2014 Annual Report

June, 2014

Adaptive Management Plan for Reducing PCBs in Stormwater Discharges

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2014 Annual Report

ADAPTIVE MANAGEMENT PLAN FOR REDUCING PCBS IN STORMWATER DISCHARGES

INTRODUCTION

Polychlorinated biphenyls (PCBs) are manmade compounds that have been identified ubiquitously throughout the environment. PCBs were sold under the trade name of "Aroclor" and were typically used in transformer fluids, adhesives, cements, additives, lubricants and fire retardants until manufacturing of PCBs was banned in the US in 1977. However, they persist in the environment and bio-accumulate in aquatic ecosystems as concentrations accumulate in organisms through the food chain. Although manufacturing of PCBs was banned in the 1970's, new sources of PCB contamination still exist in the environment. PCBs can be produced inadvertently in manufacturing processes that involve hydrocarbons, chlorine and heat such as pigments, printing inks, agricultural chemicals, plastics and detergent bars. Recycling facilities may process PCB contaminated materials such as paper products and asphalt roofing. Materials containing less than 50 parts per million (ppm) are not regulated under the Toxics Substances Control Act (TSCA) and are not considered "PCB-contaminated" (40 CFR 761.3). For comparison, current EPA human health surface water quality standards for PCBs is 170 picograms per liter, equivalent to 0.00000017 ppm (National Toxics Rule, 40 CFR 131.36). The Spokane Tribe adopted a water quality standard of 1.3 picograms per liter (0.0000000013 ppm) due to higher fish consumption rates used to derive the standard.

One pathway for PCBs to enter surface water bodies is through stormwater. Runoff from precipitation may collect pollutants along roadways, parking lots and other contributing areas, enter storm drains, and then discharge to water bodies with little pre-treatment. In addition to a separate storm sewer system, the City of Spokane also has a combined sanitary and storm sewer where stormwater and sewage are combined in the same pipes. When storm events exceed the capacity of the combined sewer system, it overflows and discharges into the Spokane River in what is called a Combined Sewer Overflow (CSO). The Spokane River courses through the City of Spokane, with nearly 100 stormwater and CSO outfalls along the 18 mile reach.

To assess concentration of PCBs in some common stormwater contaminants, samples of off-the-shelf motor oil, transmission fluid, and shredded tire scraps were sent for laboratory analysis in 2011. Table 1 shows results of this informal investigation. The shredded tire sample could not produce a definitive result due to sample matrix interference.

Table 1. Oil and Transmission Fluid Sample PCB Concentrations

Sample	Total PCB, micrograms per kilogram (ppb) (EPA Method 1668)
Pennzoil SAE5W-30	37.8
Quaker State SAE5W-30	14
Valvoline Mercon V	49.5
Red Line D4 Automatic Transmission Fluid	8.8
Valvoline Full Synthetic 5W-30	116

STUDY AREA

The Spokane River begins at the outlet of Lake Coeur d'Alene in north Idaho, about 12 miles east of the Washington-Idaho border. Its basin encompasses more than 6,000 square miles. The River flows through the Cities of Coeur d'Alene, Post Falls, Liberty Lake, Spokane Valley, and urban areas of Spokane County before flowing through the City of Spokane. Downstream of the City of Spokane is Long Lake and the Spokane Indian Reservation before the Spokane River discharges to the Columbia River. Mean monthly flow rates in the river, as measured at the USGS Spokane River at Spokane gage, range from 1,700 cubic feet per second (cfs) in August to 17,700 cfs in May with a median peak spring flow of 25,000 cfs (USGS, 2012). Much of the Spokane region upstream of Long Lake is situated over the Spokane Valley Rathdrum Prairie (SVRP) Aquifer, a sole-source aquifer contributing drinking water to nearly half a million people. The Spokane River and SVRP Aquifer are an intimately linked water resource. Figure 1 shows the Spokane River basin and SVRP aquifer.

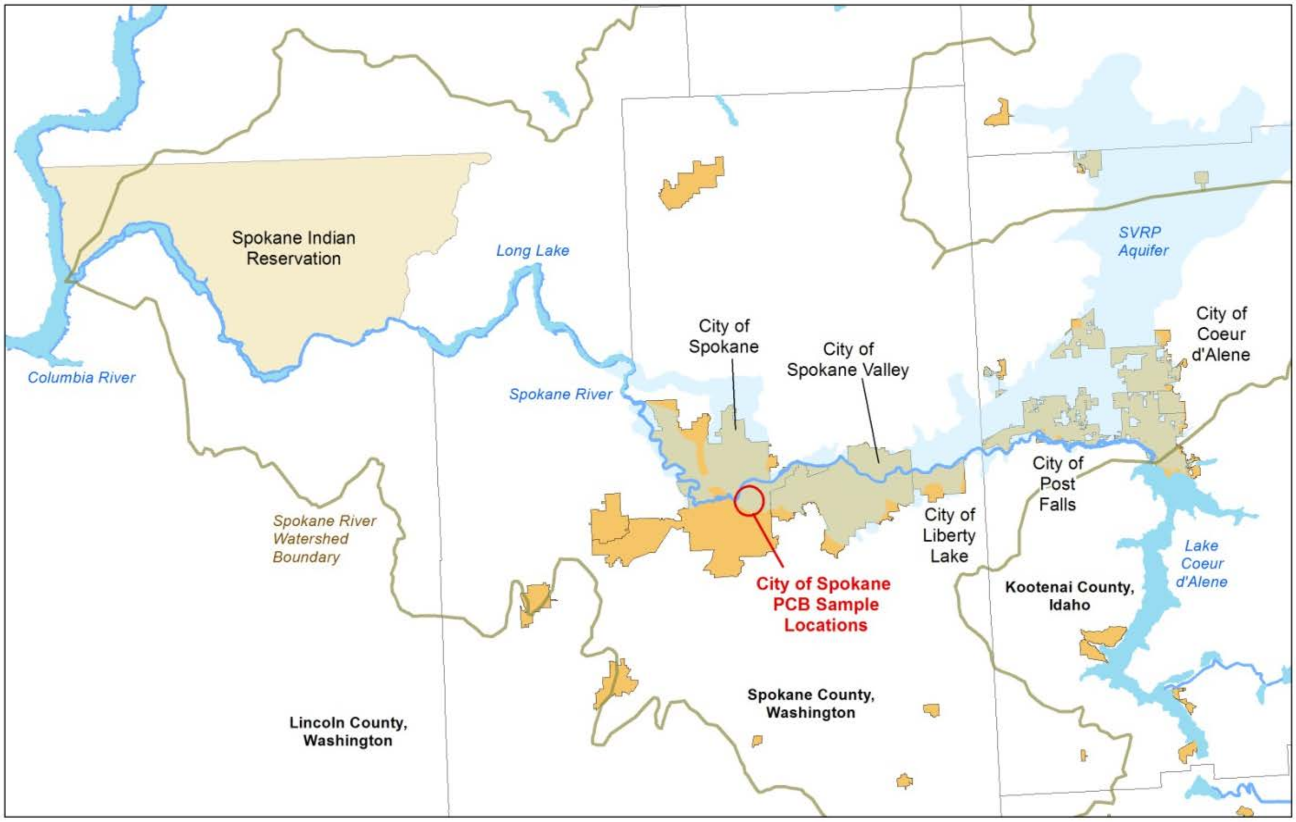

Figure 1. Spokane River Vicinity Map

BACKGROUND: PCBS AND THE SPOKANE RIVER

Several segments of the Spokane River violate water quality standards for the presence of PCBs and have been placed on the state Water Quality Assessments (303(d)) list of impaired water bodies. In 2007, the Washington State Department of Ecology (Ecology) published the "Spokane River PCB TMDL Stormwater Loading Analysis" (Parsons, 2007). In 2011, Ecology published the "Spokane River PCB Source Assessment, 2003-2007," originally as a draft PCB Total Maximum Daily Load (TMDL) (Ecology, 2011 A). However, rather than develop a PCB TMDL, Ecology elected to pursue an innovative straight-to-implementation strategy. The intent is to more directly approach PCB loading to the Spokane River instead of spending a decade or more establishing a TMDL and wasteload allocations before taking any actions to solve the problem. NPDES permits issued to waste discharge facilities in 2011, including the City of Spokane, require the formation of a regional task force and establishment of performance-based PCB limits within the first permit cycle. Thus, the Spokane River Regional Toxics Task Force was officially formed in early 2012. The City of Spokane is a Task Force member, addressing both wastewater and stormwater discharges.

REGULATORY REQUIREMENTS

In the 2007 and 2011 reports, Ecology concluded that there were significant concentrations of PCBs in both stormwater and CSO discharges and that PCBs in these systems needed to be reduced in order to meet both the State of Washington's and Spokane Tribe's water quality standards. The City of Spokane is subject to the regulatory requirements imposed by the NPDES Municipal Stormwater Permit. Specifically, section S.4, entitled "Compliance with Standards" allows permittees to follow an adaptive management plan compliance pathway when there is evidence that stormwater discharges may be causing or contributing to a violation of water quality standards. The City's adaptive management plan is intended to address this compliance pathway, and is also designed to reduce PCBs in stormwater that enters the combined sewer system as well as to support compliance with the NPDES Wastewater Permit that governs discharges from the Riverside Park Water Reclamation Facility and CSO outfalls. The City negotiated the Adaptive Management Plan with the Spokane Riverkeeper, Center for Justice and Gonzaga University Law School Environmental Law Clinic as a part of a Consent Decree resolving a Notice of Intent to Sue served on the City pursuant to the Clean Water Act. The Adaptive Management Plan's core goals and principles were based on these organizations' proactive interest in addressing PCBs in the City's stormwater discharges.

ADAPTIVE MANAGEMENT

The goal of the adaptive management plan is to reduce PCBs in stormwater through three main strategies: (1) to further analyze and interpret existing PCB data; (2) to identify likely sources of PCBs and prioritize the design and implementation of appropriate remedial actions and BMPs; and (3) to develop and design an adaptive approach for additional data collection and remedial action to further reduce PCBs in the Spokane River.

Phase I of the Adaptive Management Plan focuses on remedial maintenance, sampling, and analysis of existing information. Work began in 2010. Priority areas of investigation were selected where the highest PCB concentrations have been found in previous studies and where land use practices are likely to contribute elevated levels of PCBs. The Union stormwater basin, a separated stormwater basin covered by the NPDES Municipal Stormwater Permit, was selected for this purpose. For the CSO discharges covered under the NPDES Wastewater Permit, the portion of the CSO 34 basin located in the heavy industrial zone was selected. In 2011, remedial maintenance and sampling shifted south (upstream) in the CSO 34 basin, where light industrial and other mixed land uses are found. Because fewer PCBs were found in this area, sampling was again focused on the heavy industrial zones and Union basin in 2012 and 2013. Figure 2 shows the location of sampling activities. The following sections highlight the elements of the adaptive management plan.

