToxicsChemicals.pdf and Washington State Department of Ecology's "Reducing Toxic Threats" strategy: http://www.ecy.wa.gov/toxics/index.htm which aims at controlling the small but steady releases of toxic chemicals contained in everyday products that enter the environment and cause pollution. This

	control action creates market incentives to reduce PCBs found in products, which has a broader benefit than the Spokane watershed.
Time Frame:	Purchasing controls can be implemented in the short term. Given the time lag between implementing purchase controls and: 1) exhausting the supplies of previously purchased materials, and 2) having inadvertently produced PCBs make their way through the watershed to the Spokane River, it is not expected that noticeable improvements would be seen within five years.

Survey of Local Utilities for Electrical Equipment

Description:	Conduct a survey of local utilities and other owners of electrical equipment to document the presence/amount of PCBs in transformers. Identify PCB-containing equipment (nominal 1 ppm concentration) that has a reasonable pathway to the river, if spilled, and target for removal.
Type:	Institutional - education
Significance of Pathway:	The action focuses on the potential for leaks or spills from industrial equipment, which has been estimated to be small (0.001 – 0.02 mg/day). 
Reduction Efficiency:	This action in and of itself will have no immediate impacts on PCB loads. If local utilities use this information to target and remove PCB-containing electrical equipment, it will be a step towards better source area identification and targeted Control Action implementation.
Cost:	An estimate to implement this control action at a statewide level in Washington Department of Ecology (2015) was less than $50,000 over two years. This was based on one FTE working 25% time on this project. At the watershed scale, it would likely be even less.
Implementing Entity:	States, Local utilities, industries with privately owned electrical equipment. The control action could be a regulatory requirement or voluntary action on the part of the utility. The latter is preferable as it meets the collaborative spirit of the Task Force.
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	A survey of local utilities was conducted as part of early stages of Comprehensive Plan development, and found that these utilities have already taken significant measures to reduce the PCB content in their equipment.
Ancillary Benefit:	This control action has the ancillary benefit of replacing older equipment, which is more likely to fail, with newer equipment; potentially reducing the number of spills and improving reliability.
Time Frame:	Given the very small magnitude of the source area, this Control Action is not expected to result in noticeable improvements in the next five years.

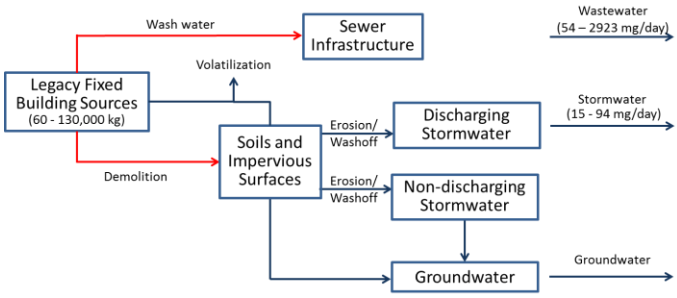
Regulation of Waste Disposal

Description:	This action consists of programs designed to review local/regional laws regulating waste disposal (including oil burning) and illegal dumping, and revise as necessary (e.g. enforcing fines/other penalties for improperly disposing of PCBs.)
Type:	Institutional--government practices
Significance of Pathway:	This action potentially affects a wide range of pathways, although the magnitude contributed by illegal disposal to any of these pathways is unknown.
Reduction Efficiency:	The reduction efficiency of this Control Action is unknown, but is likely small in terms of reducing the overall loading magnitude of any given pathway.
Cost:	The cost of this Control Action is unknown, but is expected to be less than $100,000
Implementing Entity:	Local governments.
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	None.
Ancillary Benefit:	This action may provide some limited ancillary benefit, by controlling improper disposal/release of other pollutants associated with illegal disposal.
Time Frame:	This Control Action is not expected to result in noticeable improvements in the next five years.

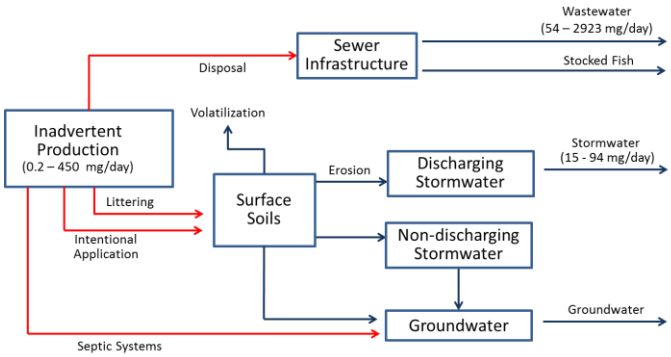
Removal of Carp from Lake Spokane

Description:	This action involves removing carp from Lake Spokane. Carp in the lake are known to be contaminated with PCBs, and removing them would prevent further cycling in the watershed.
Type:	Institutional--government practices
Significance of Pathway:	Removal of carp does not fall into the previously addressed delivery pathways, as those pathways all addressed external loads of PCBs to the system while carp represent a receptor of PCBs that have already been delivered. Nonetheless, this action can account for a significant amount of PCBs being removed, as removal of 1000 carp yields ranges of 1.5 – 4.1 grams of PCBs that could potentially be removed from Lake Spokane. If conducted on an annual basis, this corresponds to slightly less than 1% of the estimated load to the Spokane River.
Reduction Efficiency:	This is action is 100% efficient in removing PCBs from those carp that are harvested from in the lake, though 100% removal of carp in Lake Spokane is likely impracticable.
Cost:	Unknown at this point, though a pilot study is underway/planned.
Implementing Entity:	Avista Utilities and Washington Department of Ecology
PP Hierarchy:	This control action is at the bottom on the Pollution Prevention hierarchy, as it is designed to remove PCBs that are currently in the lake.
Existing Efforts:	This Control Action was suggested as a complement to existing studies conducted by Avista regarding removal of carp from Lake Spokane for the purposes of phosphorus removal. Should this effort be undertaken by Avista, there will be a direct removal of PCBs from the watershed and lake environment.
Ancillary Benefit:	This Control Action provides significant ancillary benefits. Removal of carp will also lead to a reduction in sediment phosphorus release caused by carp stirring up bottom sediments.
Time Frame:	This Control Action is not expected to result in noticeable improvements in the next five years.

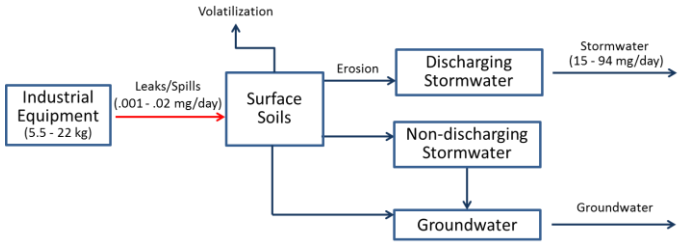
Building Demolition Control Actions

Description:	This Control Action consists of establishing regulations or local ordinances that require management of PCB-containing materials and waste during building demolition and renovation.
Type:	Institutional - government practices
Significance of Pathway:	This Control Action is targeted towards legacy fixed building sources, which have been identified as one of the largest source areas of PCBs with an estimated mass range of 60 to 130,000 kg. Klosterhaus et al (2014) summarize the available literature that demonstrates that the rate that legacy PCBs can be delivered to surrounding soils during demolition and renovation, while uncertain, is likely very significant. Furthermore, PCBs liberated through renovation can be delivered through wash water to the sewer infrastructure. The delivery pathways by which these PCBs reach the river are large (stormwater systems at 15 to 94 mg/day; wastewater at 54 to 2923 mg/day). While the exact amount of PCBs which could be reduced by this action contribute to these delivery pathways is unknown, the magnitude of the source area and delivery pathways are so large that this may be a significant pathway. 
Reduction Efficiency:	The efficiency of this action is currently being investigated. Given that some regulations (e.g. Environ, 2014) require removal/remediation of all building materials with PCB concentrations greater than 50 ppb, this action has the potential to be highly effective in reducing loads.
Cost:	Costs to implement institutional-government programs would be associated with regulations, local ordinances or codes associated with managing demolition and removal projects and expected to be similar to the PCB-purchasing regulations and codes that were passed recently. In addition, there would be costs associated with public outreach and education to entities engaging in demolition and renovation. Costs to manage PCB-containing materials and debris are project specific and unknown. Estimated costs just to cut and remove caulk, and to scarify or remove adjacent substrates could range from $30-$50 per linear foot
Implementing Entity:	EPA, state, local governments.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	While specific regulations are not currently in place EPA (2015) recommends that future MS4 permits should require that construction projects requiring a building permit contain requirements that the permit applicant implement specific Control Actions to minimize PCB release.
Ancillary Benefit:	This action may provide some limited ancillary benefit, by controlling improper disposal/release of other pollutants associated with building demolition. For example, a demolition practice that manages lead paint or asbestos may potentially be used to manage PCBs and vice versa.
Time Frame:	The time frame by which Building Demolition Control Actions would achieve noticeable reductions in loading is unknown.

PCB-Product Labeling Law

Description:	This action consists of developing and passing an ordinance that requires labeling products that contain PCBs, similar to the 2014 law for labeling construction materials that contain asbestos (RCW 70.310.030).
Type:	Institutional--government practices
Significance of Pathway:	This control action is targeted towards the source area of inadvertently produced PCBs, which are being imported into the watershed at a rate of 0.2 to 450 mg/day. It has the potential to affect the significant delivery pathways of wastewater (54-2923 mg/day) and stormwater (15-94 mg/day) loading, although the specific contribution of inadvertent sources to these pathways is unknown. 
Reduction Efficiency:	The effectiveness of product labels to affect consumer behavior has been shown to vary widely based on many factors (Cox et al, 1997), such that the reduction efficiency is considered unknown at this time.
Cost:	Costs to be considered include regulatory rulemaking and public outreach. While the exact cost is unknown, it is expected to be under $100,000.
Implementing Entity:	Washington Department of Ecology, local governments
PP Hierarchy:	This control action is high on the Pollution Prevention hierarchy, as it is designed to reduce the use of inadvertently produced PCBs.
Existing Efforts:	There are currently no existing efforts regarding labeling products for PCBs. However, this control action is similar to an initiative taken by the Spokane Regional Clean Air Agency for asbestos in construction products.
Ancillary Benefit:	This control action raises public awareness about PCBs in products and supports Ecology's Reducing Toxics Threats initiative.
Time Frame:	Given the time lag between implementing product labeling and: 1) exhausting the supplies of previously purchased materials, and 2) having inadvertently produced PCBs make their way through the watershed to the Spokane River, it is not expected that noticeable improvements would be seen within five years.

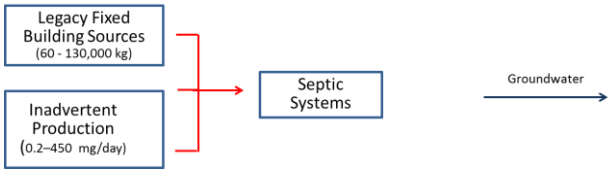
Leak Prevention/Detection In Electrical Equipment

Description:	This action consists of implementation of state and/or local ordinance to require a leak prevention/detection system in any PCB-containing transformer or capacitor.
Type:	Institutional--government practices
Significance of Pathway:	The action focuses on the potential for leaks or spills from industrial equipment, which has been estimated to be small (0.001 – 0.02 mg/day). 
Reduction Efficiency:	This action is expected to be highly effective, as it requires implementation of a system specifically designed to control this pathway.
Cost:	The cost creating an ordinance is expected to be under $100,000, although costs to utilities to implement the program will be higher.
Implementing Entity:	Washington Department of Ecology; local governments, utilities, electrical equipment owners
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	A survey of local utilities was conducted as part of Comprehensive Plan development, and found that these utilities have already taken measures to reduce the PCB content in their equipment. This action is therefore considered largely redundant.
Ancillary Benefit:	This control action has the ancillary benefit of replacing older equipment, which is more likely to fail, with newer equipment; potentially reducing the number of spills and improving reliability
Time Frame:	Given the very small magnitude of the source area, this Control Action is not expected to result in noticeable improvements in the next five years.