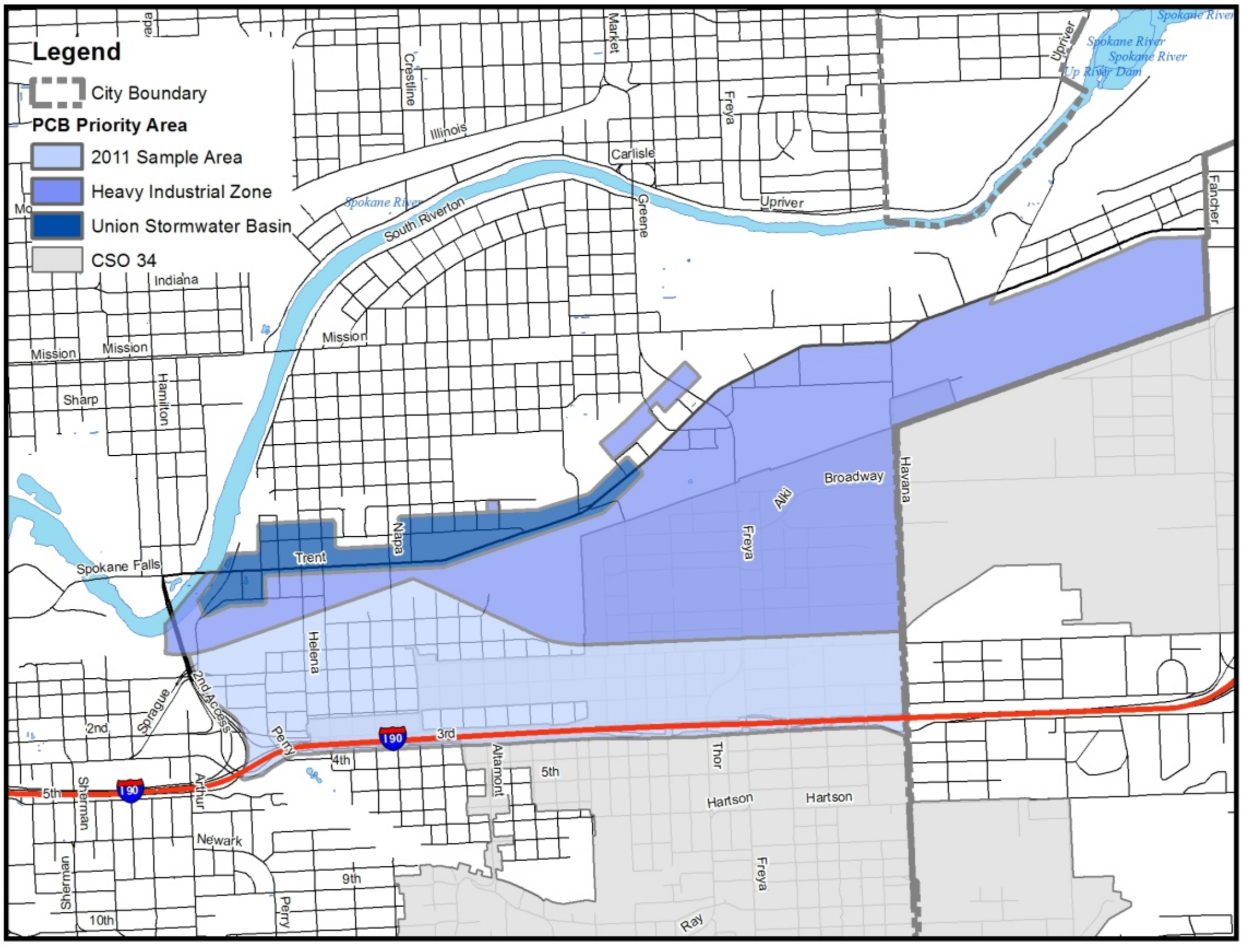

Figure 2. Priority Areas of Investigation

Research and Reconnaissance

Windshield Evaluations

Properties located within the 2010 priority sample areas were visually inspected to determine potential sources of PCBs to stormwater. Information gathered during evaluations included pictures of the site, type of business, paved or unpaved driving surfaces, stormwater flow direction and downstream inlets (if any), potential for sediment tracking onto City right of way, and potential current and past potential sources of PCBs.

For a site to contribute PCB to catch basins, stormwater may either flow off the property into City right of way, or soil could be tracked off the property into City right of way, where stormwater could then wash it into catch basins. Sediments are more likely to be contaminated with PCBs where past land uses and business operations have been associated with PCBs, such as handling transformers, paints and coatings, electrical transmission and distribution, industrial machinery, scrap yards, wood treatment, rail yards, used oil spread for dust control, and many other heavy industrial operations.

It is the City's policy that private properties contain all stormwater generated on site. In general, stormwater from most properties observed in the windshield survey did not flow onto City right of way except for on small portions of the property such as approaches that are sloped downhill toward the street. Several of the sites are not fully paved and allow minor sediment tracking into the right of way. A network of railroad properties crosses this heavy industrial area and there are several automotive repair and storage areas. However, the stormwater inspectors who performed the windshield evaluations did not detect any significant locations where high PCB loads are likely contributing to the storm sewer system. Rather, it is more likely a patchwork of smaller sources as well as widespread, low-level contamination from historic land uses.

Known Contaminated Site Research

Several properties in the vicinity are known to be contaminated with PCBs and other toxics of concern. Databases were queried to identify suspected and confirmed contaminated site locations, such as Ecology's Integrated Site Information System (ISIS) and Facility/Site Database. Maps showing these locations in the vicinity of the project area are shown in Appendix A (Ecology, 2011 B). PCB cleanup site locations relative to the City's catch basin sampling locations are shown in Figures 4, 5, and 6. Note that the Ecology PCB cleanup sites are located in areas containing the highest catch basin sediment PCB concentrations.

Catch Basin Sediment Sampling

Because PCBs in stormwater are typically adsorbed to sediments, sediments were removed from stormwater catch basins and sampled for PCBs. Data from these locations are useful in measuring how much PCBs are removed from the system and may also be useful in tracing on-going sources of PCB to the stormwater catch basins. In collaboration with Ecology's Urban Waters Initiative, standard operating procedures were developed and staff was provided with extensive training prior to sampling.

Prior to sampling, standing water in each catch basin was removed. Four sediment samples were collected from random locations in each catch basin and mixed thoroughly using a stainless steel spoon and bowl. A one-liter laboratory prepared jar was filled with the sample, then stored in a cooler on ice (between 0 and 6 degrees Celsius). After all catch basins in the group were sampled, the contents of each sample were added to a stainless steel bowl and homogenized with a stainless steel spoon. Three laboratory-prepared jars were filled with the homogenized sample and stored in a cooler on ice. Two jars were sent for laboratory analysis and one was kept in case of future need, stored in a freezer. Samples were allowed ½ inch headspace to allow for expansion. Equipment was carefully decontaminated before and after each sample to prevent inadvertent mixing and contamination. After sampling, equipment was decontaminated, rinsed with laboratory grade acetone, and wrapped with aluminum foil, shiny side out.

Sample Quality Control

The detection limits necessary for this analysis are approaching the limits of current technology. For each set of samples, the laboratory analyzes a blank sample by running clean water through the laboratory equipment. These blank samples quantify PCBs introduced to the sample from laboratory equipment, which can affect sample analysis in this ultra-low detection method. Flags were noted in the catch basin sample data where an individual congener had less than five times the concentration detected in the blank sample. These congeners were subtracted from the total PCB concentration to come up with the reported values.

Remedial Maintenance

After sampling, remedial maintenance was performed on each catch basin. Before the large volume of catch basin sediments could be handled and disposed, samples were first sent to the laboratory for preliminary Aroclor analysis, with a detection limit of 0.1 milligrams per kilogram (mg/kg) per EPA Method 8082. None of the samples exceeded Ecology's residential cleanup standard of 1.0 mg/kg, so sediments were approved for disposal at the City's North Side Landfill. Remedial maintenance was then performed by pumping out sediments from each catch basin using vactor trucks for disposal at the landfill. The catch basins were then cleaned to prevent any residual PCB contamination from being detected in future catch basin samples.

Urban Waters Coordination

The City has worked in coordination with Ecology's Urban Waters Program staff to identify likely sources of PCBs in the priority areas of investigation. The most recent information published by Urban Waters can be found in the report, "Spokane River Urban Waters Source Investigation and Data Analysis Progress Report (2009-2011)" (Ecology, 2012). Specifically, the "PCB Section" discusses related investigations in the Union Basin and CSO 34.

SUMMARY OF CATCH BASIN SAMPLING ACTIVITIES AND RESULTS (2010-2012)

Composite Samples

In 2010, all 432 catch basins located in the Union Basin and Heavy Industrial CSO 34 priority areas were sampled followed by remedial maintenance to remove all sediments. Due to lab analysis costs and quantity of samples, the sample area was broken into 41 groups, each having an average of about 10 catch basins. In 2011, sampling and remedial maintenance was performed upstream in the CSO 34 basin. The area is zoned light industrial, commercial, and residential. A total of 333 catch basins were sampled, divided into 35 groups for composite sampling. Sample group locations are shown in Figure 3. 2010 sample groups are shown in green and 2011 in purple. Groups are delineated by basin type, including CSO, drywell, and separated stormwater.

Samples from all catch basins in each group were composited. After initial Aroclor analysis was performed to determine remedial maintenance measures, samples were sent to Pacific Rim Laboratories for congener analysis using EPA Method 1668. This method allows for detailed analysis of 209 PCB congeners to a detection limit of 0.003 micrograms per kilogram (ug/kg), or parts per billion.