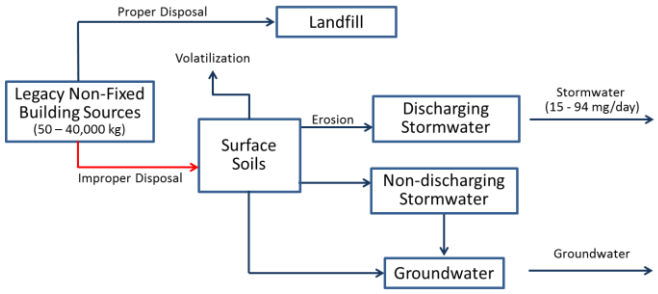
Environmental Monitoring

Description:	This is not technically a control action; rather, it consists of expanded environmental monitoring to identify the significance of uncertain source areas and pathways.
Type:	Institutional -- government practices
Significance of Pathway:	This action affects potentially all pathways.
Reduction Efficiency:	This action in and of itself will not have immediate impacts on PCB loads but will be a step towards better source area identification and targeted Control Action implementation.
Cost:	The cost of individual monitoring projects conducted to date by the Task Force have been small ($100,000) to moderate ($100,000 to $1,000,000).
Implementing Entity:	Spokane River Regional Toxics Task Force, Washington Department of Ecology, other entities
PP Hierarchy:	Depending upon that nature of the monitoring, this action could provide information on Control Actions throughout the entire range of the hierarchy.
Existing Efforts:	While several monitoring programs are currently in place, they are only addressing a small subset of the total number of uncertain source areas and pathways. Future studies would be targeted at investigating different source areas and pathways, such that there should be little overlap between new monitoring and existing monitoring.
Ancillary Benefit:	The ancillary benefit provided by monitoring will depend on the specific nature of the monitoring project, and could vary from negligible to significant. In addition to addressing data gaps needed to employ new control actions, monitoring can assess the effectiveness of individual control actions as well as the cumulative effectiveness of the comprehensive plan.
Time Frame:	This Control Action is not expected to result in noticeable improvements in the next five years.

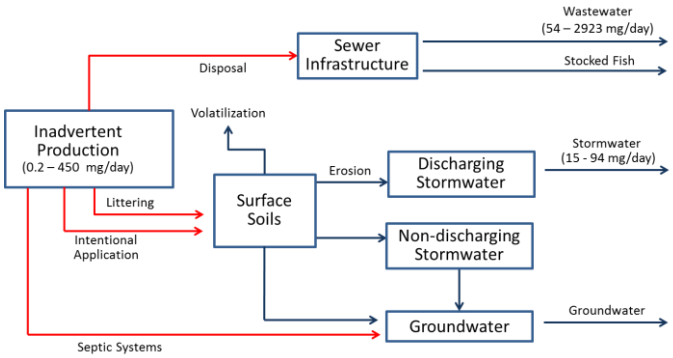
Accelerated Sewer Construction

Description:	This action consists of acceleration of sewer construction to replace septic systems.
Type:	Institutional--government practices
Significance of Pathway:	The source areas that contribute PCBs to septic systems are large. The ultimate delivery of these PCBs to the river and lake, while uncertain, is likely to be small. 
Reduction Efficiency:	This action will be nearly 100% efficient in removing loads from those septic systems that are not connected to a sewer system. Connection to a sewer system will transfer these loads to wastewater treatment plants, which will be effective in removing the PCBs. The PCB removal efficiency of a septic system is unknown, and may be equally effective as centralized wastewater treatment. While septic tank elimination has multiple benefits accelerated sewer construction may not result in the reduction of PCBs to the Spokane River.
Cost:	The cost for sewer construction is expected to be significant (i.e. much higher than the current $1M threshold used for evaluation).
Implementing Entity:	Local municipalities and governments.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	Spokane County has a mandatory septic tank elimination program for septic tanks within the Urban Growth Area (UGA) in areas that have sewer available, requiring connection within a year of notification and enforcement through the Prosecutor's office. There is some overlap between the UGA and the Critical Aquifer Recharge Area (CARA), but still a large amount of area where sewer construction could help eliminate discharge to the CARA.
Ancillary Benefit:	This action will provide significant ancillary benefits, by removing the loading of a wide range of pollutants (e.g. nitrogen) to the aquifer.
Time Frame:	Given the very small magnitude of the source area, this Control Action is not expected to result in noticeable improvements in the next five years.