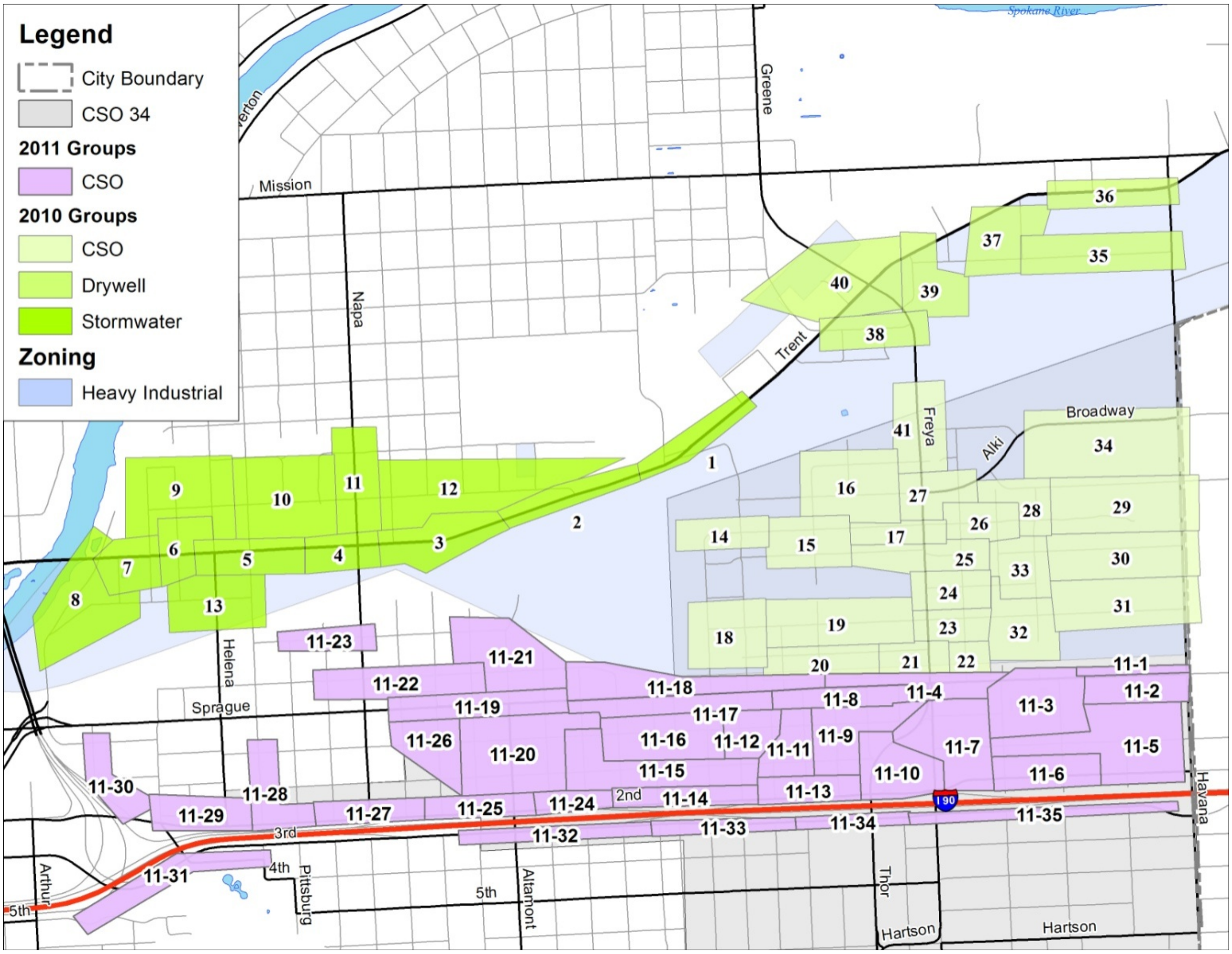

Figure 3. Group Composite Sample Locations

None of the sample detections in the Aroclor analysis exceeded the 1 mg/kg threshold, so all catch basin sediments were disposed at the North Side Landfill. Results from the 2010 and 2011 composite sampling are shown in Figure 4. To compare known sources of PCB contamination, Ecology PCB cleanup sites are also shown in Figure 4.

Nearly 280,000 pounds of sediment were removed from catch basins in 2010. Based on the congener analysis, a total of about 26 grams of PCBs were removed from the system and prevented from entering the Spokane River or aquifer. About 268,000 pounds of sediment were removed from the 2011 composite group sampled catch basins. The total mass of PCBs in these sediments was about 3.7 grams. Because a similar volume of sediment was removed in 2011 and 2010, it can be inferred that PCB sources are fewer in the 2011 sample area.

Individual Catch Basin Sediment Samples

In addition to composite sediment sampling in 2011, sediment samples were collected from individual basins from the highest concentration 2010 groups located in the separate stormwater or CSO areas. Analysis results showed that PCB concentrations were detected in the individually-sampled catch basins, within the range of concentrations observed the previous year (see Figure 4). Therefore, there is some form of a continual source of PCBs to catch basin sediments in these areas.

2012 Catch Basin Sampling

2012 sampling focused on the higher PCB concentration areas in the 2010 sample groups (the Union Basin and heavy industrial CSO 34) to determine if there are ongoing PCB sources. Where each catch basin within the group designation had enough sediment to sample, a composite sample was collected and analyzed for PCB Aroclors and congeners, followed by remedial maintenance. Sampling was intended to match previous group or individual samples for a more direct comparison of PCB sources from year to year.

Results of 2012 catch basin sediment sampling are shown in Figure 5. The composite sample PCB concentrations decreased slightly. However, PCBs were still present in all locations. This suggests that remedial maintenance may be reducing PCB concentrations; however, there is an ongoing and diffuse source of PCBs. Comparisons in catch basins sampled more than once are shown in the following tables.

About 39,600 pounds of sediment were removed from the 2012 sampled catch basins. The total mass of PCBs in these sediments was about 2.7 grams.

Table 2. Group Composite Sample Comparisons (2010 and 2012)

Group Number	2010 Concentration (ug/kg)	2012 Concentration (ug/kg)	% Reduction
Group 1-C	754.0	464.0	38%
Group 2-C	296.0	126.0	57%
Group 8-C	115.0	87.9	24%
Group 11-C	179.0	74.0	59%
Group 12-C	731.0	612.0	16%

Table 3. Individual Sample Comparisons (2011 and 2012)

Group Number	2011 Concentration (ug/kg)	2012 Concentration (ug/kg)	% Reduction
Group 13-id-3	1185.0	767.0	35%
Group 13-id-4	279.0	120.0	57%
Group 13-id-11	5.0	5.6	-12%
Group 24-id-10	103.0	69.4	33%
Group 24-id-11	121.0	95.1	21%
Group 25-id-1	115.0	93.9	18%

NOTES:
C = COMPOSITE SAMPLE;
ID = INDIVIDUAL SAMPLE;
UG/KG = MICROGRAMS PER KILOGRAM (PARTS PER BILLION)

Confirmation Sample

To date, all of the catch basin sediment samples have been collected in the Union Basin, heavy industrial zone, or the CSO 34 basin. To confirm that the PCB concentration in these samples are greater than typical catch basin sediment concentrations in other areas of the city, a catch basin was selected for PCB sampling in north Spokane. The selected catch basin was chosen in a residential area where the catch basin cleaning schedule was consistent with the previous 2010 PCB catch basin cleaning. The catch basin chosen for this confirmation sample is located at the intersection of Garland and Normandie. The PCB concentration was 13.1 ug/kg, which is lower than the majority of the PCB concentrations in the priority area of investigation.

Source Investigations

Individual catch basin sediment sampling in 2012 identified select catch basins that had relatively high PCB concentrations compared to others. On April 25, 2013, staff from the City of Spokane, Spokane Riverkeeper, and Urban Waters conducted a site visit in the Union Basin. The goal of the site visit was to identify potential sources of PCBs to catch basins, particularly those with the highest concentrations. No obvious sources could be identified. It was observed that the historic industrial land use and associated legacy sources are ubiquitous in the area.

The highest catch basin sediment concentration observed in 2012 was in Group 6 at the northeast corner of Hogan and Trent. Sample 6-id-5 had a concentration of 1551 ug/kg PCBs. The contributing area to this catch basin is the east half of Hogan north of Trent. An adjacent vacant field east of Hogan was also identified as a potential source of runoff to the catch basin. Soil samples were collected on the east side of the sidewalk and in the crack between the road and the sidewalk by Urban Waters and split samples were collected by the City of Spokane and analyzed using EPA Method 8082. All three of the City's samples were non-detect, indicating that the adjacent field is not a likely source of PCBs. Ecology used a lower detection limit for EPA Method 8082, and were able to detect PCBs in the samples. However, the results were in the low-part per billion range (ug/kg), confirming that this location is likely not a substantial source of PCBs to the catch basin at Hogan and Trent. No obvious sources are apparent in this location. It is possible that an intermittent or mobile source contributed to the high PCB concentration.

City Parcel PCB Cleanup Site

The City Parcel PCB Cleanup Site was formerly owned by Spokane Transformer, whose transformer repair and recycling activities contaminated site soils with PCBs. In 2008, remediation was performed at the site, removing soils with greater than 10 mg/kg PCBs. This is the equivalent of 10,000 parts per billion. Although remedial actions were performed on the City Parcel property, relatively high PCB concentrations were detected in the catch basins receiving stormwater from the vicinity of the site. The basin immediately downstream of the site is a drywell with an overflow structure that connects to the storm sewer system, which had a PCB sediment concentration of 3,285 ppb. The City inserted a plug into the overflow pipe, effectively disconnecting the City Parcel site's stormwater from directly entering the storm sewer system. However, soils from the site and vicinity may migrate to the storm sewer system through wind-blown and track-off mechanisms.

The City Parcel cleanup focused on soils within the property boundaries and did not extend into adjacent properties or right-of-way. Confirmation samples collected during cleanup activities were greater than 1 mg/kg (1,000 ppb) on the north and west sides of the property adjacent to City right-of-way, indicating that the PCB contamination may have extended beyond the property boundaries. Ecology is planning to conduct additional sampling in summer 2014 to identify the extent of contamination beyond the City Parcel property.

Storm Sewer Construction Materials Investigation

The City of Tacoma has tracked PCBs in its storm sewer system leading to the Thea Foss Waterway using sediment traps (Tacoma, 2014). The City thoroughly cleaned the entire storm sewer system in this area to remove legacy contamination; however, after the cleaning, PCBs were still detected. After further investigation, a high source of PCB, up to 260 ppm, was detected in crack sealant used in a 1970's construction project.

In June 2010, the City of Spokane evaluated the storm sewer system in the Union Basin for the presence of PCB-containing materials and legacy contamination in the pipes. The area of focus was the storm sewer system downgradient of the City Parcel site, along Springfield Avenue from Cook Street to Crestline Street (1,100 feet of pipe) plus the pipes connecting to catch basins in the three intersections. First, a pig was pulled through the storm sewer pipes, but this smeared sediments all over the pipes. To remedy this, crews used a hydrovac to clean all of the pipes in the Union Basin. A TV camera was then used to verify the pipes were cleaned. There was no visual presence of sediment or products such as the crack sealer that was found in Tacoma. The City of Spokane has not installed sealant between the road asphalt and concrete curb in this area. Similar to Tacoma's results, PCBs were still detected in sediments and stormwater after the pipes were thoroughly cleaned.

As part of the PCB product sampling project discussed below, the City plans to sample PVC pipe, cured-in-place pipe liner, short line pipe repair material, asphalt sealer, and crack sealer for the presence of PCBs.

STORMWATER SAMPLING

Stormwater sampling began in fall 2012. Samples were initially collected in the Union stormwater basin, a municipal separate storm sewer (MS4) basin. Automatic flow-weighted composite samplers and flow monitors were installed in two locations within the Union stormwater basin as shown in Figure 5. Stormwater sampling may provide data that can be used to estimate PCB loadings from basins as well as track the stormwater PCB concentration over time.

The City, in coordination with Ecology's Urban Waters Initiative, developed a monitoring and sampling plan for stormwater sampling. The City's stormwater sampling equipment near the Union Basin outfall was installed in the same location where Urban Waters has been collecting stormwater samples. Therefore, the City's sampling data can be more closely correlated to data collected by Urban Waters. The upstream stormwater sampling equipment was installed near the intersection of Lee and Springfield. This is just downstream of a former PCB Cleanup Site known as City Parcel (formerly owned by Spokane Transformer). The catch basin closest to the City Parcel site had a relatively high PCB concentration during 2010 catch basin sediment sampling, so the Wastewater Management Department disconnected it to prevent contaminated stormwater and sediment from reaching the river. The stormwater sampler is intended to verify if this remedial action was successful.

Additional automatic flow-weighted composite stormwater sampling equipment was subsequently installed in two more MS4 basins in the City and two CSO basins. The Cochran stormwater basin encompasses about 5,300 acres of the north side of the City of Spokane and provides a good representative stormwater sample for the City. The Washington stormwater basin is located north of downtown and is located in a more urban area. Sampling equipment was also installed just downstream of the CSO 34 regulator in spring 2013 and at the CSO 06 regulator in fall 2013. Stormwater basins and sample locations are shown in Figure 6.

Sample Quality Control

For each set of samples, the laboratory analyzes a blank sample by running clean water through the laboratory equipment to detect PCBs introduced to the sample from the equipment and/or laboratory setting. Flags were noted in the stormwater sample data where an individual congener had less than 10 times (10x) the concentration detected in the blank sample. These congeners were subtracted from the total PCB concentration to come up with the reported values.

A blank correction of 10x was used for stormwater analysis to match the quality control procedures outlined in the QAPP for the City's wastewater PCB sampling. As the Spokane region has increased its PCB sampling efforts, different entities have developed their own quality control procedures, using blank correction values ranging from zero (no correction) to 10x. The Spokane River Regional Toxics Task Force (SRRTTF) is developing a QAPP for regional sample efforts, with a draft correction value of 3x. One goal of the SRRTTF is to standardize PCB sampling and quality control procedures. When the SRRTTF has finalized this protocol, the City will adjust its blank correction procedures accordingly. It is not anticipated that the reported values will change substantially because most of the blank samples have had relatively low contamination. Reported stormwater concentrations with a blank correction of 10x are approximately 5% lower on average than uncorrected values (ranging from no change to as much as 30% lower).

Results

PCB samples have been collected in each of the stormwater and CSO sample locations and analyzed using EPA Method 1668. Stormwater and CSO PCB sample results are shown in Table 4 and graphically in Figure 7.

Ecology's Urban Waters staff sampled stormwater near the Union basin outfall from 2009 to 2011. Samples were collected in the same location as the City's Trent & Erie samples. Results showing Ecology and City of Spokane samples chronologically are shown in Table 5. Ecology collected grab samples and the City collected composite samples, so they are not directly comparable. However, the trend shows a decreasing PCB concentration after the City plugged the connection to the Lee and Springfield drywell and initiated remedial maintenance in the Union basin in fall 2010 and again in fall 2012. The relatively high PCB concentration in September 2010 may have been caused by residual material moving through the system from remedial maintenance in the dry summer months. Also, early September is generally a 'first-flush' type of storm in the Spokane area, where late summer is typically very dry. Less than one tenth of an inch of rain fell on September 9, 2010, preceded by only one minor rain event in August and two in July.

The Liberty Lake Source Trace Study (Ecology, 2010) sampled PCBs in stormwater. The intent of the study was to identify "urban background" concentrations where there is no known point source of PCBs. Stormwater concentrations ranged from about 458 to 8,415 pg/l (parts per quadrillion, ppq). The City's PCB stormwater samples from the Cochran and Washington stormwater basins generally fall within this range (Figure 7). This indicates that there may not be significant individual PCB point sources in these basins, and that the PCB concentrations are likely coming from a plethora of nonpoint sources.

PCB concentrations in CSO 34 are somewhat elevated as compared to the Liberty Lake study, Cochran and Washington stormwater basins. CSO samples contain wastewater in addition to stormwater, so the potential PCB sources are somewhat different. CSO 34 is part of the priority study area, and has heavy industrial land use at the northern end. CSO 06 had only slightly elevated PCB concentrations as compared to Liberty Lake, Cochran, and Washington stormwater basins. CSO 06 is located in a residential area of the City.

As expected, PCB concentrations are elevated from the Liberty Lake "urban background" in the Union Basin, and are highest at the Lee and Springfield sampler next to the City Parcel PCB cleanup site. While direct drainage from the City Parcel site is prevented from entering this stormwater basin, surface soils still contain PCBs. There is the potential for wind-blown dust from this site to enter the storm system.

Correlation to Other Factors

A number of factors were plotted against PCB concentration in order to assess correlations, including total suspended solids (TSS), total storm precipitation, storm intensity, and runoff volume. It was assumed that a correlation between PCB concentration and TSS would be observed because PCBs tend to adsorb to fine particulates. However, there was no strong correlation between the two parameters. There was also no discernible correlation to total precipitation or rainfall intensity. PCB concentrations tended to decrease with higher runoff volumes. This is expected due to dilution of a finite amount of PCBs in the system.

When PCBs were simply plotted on a time scale with climate data, patterns emerged (Figures 8 and 9). Seasonal patterns are evident, with peaks in fall and spring. The fall 'first flush' storm has a relatively higher PCB concentration as PCBs accumulate over the dry summer months. Concentrations decrease through the fall when storms are frequent. A temperature inversion occurred in January, trapping wood smoke near the ground surface that may have contributed to PCB accumulations. The highest PCB concentrations were observed after periods of high winds. April 2013 was the windiest month since February 1999. Subsequently, each of the five locations sampled in May 2013 had markedly elevated PCB concentrations. In August 2013, a large dust storm blew over the region from the Columbia Basin. The CSO 34 sample collected just days later had the highest PCB concentrations collected from that basin.

In water year 2014 (beginning October 1, 2013), a similar pattern appears to be emerging in the Cochran Basin and nearby CSO 06. Concentrations are highest at the onset of fall rain, decreasing through the fall and winter, and again increasing after a dry, windy spring.

PATTERN TRACING

PCB molecules, or congeners, can have between one and ten chlorine atoms each. Homologues are a set of congeners with the same number of chlorine atoms. *Mono*chlorobiphenyls (monoCBs) are PCBs with one chlorine, *di*chlorobiphenyls (diCBs) are PCBs with two chlorines, and so on. Homologue patterns can be useful in tracing PCB sources or differentiating separate PCB sources because they identify different mixes of PCB congeners in a sample.

Homologue patterns for catch basin sediment samples and stormwater samples are shown in Appendix B. Composite samples from 2010 and 2011 were not analyzed due to the homogenous nature of the samples. For comparison to known PCB sources, homologue patterns for the sampled oils and hydraulic fluids are shown on page B-11. Patterns for standard Aroclor mixes are shown on page B-12.

Oils and fluids were tested off the shelf, and are primarily composed of the lower-chlorinated monoCB, diCB, and triCBs. These lighter PCBs are more susceptible to evaporation and less likely to be present in sediment samples that have been sitting at the bottom of a catch basin for one or two years.

Results

Patterns are fairly consistent through most of the catch basin sediment and stormwater samples. They most closely represent the pattern for Aroclor 1260, although there tends to be a greater percentage of lower-chlorinated congeners in most of the sediment and stormwater samples. Aroclor 1260 was commonly used in transformers, hydraulic fluids, synthetic resins, and dedusting agents.

Sample "Retest 07" on page B-7 is from the catch basin immediately downstream of the City Parcel PCB cleanup site (formerly Spokane Transformer) in Group 12. The pattern very closely mimics the pattern of Aroclor 1260. Similarly, the Lee & Springfield stormwater samples (page B-2) have a very similar pattern to Aroclor 1260 as did the 2012 Group 12 composite sample (page B-10).

The 2012 Group 4 sample number 4-9 had an unusually high percentage of the "lighter" or lower-chlorinated congeners when compared to the other samples, especially monochlorobiphenyl (page B-7). However, the total concentration was relatively low at 111 ug/kg. It is located underneath a railroad bridge on Trent Avenue.

2012 Group 6 sample number 6-5 and its duplicate also had a relatively high percentage of the "lighter" congeners and was dominated by pentachlorobiphenyl (page B-8). It is located on the northeast corner of Hogan and Trent, and had the highest individual catch basin PCB concentration in 2012 of 1,551 ug/kg. The pattern is similar to Aroclor 1254, which was one of the most widely used Aroclors, and can be found in transformers, caulks, hydraulic fluids, rubbers, adhesives, inks, and cutting oils among other products.

While pattern tracing can give hints toward identifying varying PCB sources, it should be noted that this method is only approximate. The mix of PCB congeners in a compound changes over time and is altered through the environment as certain fractions adsorb to soils, are carried away in stormwater, or evaporate.

PRODUCT SAMPLING

The City of Spokane received a Grant of Regional or Statewide Significance from Ecology to sample municipal products that may come into contact with stormwater for PCBs. The analysis and homologue patterning may further assist in tracing true sources of PCBs to stormwater. Sampling is scheduled to begin in summer 2014, and will include products such as:

- Yellow and white traffic paint
- Hydrant paint
- Utility locate paint
- Dust suppressant
- Deicer
- Pesticides
- Motor oil
- Various engine oils
- Diesel and gasoline
- Asphalt sealers
- PVC pipe and pipe liners

In all, about 40 product samples will be collected and analyzed per EPA Method 1668. The full set of congeners will be analyzed to determine which congeners and/or patterns can be associated with stormwater samples. The final report will be completed by February 2015.

UNION BASIN MITIGATION

Due to the ubiquitous nature of PCB sources to stormwater, the preferred mechanism for preventing PCBs from entering the Spokane River is to disconnect the stormwater basin from its outfall. The Union Basin is relatively small, and is located in an area with good infiltration, presenting an opportunity for infiltration Best Management Practices (BMPs).

The San Francisco Estuary Institute developed a BMP Toolbox for reducing PCBs in municipal stormwater (SFEI 2010). BMPs such as vegetated swales and bioretention facilities were listed as applicable BMPs for controlling runoff from impervious surfaces.

With a grant from the Department of Ecology, the City is currently designing a system of infiltration BMPs in the Union Basin. The preliminary design consists of bio-infiltration facilities (swales) and tree box filters, a form of bioretenion. These BMPs are designed to treat and infiltrate stormwater, capturing PCBs in the treatment media and allowing the stormwater to infiltrate to the subsurface. The outfall will be disconnected, preventing untreated stormwater from entering the river.

SUPPLEMENTAL ENVIRONMENTAL PROJECTS

In addition to the Adaptive Management Plan, five supplemental environmental projects were agreed to as part of the Consent Decree.

Supplemental Environmental Project I: Low Impact Development

In the Consent Decree, the City agreed to develop a Low Impact Development (LID) ordinance. "Low Impact Development," also referred to as "green infrastructure," involves stormwater management and land development strategies that use natural or man-made features to filter and retain stormwater before it reaches the City's separate storm sewer or combined storm and sanitary sewer systems. The City of Spokane convened an LID Main Committee and Subcommittee to coordinate and develop the City's LID efforts. The committees are composed of staff from Planning, Engineering Services, Capital Programs, Wastewater Management, Legal, Communications, Parks, and the environmental community.