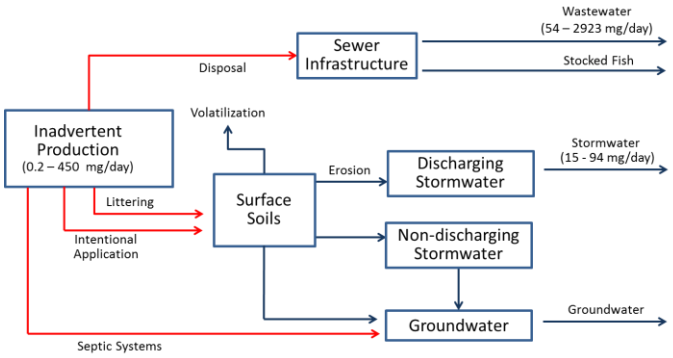
PCB Identification During Inspections

Description:	This action consists of identifying PCB-containing materials as part of other regular inspections (e.g., building permits, IDDE, facility inspections). It involves training inspectors to identify materials and what to do next (safe disposal, encapsulation, etc.).
Type:	Institutional -- government practices
Significance of Pathway:	This control action is targeted towards legacy non-fixed building sources, which have been identified as one of the largest source areas of PCBs with an estimated mass range of 50 to 40,000 kg. Due to the uncertainty in the number of appliances improperly disposed, as well as the ultimate fate of those PCBs, the significance of this pathway is considered unknown. 
Reduction Efficiency:	This action in and of itself will not have immediate impacts on PCB loads but will be a step towards better source area identification and targeted Control Action implementation.
Cost:	San Mateo County (CA) estimated their total cost to add PCB product identification to a regular building inspector's task list to be about $5,500/year (planning was $1500/year and operating expenses were $4,000/year). Operating costs assumes 2 hours training/year plus 8 hours reporting/year per person for 5 people at $80/hr salary. This assumes that planning costs are good for a 10 year period. Based on this example, the cost to implement this control action in Spokane County would be relatively inexpensive, and definitely less than $100,000.
Implementing Entity:	Local governments.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	The Washington Legislature recognized distressed urban waters (including the Spokane River) and created the Urban Waters Initiative (implemented by Ecology) and Local Source Control Program s (implemented by Regional County Health District). These programs regularly inspect hazardous waste generators and the works with local businesses to identify potential problems and provide technical assistance in correcting them.
Ancillary Benefit:	This action provides some ancillary benefit by identifying and helping to correct pollution sources other than PCB control.
Time Frame:	This Control Action is not expected to result in noticeable improvements in the next five years.

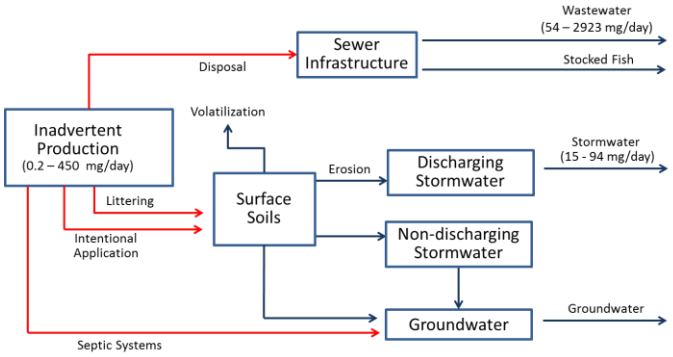
Regulatory Rulemaking

Description:	This action consists of regulatory reform of Federal TSCA and FDA's food packaging regulations (21 CFR 109) to 1) re-visit currently allowed concentration of PCBs in chemical processes; 2) eliminate or reduce the creation of inadvertently generated PCB; and 3) reassess the current use authorizations for PCBs.
Type:	Institutional -- government practices
Significance of Pathway:	This control action is targeted towards legacy sources as well as inadvertently produced PCBs, which are being imported into the watershed at a rate of 0.2 to 450 mg/day. It has the potential to affect the significant delivery pathways of wastewater (54-2923 mg/day) and stormwater (15-94 mg/day) loading, although its exact significance is unknown. 
Reduction Efficiency:	The overall efficiency is of this control action is unknown. Theoretically, it can reduce the contribution of affected inadvertent sources by 100%, if products currently containing PCBs can eliminated. In addition, the definition of PCBs under current use authorizations could be redefined to a number less than 50 ppm, which would help in the management of legacy PCB sources.
Cost:	The costs associated with this control action include costs needed to effectively engage with federal agencies (meetings, white papers, etc.) and costs incurred by the federal agencies to revise the regulations. These costs are unknown but could be substantial.
Implementing Entity:	The regulatory rulemaking will be implemented by Federal governments and agencies (e.g. EPA).
PP Hierarchy:	This control action is high on the Pollution Prevention hierarchy, as it is designed to reduce the creation of inadvertently produced PCBs. Federal rulemaking to reassess the current use authorizations for PCBs is intermediate on the Pollution Prevention hierarchy, as it is designed to manage the use of existing PCBs.
Existing Efforts:	A coalition of conservation groups, tribal organizations, cities, counties, business, industry, regulatory agencies, legislators, academics, Labor, trade organizations and many others have been working to get new rules introduced, but efforts to date have been unsuccessful. EPA currently has two use authorizations rulemakings underway that are relevant to this control action. The FDA does not have a similar rulemaking. However, the FDA rules are extremely old, with standards dating back to the early 1980s.
Ancillary Benefit:	If the FDA standards are revisited, this could potentially result in reducing exposure to PCBs in food sources and also in fish meal used by fish hatcheries.
Time Frame:	Given the time lag between implementing regulations and: 1) exhausting the supplies of previously purchased materials, and 2) having inadvertently produced PCBs make their way through the watershed to the Spokane River, it is not expected that noticeable improvements would be seen within five years.

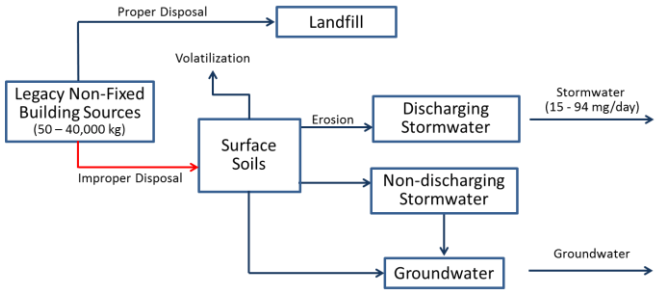
Compliance with PCB Regulations

Description:	This control action consists requiring stricter accountability for compliance with existing rules. Potential activities include enforcement of existing TSCA rules to ensure imported and manufactured products are complying with allowable PCB levels, and enforcement of rules related to oil burning.
Type:	Institutional--government practices
Significance of Pathway:	This control action is targeted towards the source area of inadvertently produced PCBs, which are being imported into the watershed at a rate of 0.2 to 450 mg/day. It has the potential to affect the significant delivery pathways of wastewater (54-2923 mg/day) and stormwater (15-94 mg/day) loading, although its exact significance is unknown. 
Reduction Efficiency:	The overall efficiency is of this control action is unknown, due to uncertainty in the extent to which compliance with regulations currently exists.
Cost:	There is no direct cost to the Task Force associated with regulatory reform, although there are costs associated with attempting to educate legislators on the need for revisions that are likely small (<$100,000) to moderate ($100,000 to $1,000,000). Additional costs for this control action involve expenses associated with compliance and enforcement activities.
Implementing Entity:	Federal government.
PP Hierarchy:	This control action is high on the Pollution Prevention hierarchy, as it is designed to reduce the creation and use of inadvertently produced PCBs.
Existing Efforts:	The Task Force has requested this control action from the USEPA. The request remains relevant.
Ancillary Benefit:	A compliance program signals to producers of products that contain inadvertently produced PCBs (such as pigments) that violation of the TSCA manufacturing and import rules are not acceptable. This has the ancillary benefit of companies self-monitoring their own operations and reducing the overall production of this type of PCB.
Time Frame:	Given the time lag between requiring stricter accountability and: 1) exhausting the supplies of previously purchased materials, and 2) having inadvertently produced PCBs make their way through the watershed to the Spokane River, it is not expected that noticeable improvements would be seen within five years.