Public Education Campaign

A public education campaign was launched to help inform the general public about low impact development opportunities. Initial campaign materials included a utility bill insert, informational brochure, and web page. The materials were made available to the public in spring 2012 through utility bill inserts, the Engineering Services brochure kiosk, in permit information packets, and online. A PDF copy of the brochure and website materials can be viewed at www.spokanewastewater.org/LID.aspx .

Preparation of Ordinance

Originally, the Subcommittee planned to identify LID techniques appropriate for the City of Spokane and develop a draft ordinance based on these findings. However, Spokane County was awarded a grant from the Department of Ecology to produce an Eastern Washington Low Impact Development Guidance Manual. The City of Spokane joined the associated Stakeholder Advisory Group in addition to several other Eastern Washington Phase II jurisdictions.

Technical standards and guidance for using LID principles and best management practices has been developed under the Eastern Washington Low Impact Development Guidance Manual process. The City of Spokane's ordinance was developed in conjunction with the guidance manual, but as a separate process without involvement from other Phase II jurisdictions. The final guidance manual and training materials are published on the Washington Stormwater Center's website:
http://www.wastormwatercenter.org/ew-lid-guidance-manual/

The City's ordinance process involved the formation of an internal Technical Advisory Committee with representatives from each pertinent City department and an external Stakeholders Group to facilitate input from the development community, utilities, the environmental community, consultants, professionals, landowners, residents, and other interested parties. These groups worked on the development of incentives for LID implementation, drafting ordinance language, and providing input on the Eastern Washington LID Guidance Manual.

The ordinance includes provisions for stormwater fee discounts, allowance for the use of pervious concrete on sidewalks, encouragement to use LID in street layout design, and adoption of the Eastern Washington LID Guidance Manual as an optional reference for guidance on the design of stormwater facilities. The ordinance was unanimously passed by City Council on August 26, 2013 and became effective October 1, 2013. The full ordinance (ORD C35021) can be downloaded at https://static.spokanecity.org/documents/publicworks/stormwater/greeninfrastructure/lid-ordinance.pdf or viewed in the Spokane Municipal Code.

Supplemental Environmental Project II: Rose Foundation

The Rose foundation for Communities and the Environment was paid $125,000 by the City of Spokane to fund environmental project activities that improve water quality within the Spokane River Watershed. Payment to the Rose Foundation was made by the City in September, 2011 by City Warrant No. 433577. The Rose Foundation advertised the grant as the "Mike Chappell fund for the Spokane River." Grant proposals to the Rose Foundation were due in April, 2012 and the Rose Foundation announced grant recipients on June 6, 2012. Funded projects include the following:

- Two Spokane River Toxics Cleanup Projects
    - Reduce PCBs and other toxics in the river through public education and building public support for Clean Water Act enforcement and creation of a statewide water quality standard protective of human health
- Spokane River Shoreline Master Program Update Project
    - Protect shoreline habitat and water quality by participating in Shoreline Master Program updates along the Spokane River
- Latah Creek Watershed Restoration Project
    - Restore, enhance, and conserve four miles of riparian zone along Latah Creek
- Industrial Stormwater Dischargers Survey
    - Survey of industrial stormwater dischargers into the Spokane River in Kootenai County and Lake Coeur d'Alene
- Spokane River Watershed Restoration Project
    - Stream bank restoration and planting of 10,000 native trees along Latah Creek
- Spokane River Stormwater Initiative
    - Ensuring stormwater permit compliance and providing educational opportunities for students at Lewis and Clark High School and Gonzaga University

Supplemental Environmental Project III: Storm Drain Marking Program

The City has implemented a storm drain marking program, used as an educational tool to help prevent polluted discharges to the storm sewer system. Three curb markers were developed, one each for the MS4, CSO, and drywell locations as shown below, respectively.

Priority was given to locations with the highest incidence of PCB discharges in stormwater. At the completion of sampling and remedial maintenance for the 2010 and 2011 sample locations, curb markers were placed at each storm inlet. Curb markers inform the public not to dump waste down the drain, and include the City's stormwater hotline phone number for reporting illicit discharges.

Priority areas were identified where the curb markers will have the most benefit. The priority locations for curb marker installations include the following:

- City of Spokane public schools
- Spokane Community College
- Problematic and high risk areas

Wastewater Management staff have completed these areas and continue to install curb markers in coordination with regular maintenance activities. As a voluntary measure, the City has elected to continue the curb marking program and plans to continue curb marking throughout the City. Over 7,000 curb markers have been installed.

Supplemental Environmental Project IV: GIS Layer

Wastewater Management has developed Geospatial Information System (GIS) layers, identifying the location of MS4 features such as pipes, catch basins, and outfalls. A read-only copy of the MS4 GIS layers were provided to the Spokane Riverkeeper in October, 2011. These layers can also be accessed by the public at the Wastewater Management web site as well as Spokane's "City Map" website, www.spokanegis.org/citymap2/.

Supplemental Environmental Project V: Stormwater Educational Guide

Funding was provided to the Spokane River Forum for producing a stormwater educational guide. The guide is intended to inform industry and the public about the effect of pollutants in stormwater on the Spokane River and regulatory requirements for stormwater management. The Spokane River Forum, City of Spokane, and Spokane Riverkeeper worked collaboratively to produce the educational guide. The guide can be obtained at City Hall or digitally on the Spokane River Forum's website, http://www.spokaneriver.net/spokanestormwater/book.swf.

ECOLOGY CONSULTATION; PUBLIC INVOLVEMENT

The Consent Decree requires the City to consult with Ecology in implementing and updating the Adaptive Management Plan. Several instances are noted above in this Annual Report where the City acted in consultation with Ecology staff.

The Consent Decree also requires the City to conduct public involvement when it issues this Annual Report. The 2014 PCB Annual Report will be presented at the July, 2014 Spokane River Regional Toxics Task Force meeting. The task force is composed of staff from Ecology, EPA, IDEQ, local jurisdictions, industries, and environmental entities involved in the identification and reduction of toxics in the Spokane River. Actions taken by the City of Spokane under the PCB Consent Decree are integral to the identification and reduction of PCB sources to the river.

The City will also present this information at StormCon, held in Portland, Oregon in August 2014. StormCon is a national annual stormwater conference that brings together industry experts to present and discuss stormwater program management needs, BMP performance case studies, water quality monitoring, research, technology, and services.

ADDITIONAL RELATED PROJECTS

Integrated Clean Water Plan

The City of Spokane adopted an Integrated Clean Water Plan in May, 2014. The plan details a strategy to manage CSO overflows, reduce stormwater flows to the Spokane River, and improve effluent from the Riverside Park Water Reclamation facility. When prioritizing projects and assessing their effectiveness in removing pollutants from the river, PCBs were a major consideration. Projects selected for optimal PCB removal were:

- Capturing, treating, and infiltrating flow from the Cochran stormwater basin
- Installing control facilities in CSO 34
- Operating membrane filtration technology at the Riverside Park Water Reclamation facility year-round instead of only during the critical season

The Integrated Clean Water Plan can be downloaded from the City's website, https://static.spokanecity.org/documents/publicworks/wastewater/integratedplan/integrated-clean-water-plan-draft.pdf

Toxics Management Plan

The NPDES Waste Discharge Permit for the Riverside Park Water Reclamation Facility (RPWRF) includes provisions for PCB sampling in the City's sewer system and preparation of a Toxics Management Plan (TMP), submitted to Ecology annually by September 15th. The TMP addresses source control and elimination of PCBs from the RPWRF to the Spokane River with the following elements:

- Identifying known and potential sources of PCBs, including industrial and commercial sources, contaminated stormwater, and contaminated soils and sediment.
- Including PCBs as an element of RPWRF's pretreatment program.
- Eliminating active sources of PCBs.
- Changing procurement practices to use PCB-free products over those regulated to only the TSCA threshold.
- Educating the public (individually or collaboratively with other Spokane River dischargers) about the difference between PCB-free products and those which may still contain PCBs below the TSCA threshold.

The City has developed a monitoring program to assess PCB concentrations in the collection system as well as the influent and effluent at the RPWRF. As data is gathered, the City will gain a better understanding of PCB loading to the RPWRF. A public education effort is also underway in coordination with the Spokane River Regional Toxics Task Force to raise awareness of PCBs in the community.

PCB Product Purchasing Ordinance

The City of Spokane passed an ordinance in June 2014 giving preference to products and packaging that do not contain PCBs. The ordinance states that no City department may knowingly purchase products containing PCBs unless it is not cost-effective (increasing the purchase price more than 25%) or feasible to do so. The City may elect to sample products or accept analysis results from suppliers or other outside sources.

The ordinance is similar to a bill recently passed by the Washington State Legislature, SB 6086, Reducing Poloychlorinated Biphenyls in Washington State. The bill became effective June 12, 2014, and gives preference to purchase of products and packaging that does not contain PCBs by Washington state agencies.

The suite of projects identified in this annual report are intended to identify and reduce PCB loading to the Spokane River. The City of Spokane continues to work with regional interests in characterizing and reducing PCBs and other pollutants as collaboration with other entities is a cornerstone of making progress in toxics reductions. Through the work of the City and in partnership with the Spokane River Regional Toxics Task Force and Ecology, these studies and activities are making progress toward reaching water quality standards for PCBs in the Spokane River.

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Table 4
Stormwater PCB Analytical Results

SAMPLE LOCATION	DATE	Hydrology		PCBs (pg/l)
		Volume (gal)	Precip. (in)	
Trent & Erie (Union Basin)	10/29/2012	157,300	0.43	37,093
	11/1/2012	22,300	0.11	43,681
	11/3/2012	73,700	0.24	47,960
	11/8-9/2012	44,900	0.34	17,473
	11/12-13/2012	61,300	0.33	48,438
	3/20/2013	85,560	0.26	19,402
	4/10/2013	8,112	0.07	13,563
	5/13/2013	56,630	0.31	47,455
Lee & Springfield (Union Basin)	10/29/2012	7,100	0.43	35,289
	11/19-20/2012	15,400	1.18	35,141
	3/20/2013	11,489	0.68	66,071
	5/21/2013	1,355	0.25	136,098
	6/19-20/2013	15,308	1.32	82,133
	8/1-2/2013	12,344	1.00	86,373
Cleveland & Nettleton (Cochran Basin)	10/15/2012	3,703,300	0.37	12,444
	10/15/2012 (Dup)	3,703,300	0.37	10,763
	10/25/2012	352,700	0.03	8,415
	11/3/2012	1,868,600	0.20	7,853
	11/8-9/2012	1,683,200	0.17	3,343
	11/12-13/2012	2,941,000	0.27	2,964
	11/19-20/2012	12,857,700	0.95	6,067
	12/4-5/2012	3,641,300	0.23	5,228
	1/8-9/2013	18,282,800	0.09	695
	1/25/2013	12,838,900	0.34	1,858
	2/22/2013	[Instrument Error]	0.18	3,863
	3/6-7/2013	3,279,000	0.25	3,226
	3/20/2013	3,504,100	0.34	5,695
	5/13/2013	1,485,700	0.25	16,288
	5/21-23/2013	1,852,000	0.29	14,592
	6/19-20/2013	17,320,000	1.69	5,557
	11/7/2013	6,037,000	0.67	15,257
	1/8-9/2014	7,060,100	0.53	4,171
	2/11-12/2014	22,144,400	0.20	4,127
	4/17-18/2014	2,643,600	0.52	10,091
Washington St Bridge (Washington Basin)	2/22/2013	260,300	0.18	7,546
	3/6/2013	486,200	0.26	3,113
	4/9/2013	36,017	0.06	3,114
	5/13/2013	213,600	0.27	12,930
	5/13/2013 (Dup)	213,600	0.27	12,473
	5/21/2013	222,600	0.27	12,669
	6/9/2013	2,886,200	1.29	3,385

CSO 34	5/21-23/2013	201,400	0.26	17,164
	6/20/13 (Grab)	[Instrument Error]	1.5	5,742
	6/20-21/13 (Composite)	[Instrument Error]	1.5	8,702
	8/1-2/2013	902,800	0.93	12,134
	9/4/2013	147,500	0.36	23,311
CSO 06	11/7/2013	208,500	0.58	12,680
	1/8-9/2014	266,600	0.44	8,634
	2/11-12/2014	1,392,550	0.21	8,460
	4/24/2014	61,504	0.41	15,862
Equipment Blank	8/24/2012	--	--	168
Trip Blank	3/19/2013	--	--	123
Equipment Blank	3/19/2013	--	--	66

Notes:
pg/l = picograms per liter (parts per quadrillion); gal = gallons; in = inches
Samples analyzed per EPA Method 1668
Blank correction: congeners with 10x laboratory blank detection > sample result not counted in total

Table 5
Union Basin Outfall PCB Analytical Results, Stormwater

SAMPLE ORGANIZATION	DATE	Sample Type	Precipitation (inches)	PCBs (pg/l)
Ecology (UNIONLPT Sample Location)	6/8/2009	Grab	0.29	73,000
	10/2/2009	Grab	0.11	58,200
	2/16/2010	Grab	0.12	460,000
	4/29/2010	Grab	0.48	60,600
	Union Basin Pipe Cleaning and Lee/Springfield Plug Installed June 2010; Remedial Maintenance July-Aug 2010			
	9/9/2010	Grab	0.06	256,000
	1/7/2011	Grab	0.19	55,300
City of Spokane (Trent & Erie Sample Location)	10/29/2012	Composite	0.43	37,346
	Union Basin Remedial Maintenance 10/29/12 to 11/5/12			
	11/1/2012	Composite	0.11	43,841
	11/3/2012	Composite	0.24	47,972
	11/8/2012	Composite	0.34	18,113
	11/12/2012	Composite	0.33	48,862
	3/20/2013	Composite	0.26	19,403
	4/10/2013	Composite	0.07	13,766
	5/13/2013	Composite	0.31	47,455

Notes:

pg/l = picograms per liter (parts per quadrillion)

Samples analyzed per EPA Method 1668

Ecology blank correction: congeners with 5x laboratory blank detection > sample result not counted in total

City Blank correction: congeners with 10x laboratory blank detection > sample result not counted in total

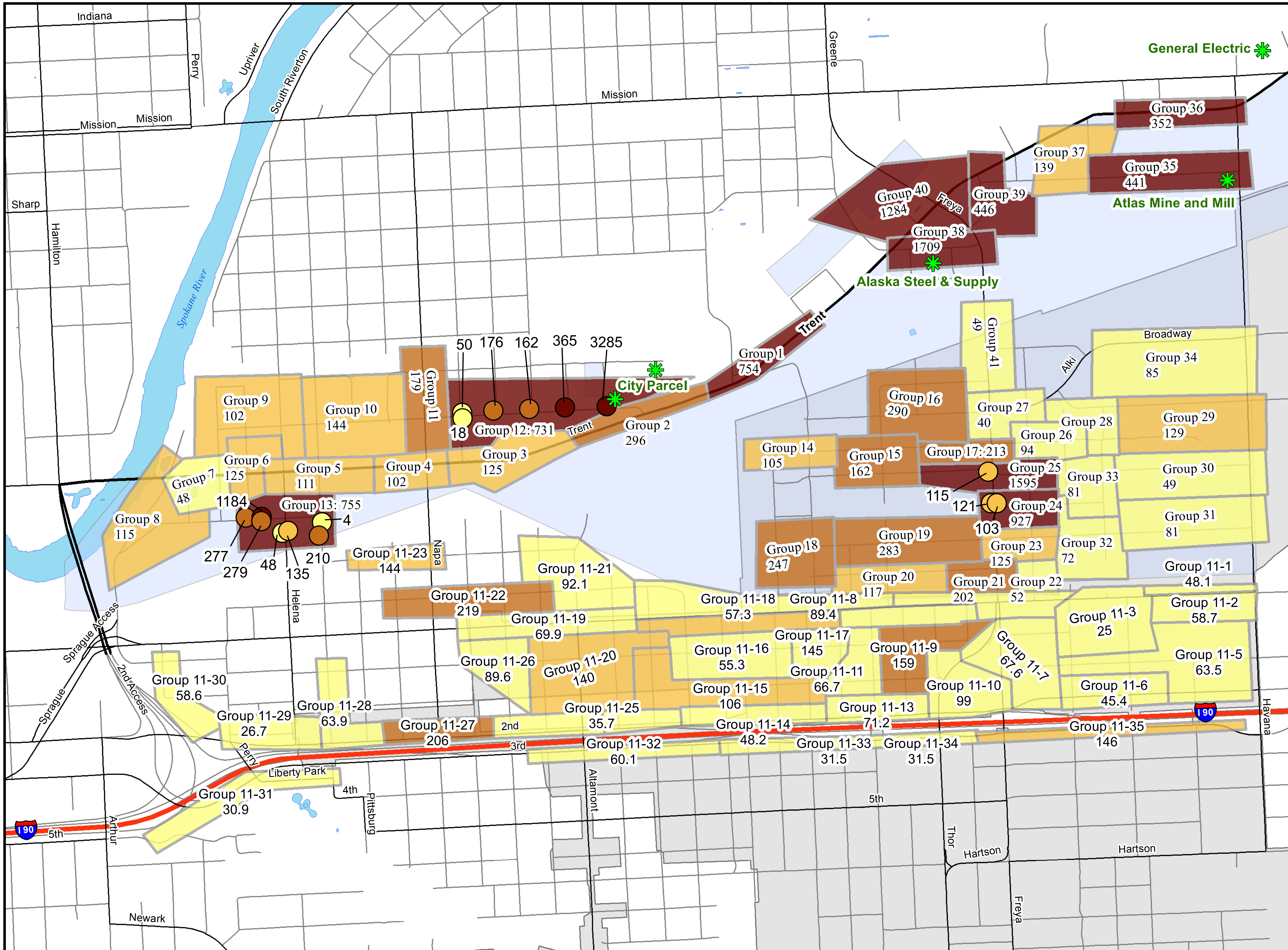

Figure 4
Group Composite and Individual PCB Samples 2010-2011

Congener Analysis (Pacific Rim Lab)

Legend

Ecology PCB Cleanup Sites

PCB Concentration (ug/kg)

- 0 - 100
- 101 - 150
- 151 - 300
- 301 - 1709
- City Boundary

Zoning

Zoning

- Heavy Industrial

Basin Boundary

- CSO 34

Concentrations are in micrograms per kilogram (ug/kg), equivalent to parts per billion (ppb).

0 500 1,000 Feet

N W E S

Geographic Information System

SPOKANE

THIS IS NOT A LEGAL DOCUMENT: The information shown on this map is compiled from various sources and is subject to constant revision. Information shown on this map should not be used to determine the location of facilities in relationship to property lines, section lines, streets, etc.

Map Produced: 6/10/2014 LMS

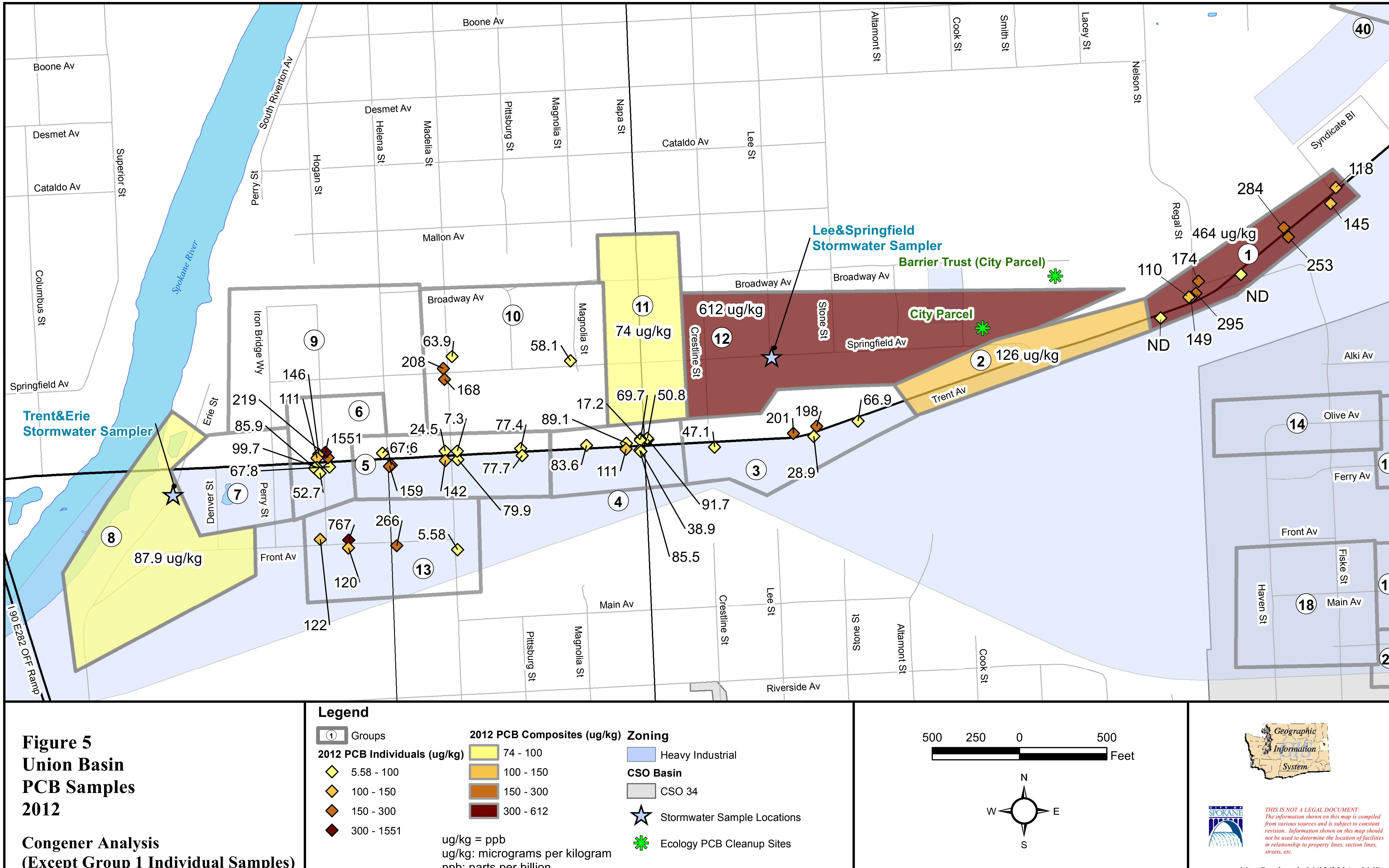

Figure 5
Union Basin
PCB Samples
2012

Congener Analysis
(Except Group 1 Individual Samples)