Support Green Chemistry Alternatives

Description:	This action consists of working with chemical manufacturers to either develop alternative (non-chlorinated) products or develop products with reduced levels of PCBs. The Task Force could support existing efforts by providing guidance and feedback to Ecology, and reaching out to other parties such as EPA and universities.
Type:	Institutional - government practices
Significance of Pathway:	This control action is targeted towards the source area of inadvertently produced PCBs, which are being imported into the watershed at a rate of 0.2 to 450 mg/day. Although its exact significance is unknown, it has the potential to affect the significant delivery pathways of wastewater (54-2923 mg/day) and stormwater (15-94 mg/day) loading. 
Reduction Efficiency:	The overall efficiency is of this control action is unknown. Theoretically, it can reduce the contribution of affected inadvertent sources by 100%, if products currently containing PCBs can eliminated. For this reason, it is rated as highly suitable in terms of reduction efficiency.
Cost:	There is no direct cost associated with supporting green chemistry alternatives, although there are costs associated with coordination with chemical manufactures that are likely small (<$100,000) to moderate ($100,000 to $1,000,000).
Implementing Entity:	Chemical manufacturers.
PP Hierarchy:	This control action is high on the Pollution Prevention hierarchy, as it is designed to reduce the use of inadvertently produced PCBs.
Existing Efforts:	Ecology provides a range of technical support and expertise to educators looking to incorporate green chemistry into teaching materials, manufacturers looking to understand the potential impacts of the ingredients in their products, and to the general public who want to know which are safer choices for products (such as the "Safer Choice" label). Ecology has partnered with Northwest Green Chemistry on some of these information resources and tools.
Ancillary Benefit:	Green chemistry has many ancillary benefits including the reduction of harm associated with improper disposal. Green chemicals either degrade to innocuous products or are recovered for further use. TSCA regulatory reform will be easier if there are green chemistry alternatives to pigments that have inadvertently generated PCBs.
Time Frame:	Given the time lag between implementing green chemistry practices and: 1) exhausting the supplies of previously purchased materials, and 2) having inadvertently produced PCBs make their way through the watershed to the Spokane River, it is not expected that noticeable improvements would be seen within five years.

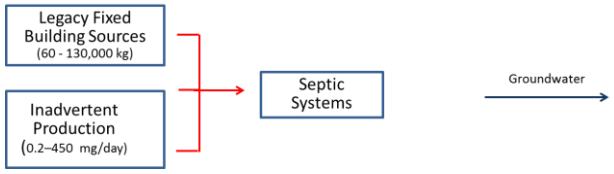
Survey of PCB-containing materials in Schools/Public Buildings

Description:	This action consists of programs designed to survey PCB-containing materials in schools/public buildings and enact a program to dispose of them properly or implement encapsulation.
Type:	Institutional - educational
Significance of Pathway:	This control action is targeted towards legacy non-fixed building sources, which have been identified as one of the largest source areas of PCBs with an estimated mass range of 50 to 40,000 kg. Due to the uncertainty in the number of appliances improperly disposed, as well as the ultimate fate of those PCBs, the significance of this pathway is considered unknown but potentially significant. 
Reduction Efficiency:	This action in and of itself will not have immediate impacts on PCB loads but will be a step towards better source area identification and targeted Control Action implementation.
Cost:	Ecology (2015) estimated that a state-wide survey of schools for PCB-containing materials would cost $68,198/year for 2 years for a total cost of $136,396. If this effort were scaled down to the Spokane River watershed it would certainly fall in the <$100,000 cost category.
Implementing Entity:	Ecology; Spokane County Regional Health District (and equivalent agencies for Idaho communities)
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	None known.
Ancillary Benefit:	This action is expected to reduce elevated human health exposure to PCBs within the affected schools and public buildings.
Time Frame:	This Control Action is not expected to result in noticeable improvements in the next five years.