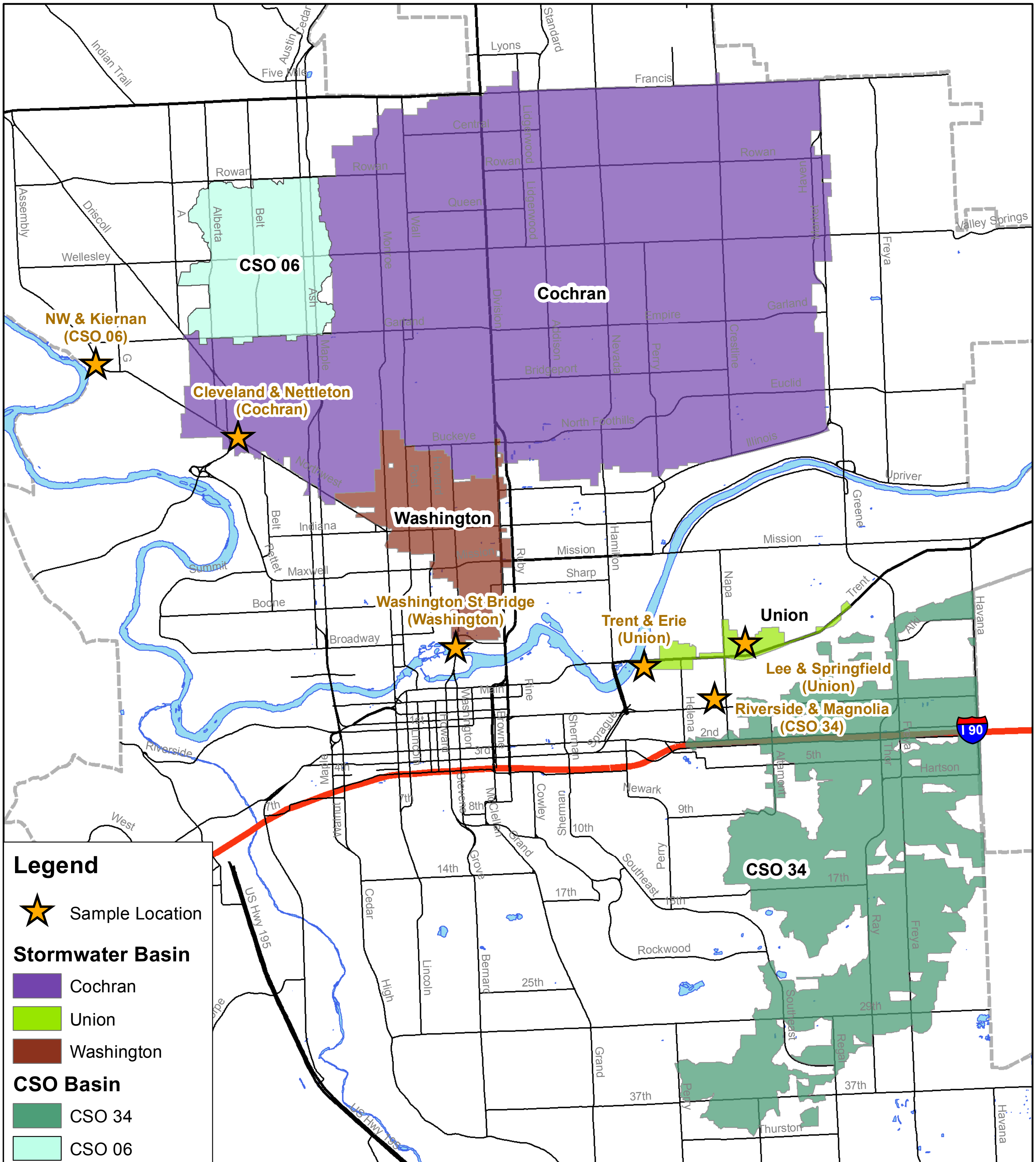

Figure 6
Stormwater/CSO Sample Locations and Drainage Basins

5,000 2,500 0 5,000
Feet

N
W E
S

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City of Spokane Wastewater Management Department LMS 6/17/2014

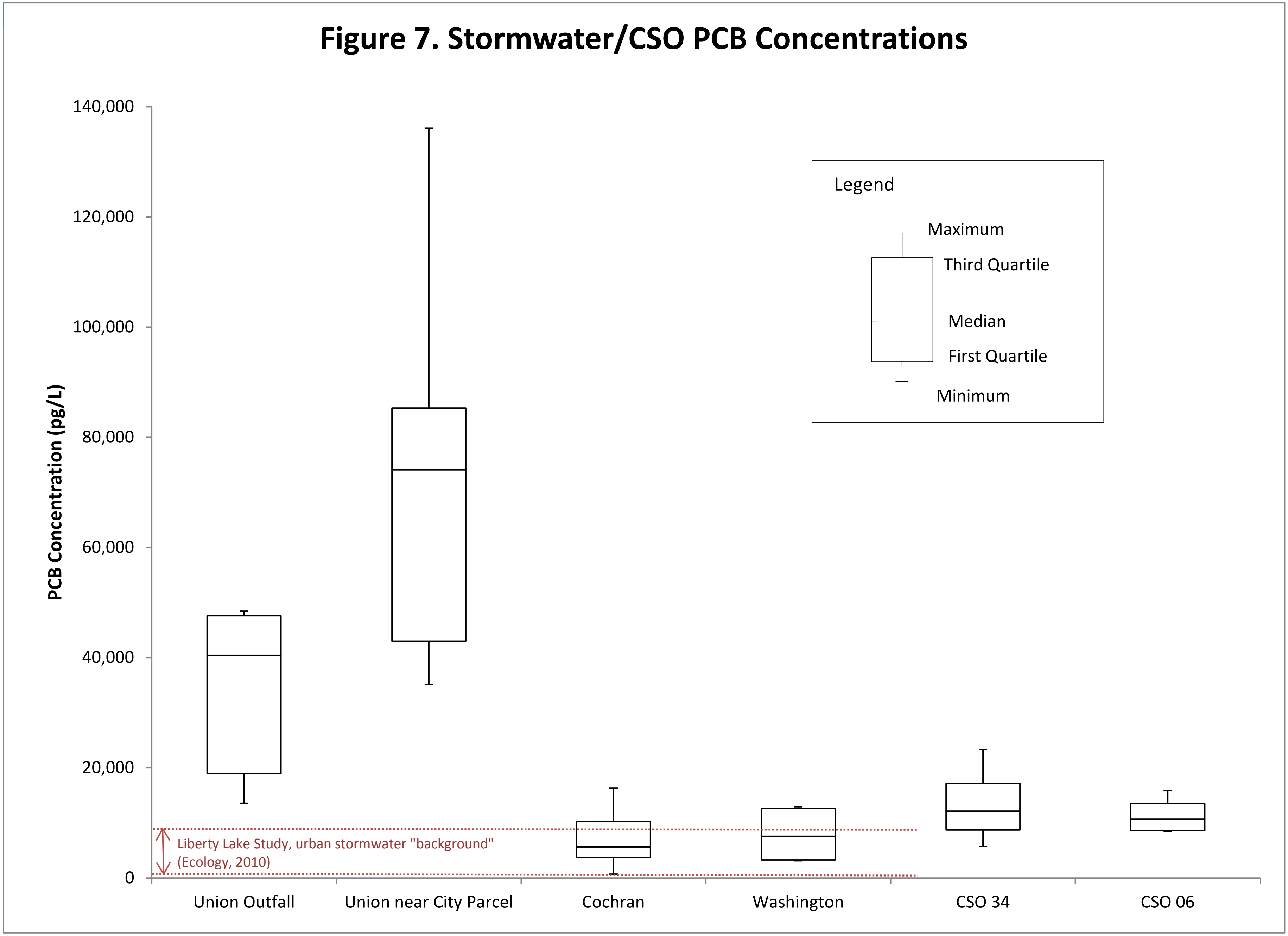


Figure 7. Stormwater/CSO PCB Concentrations
PCB Concentration (pg/L)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Legend
Maximum
Third Quartile
Median
First Quartile
Minimum
Liberty Lake Study, urban stormwater "background"
(Ecology, 2010)
Union Outfall
Union near City Parcel
Cochran
Washington
CSO 34
CSO 06