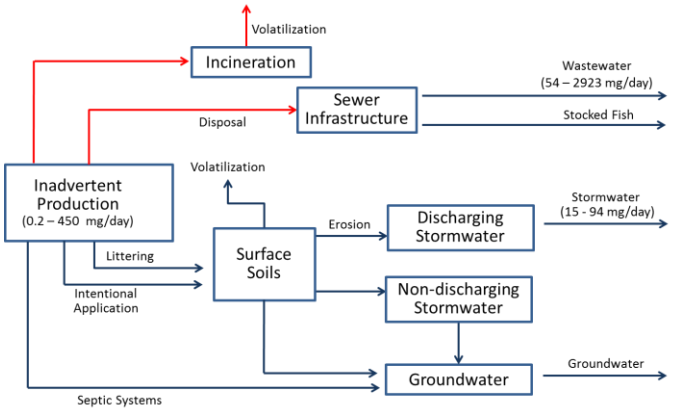
Education/outreach about PCB Sources

Description:	Conduct public education and outreach campaigns to spread information about the potential sources of PCBs, what to do with them if discovered (e.g., avoid pouring paint down the drain), and safer alternatives.
Type:	Institutional--educational
Significance of Pathway:	This action potentially affects a wide range of pathways, although the specific magnitudes to be addressed by education are unknown.
Reduction Efficiency:	This control action's reduction efficiency is likely small though it may prevent some improper disposal of PCBs and also may reduce the amount of PCB-containing products from being purchased in the long term.
Cost:	Based on the Spokane County example (below), education specifically about PCBs would likely be less than $100,000 per year.
Implementing Entity:	Local government, Ecology, or Task Force-led effort
PP Hierarchy:	This control action is intermediate in the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed, but it may also limit the use of inadvertently produced PCBs as well.
Existing Efforts:	Two years ago, Spokane County hired a water resources specialist specifically tasked with developing an education/outreach program to implement the County's NPDES permit-mandated Toxics Management Plan. Approximately 1/3 of that person's time was devoted to those activities, including web site development, preparation of outreach materials (mailers, posters, etc.), participation in the outreach workgroup, and other Water Resource Center programs. Estimated cost per year was about $35,000 including salary and outreach materials/postage. Department of Ecology also has many education efforts that involve PCBs but mainly consist of general information on their website, and not a formal communication plan or materials production. Limited outreach has been conducted in coordination with release of the Chemical Action Plan and the purchasing law.
Ancillary Benefit:	This control action could be a joint effort among Task Force members to education the public/businesses about a range of pollutants and watershed health/protection in general.
Time Frame:	This Control Action is not expected to result in noticeable improvements in the next five years.

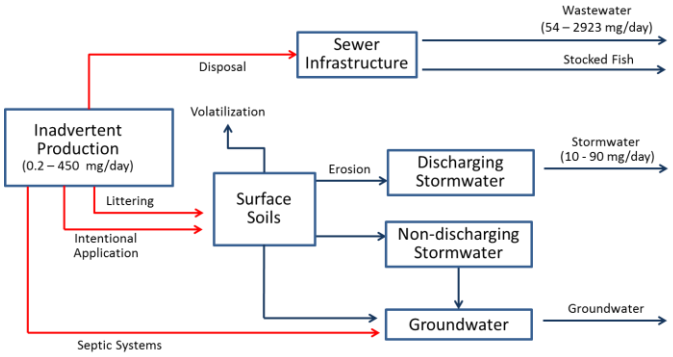
Education about discharge through septic systems

Description:	Educate on-site septic system owners located over the aquifer recharge area on proper disposal of wastes (e.g., not "down the drain") and on the environmental and functional benefits of regular tank pumping
Type:	Institutional - educational
Significance of Pathway:	The source areas that contribute PCBs to septic systems are large. The ultimate delivery of these PCBs to the river and lake, while uncertain, is likely to be small. 
Reduction Efficiency:	The reduction efficiency associated with this control action is currently unknown.
Cost:	It is expected that the cost of this activity will be less than $100,000.
Implementing Entity:	Local governments.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	This Control Action does not overlap with any other existing efforts.
Ancillary Benefit:	This Control Action could provide ancillary benefit by limiting the extent that other undesirable material are disposed through septic systems.
Time Frame:	Given the likely small magnitude of the delivery pathway, this Control Action is not expected to result in noticeable improvements in the next five years.

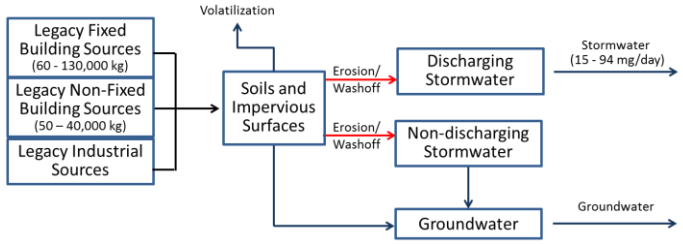
Education About Filtering of Post-Consumer Paper Products

Description:	Conduct public education and outreach campaigns to inform the public about separating recycling materials that are paper w/yellow inks/pigments into the garbage stream rather than recycle bin (educational sticker on bins).
Type:	Institutional - educational
Significance of Pathway:	This control action is targeted towards the source area of inadvertently produced PCBs, which are being imported into the watershed at a rate of 0.2 to 450 mg/day. It has the potential to affect the significant delivery pathways of wastewater (54-2923 mg/day) and stormwater (15-94 mg/day) loading, although its contribution to these pathways is unknown. Conversely, it has the potential to re-route PCBs to the atmosphere as these products are incinerated. 
Reduction Efficiency:	The reduction efficiency associated with this control action is currently unknown.
Cost:	It is expected that the cost of this activity will be less than $100,000.
Implementing Entity:	Local governments.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	This Control Action does not overlap with any other existing efforts.
Ancillary Benefit:	None known.
Time Frame:	This Control Action is not expected to result in noticeable improvements in the next five years.

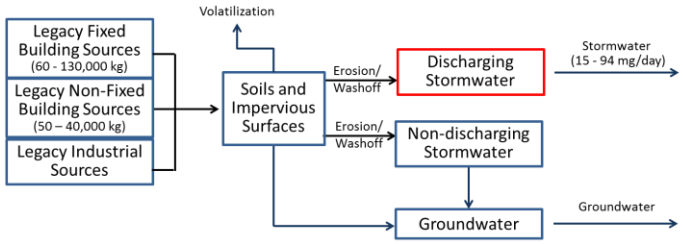
PCB Product Testing

Description:	This Control Action consists of further study of the extent to which commercial products contain inadvertently produced PCBs, as well as creation of a database to store the collected information. It could also include public education on products containing PCBs.
Type:	Institutional--education
Significance of Pathway:	This control action is targeted towards the source area of inadvertently produced PCBs, which are being imported into the watershed at a rate of 0.2 to 450 mg/day. It has the potential to affect the significant delivery pathways of wastewater (54-2923 mg/day) and stormwater (15-94 mg/day) loading, although its exact significance is unknown. 
Reduction Efficiency:	This action in and of itself will not have immediate impacts on PCB loads but will be a step towards better source area identification and targeted Control Action implementation.
Cost:	The cost of this action will depend on the number of materials evaluated. It is reasonable to assume that sampling of a diverse range of materials, in conjunction with creation of a data base, will be intermediate (i.e. between $100,000 and $1,000,000) in cost.
Implementing Entity:	This action could be implemented by a range of entities, including Washington Department of Ecology, local governments, or the Spokane River Regional Toxics Task Force.
PP Hierarchy:	This control action in high on the Pollution Prevention hierarchy, as it is designed to reduce the use of inadvertently produced PCBs.
Existing Efforts:	Initial efforts in measuring PCB content of commercial products have been conducted by Ecology and the City of Spokane, although these studies have only evaluated a subset of the thousands of products potentially of concern.
Ancillary Benefit:	This action provides some ancillary benefit by supporting Ecology's Toxic Threats reduction activities.
Time Frame:	Given the time lag between understanding existing PCB content and: 1) exhausting the supplies of previously purchased materials, and 2) having inadvertently produced PCBs make their way through the watershed to the Spokane River, it is not expected that noticeable improvements would be seen within five years.

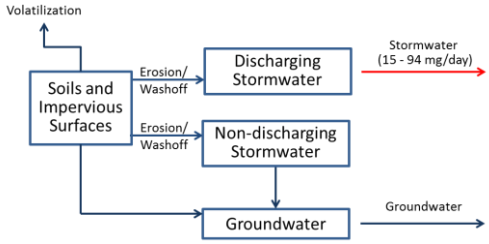
Stormwater Treatment - Pipe Entrance

Description:	This sub-category of control actions is designed to capture/treat stormwater onsite before it enters storm pipes, and can consist of: infiltration control actions such as trenches, basins, dry wells; bioretention control actions such as swales and buffer strips; filters; screens; wet vault; and hydrodynamic separator.
Type:	Stormwater Treatment - Pipe Entrance
Significance of Pathway:	This control action is targeted towards PCB contamination in stormwater. The primary mechanism delivering this source area to the river is discharging stormwater, which totals 15 to 94 mg/day and is considered a significant contributor. 
Reduction Efficiency:	Infiltration control actions can have very high removal of TSS which should be correlated to PCB load reduction. Tetra Tech (2010) reported 60-100% removal of TSS in various infiltration control actions in the Boston area. Washington State Department of Transportation (2008) also indicated high removal efficiency potential of infiltration control actions for both TSS and organic contaminants. Ecology (2007) reported 64% removal efficiency for TSS in filter strips, 71% for porous pavement, 51% for vegetated swales, and 85% for infiltration basins.
Cost:	Costs vary across specific Control Actions, but can generally be expected to be significant (i.e. >$1,000,000) for any widespread application.
Implementing Entity:	Local municipalities.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	The primary mechanism delivering this source area to the river is discharging stormwater, which comes mostly from the City of Spokane. The City is developing control actions for PCBs as part of their Integrated Clean Water Plan, and is in a better position to evaluate this action than the Task Force. It may be beneficial for other communities with stormwater discharges, although the size of their service area is relatively small.
Ancillary Benefit:	This Control Action will reduce the loading of other pollutants associated with stormwater, such as nutrients.
Time Frame:	Depending upon the nature of the controls implemented, noticeable improvements could be expected within two to five years.

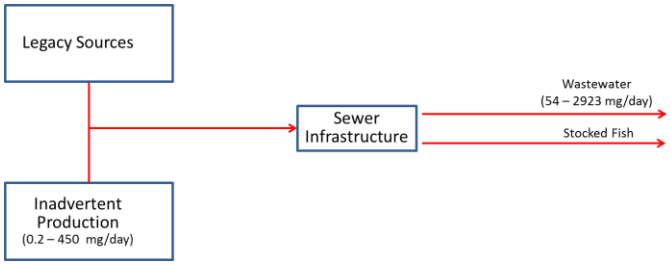
Stormwater Treatment – Pipe System

Description:	This sub-category of control actions is installed in the MS4 infrastructure (e.g., pipes, storm drain inlets). These actions usually have higher maintenance requirements (compared to other stormwater control actions) and can sometimes impede flow when not maintained properly. Options include: 1) Screens that trap contaminated solids and larger debris to prevent discharge of that material to receiving waterbodies; 2) Filters or "socks", like screens, that trap contaminated solids and prevent discharge of that material to receiving waterbodies; 3) Wet vaults, consisting of a permanent pool of water in a vault that rises and falls with storms and has a constricted opening to let runoff out. Its main treatment mechanism is settling of solids that are contaminated; and 4) Hydrodynamic separators that use cyclonic separation to trap solids and debris as stormwater flows through them before being discharged to receiving waterbodies
Type:	Stormwater Treatment - Pipe System
Significance of Pathway:	This control action is targeted towards PCB contamination in stormwater. The primary mechanism delivering this source area to the river is discharging stormwater, which totals 15 to 94 mg/day and is considered a significant contributor. 
Reduction Efficiency:	Infiltration control actions can have very high removal of TSS which can be correlated to PCB load reduction. Washington State Department of Transportation (2008) indicated high removal efficiency potential of wet ponds for both TSS and organic contaminants. Ecology (2007) reported 12% removal efficiency for TSS in centrifugal separators and 34% for filters.
Cost:	Costs vary across specific Control Actions, but can generally be expected to be significant (i.e. $1,000,000 for any widespread application.
Implementing Entity:	Local municipalities.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	The primary mechanism delivering this source area to the river is discharging stormwater, which comes mostly from the City of Spokane. The City is developing control actions for PCBs as part of their Integrated Clean Water Plan, and is in a better position to evaluate this action than the Task Force. It may be beneficial for other communities with stormwater discharges, although the size of their service area is relatively small.
Ancillary Benefit:	This Control Action will reduce the loading of other sediment-bound pollutants associated with stormwater, such as nutrients.
Time Frame:	Depending upon the nature of the controls implemented, noticeable improvements could be expected within two to five years.

Stormwater Treatment - End of Pipe

Description:	This sub-category of control actions is installed at the end of the MS4 infrastructure. Options include: 1) Constructed wetlands, 2) Sedimentation basins, 3) Discharge to ground/dry well, 4) Diversion to treatment plant, and 5) Fungi (mycoremedation) or biochar incorporated into stormwater treatment.
Type:	Stormwater Treatment – End of Pipe
Significance of Pathway:	This control action is targeted towards PCB contamination in stormwater. The primary mechanism delivering this source area to the river is discharging stormwater, which totals 15 to 94 mg/day and is considered a significant contributor. 
Reduction Efficiency:	Infiltration control actions can have very high removal of TSS which can be correlated to PCB load reduction. Washington State Department of Transportation (2008) indicated high removal efficiency potential of stormwater wetlands for both TSS and organic contaminants. Detention basins had high removal efficiency for TSS and medium removal efficiency for organic contaminants. Tetra Tech (2010) reported TSS removal efficiency of 30-85% for wet ponds and 20-50% for dry ponds in the Boston Area. Ecology (2007) reported 72% removal efficiency for TSS in constructed wetlands and 25-69% for dry ponds (higher efficiency for vegetated ponds).
Cost:	Costs vary across specific Control Actions, but can generally be expected to be significant (i.e. $1,000,000 for any widespread application.
Implementing Entity:	The primary mechanism delivering this source area to the river is discharging stormwater, which comes mostly from the City of Spokane. The City is developing control actions for PCBs as part of their Integrated Clean Water Plan, and is in a better position to evaluate this action than the Task Force. It may be beneficial for other communities with stormwater discharges, although the size of their service area is relatively small.
PP Hierarchy:	This control action is lowest on the Pollution Prevention hierarchy, as it is designed to treat PCBs immediately before they are being discharged to the system.
Existing Efforts:	The primary mechanism delivering this source area to the river is discharging stormwater, which comes mostly from the City of Spokane. The City is developing control actions for PCBs as part of their Integrated Clean Water Plan, and is in a better position to evaluate this action than the Task Force. It may be beneficial for other communities with stormwater discharges, although the size of their service area is relatively small.
Ancillary Benefit:	This Control Action will reduce the loading of other pollutants associated with stormwater, such as nutrients.
Time Frame:	Depending upon the nature of the controls implemented, noticeable improvements could be expected within two to five years.

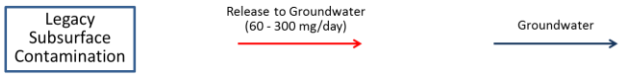
Wastewater Treatment

Description:	This sub-category of control actions correspond to reducing pollutant loading from wastewater treatment plans. Options include: 1) Development of a Toxics Management Action Plan, 2) Implementation of a source tracking program, 3) Chemical fingerprinting or pattern analysis, 4) Remediation and/or mitigation of individual sources, 5) Elimination of PCB-containing equipment, 6) Public outreach and communications, 7) Review of procurement ordinances, 8) Pretreatment regulations.
Type:	Waste water Treatment – End of Pipe
Significance of Pathway:	This control action is targeted towards PCB contamination in wastewater, which delivers a total load of 54 to 2923 mg/day and is considered a significant contributor. 
Reduction Efficiency:	Wastewater treatment has the potential to achieve high rates of PCB removal.
Cost:	Costs vary across specific Control Actions, but can generally be expected to be significant (i.e. $1,000,000 for any widespread application.
Implementing Entity:	NPDES permits are written by Ecology and EPA, while controls are implemented by municipalities and industries with NPDES permits.
PP Hierarchy:	This control action is lowest on the Pollution Prevention hierarchy, as it is designed to treat PCBs immediately before they are being discharged to the system.
Existing Efforts:	These actions are currently included as requirement in existing NPDES permits. These permits will continue to dictate wastewater treatment requirements, not the Comprehensive Plan
Ancillary Benefit:	This Control Action will reduce the loading of other pollutants associated with wastewater, such as nutrients.
Time Frame:	Depending upon the nature of the controls implemented, noticeable improvements could be expected within two to five years.

Contaminated Site Identification

Description:	This control action consists of the identification of contaminated sites that could be contributing PCBs to the Spokane River.
Type:	Contaminated Sites
Significance of Pathway:	This control action is targeted towards contaminated sites beyond those that are currently being remediated. The PCB loading from these sources is unknown, although the mass balance assessment conducted by the Task Force indicates that they could potentially be a significant contributor.
Reduction Efficiency:	This action does not reduce pollutant loads, but can contribute to future load reduction by identifying sites that contribute PCB loads that can be addressed by remediation.
Cost:	Costs will depend upon the amount of additional data collected to support investigations, but should generally be less than $100,000.
Implementing Entity:	Ecology, Task Force.
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	Ecology (2015) performed preliminary research to review existing groundwater and soil data to identify contaminated sites and evaluate their current status, and rated sites in terms of their potential for contributing PCBs to the river.
Ancillary Benefit:	Cleanup of contaminated PCB sites can provide moderate ancillary benefits, as other pollutants often co-occur with PCB contamination.
Time Frame:	This action will not directly result in load reductions, but could serve to identify additional candidate sites for the subsequent Control Action of Contaminated Site Remediation.

Contaminated Site Remediation

Description:	This control action consists of the cleanup of contaminated sites.
Type:	Contaminated Sites
Reduction Efficiency:	Cleanup activities are able to achieve a high degree of pollutant load reduction.
Significance of Pathway:	This control action is targeted towards contaminated sites, which are currently estimated to deliver a total load of 60 - 300 mg/day and is considered a significant contributor. 
Cost:	Costs vary across specific Control Actions, but can generally be expected to be significant (i.e. $1,000,000 for any widespread application.
Implementing Entity:	Ecology, identified responsible parties
PP Hierarchy:	This control action is intermediate on the Pollution Prevention hierarchy, as it is designed to manage PCBs that are currently in place in the watershed.
Existing Efforts:	Cleanup efforts are in place at known contaminated sites. These efforts include assessment of the effectiveness of prior remediation actions (e.g. Upriver Dam and Donkey Island, City Parcel, and General Electric) sites and ongoing remediation at the Kaiser site.
Ancillary Benefit:	Cleanup of contaminated PCB sites can provide moderate ancillary benefits, as other pollutants often co-occur with PCB contamination.
Time Frame:	The time frame by which noticeable improvements could be observed is currently unknown.