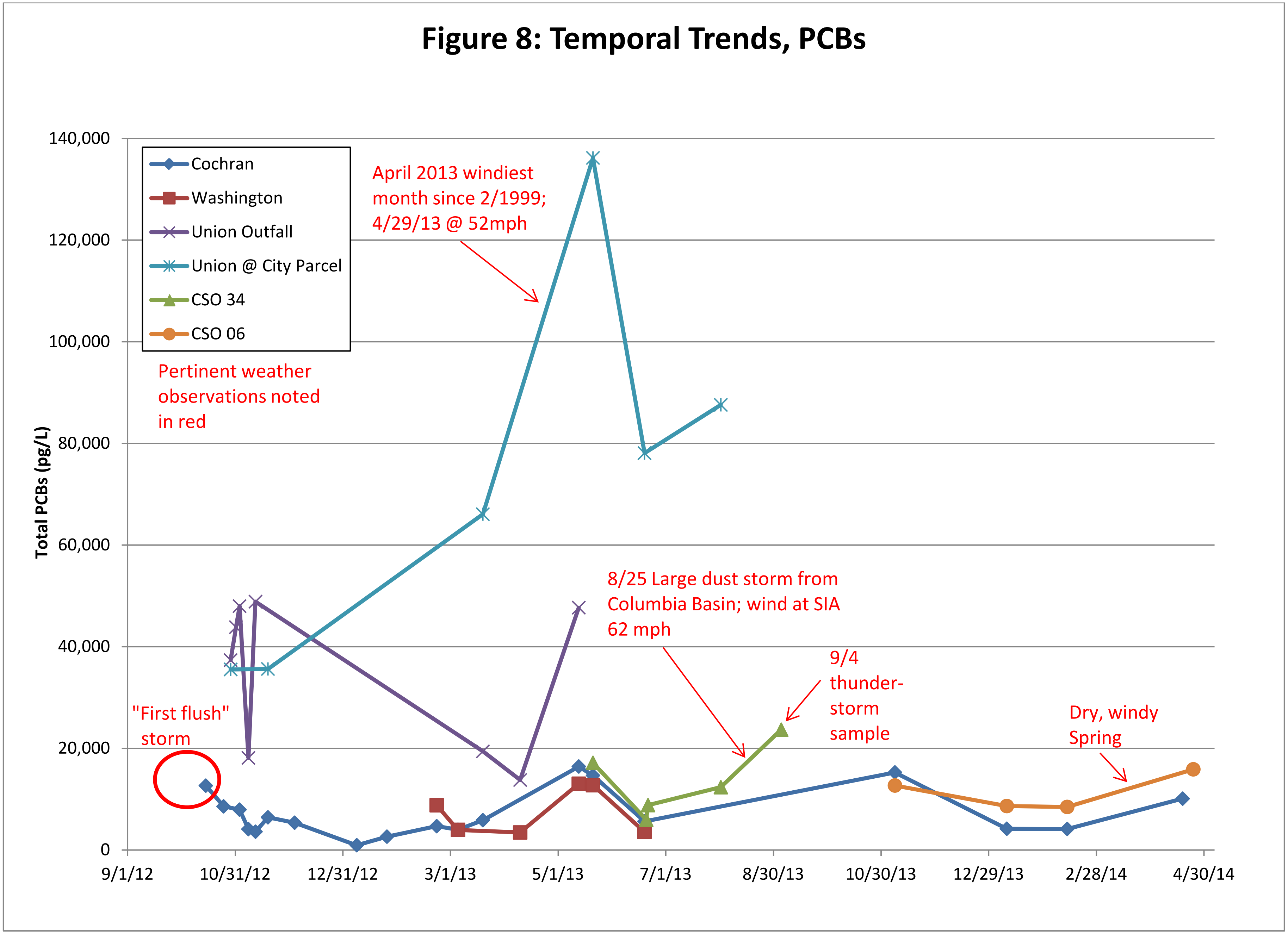


Figure 8: Temporal Trends, PCBs
Total PCBs (pg/L)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
9/1/12
10/31/12
12/31/12
3/1/13
5/1/13
7/1/13
8/30/13
10/30/13
12/29/13
2/28/14
4/30/14
Cochran
Washington
Union Outfall
Union @ City Parcel
CSO 34
CSO 06
April 2013 windiest month since 2/1999; 4/29/13 @ 52mph
Pertinent weather observations noted in red
8/25 Large dust storm from Columbia Basin; wind at SIA 62 mph
9/4 thunder-storm sample
"First flush" storm
Dry, windy Spring

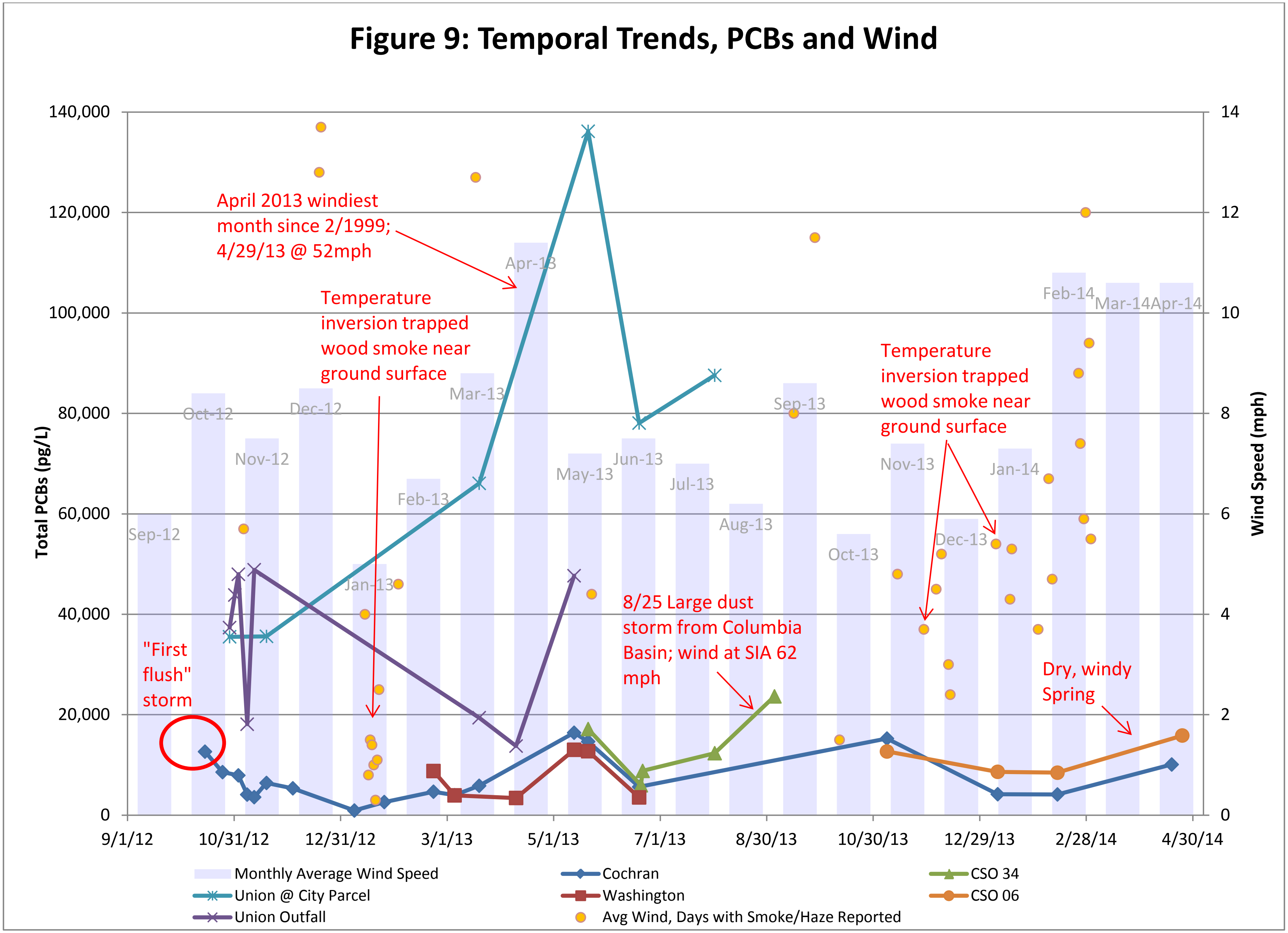
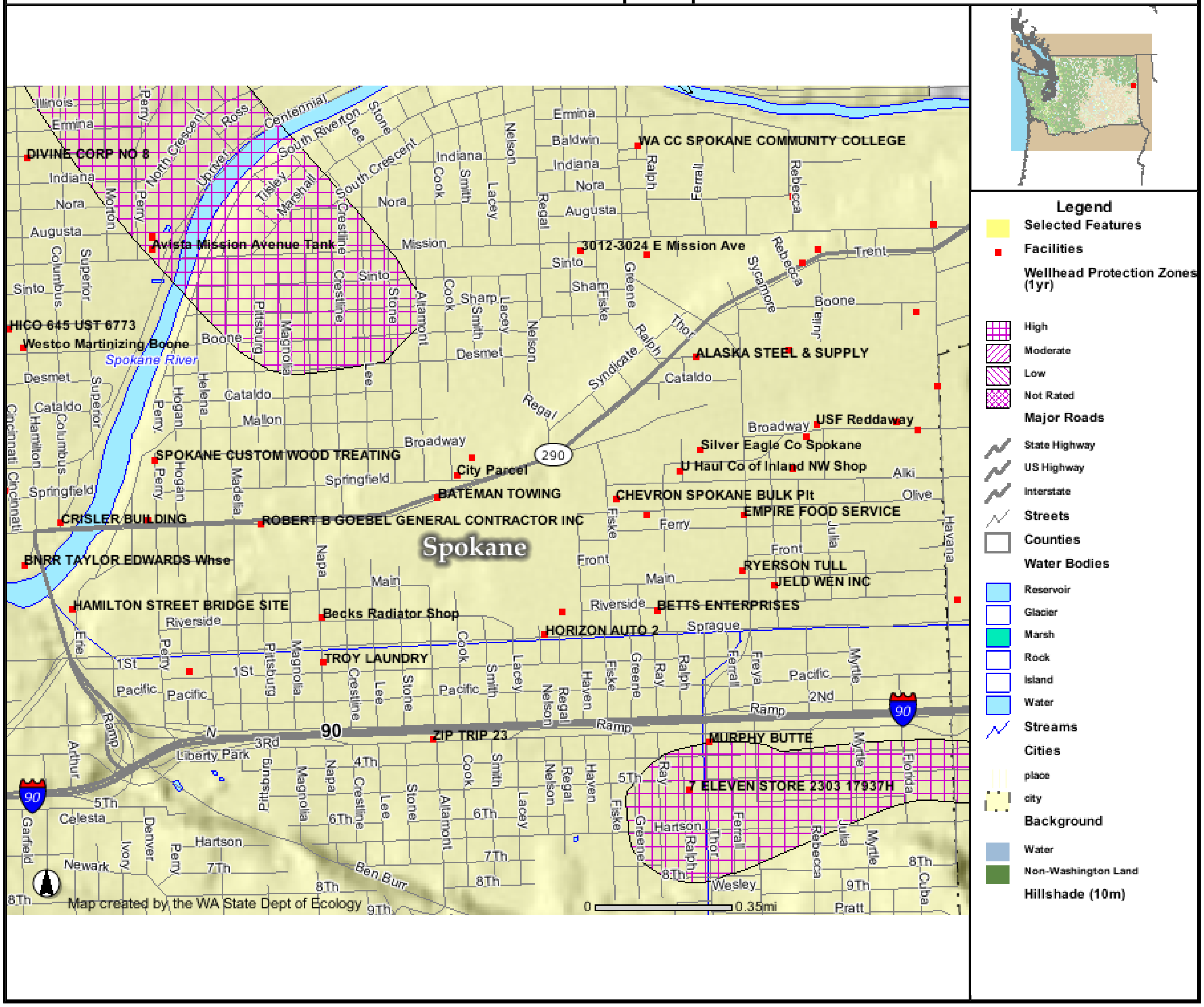


Figure 9: Temporal Trends, PCBs and Wind
Total PCBs (pg/L)
Wind Speed (mph)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
14
12
10
8
6
4
2
0
9/1/12
10/31/12
12/31/12
3/1/13
5/1/13
7/1/13
8/30/13
10/30/13
12/29/13
2/28/14
4/30/14
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13
Jun-13
Jul-13
Aug-13
Sep-13
Oct-13
Nov-13
Dec-13
Jan-14
Feb-14
Mar-14
Apr-14
April 2013 windiest month since 2/1999; 4/29/13 @ 52mph
Temperature inversion trapped wood smoke near ground surface
Temperature inversion trapped wood smoke near ground surface
"First flush" storm
8/25 Large dust storm from Columbia Basin; wind at SIA 62 mph
Dry, windy Spring
Monthly Average Wind Speed
Union @ City Parcel
Union Outfall
Cochran
Washington
Avg Wind, Days with Smoke/Haze Reported
CSO 34
CSO 06

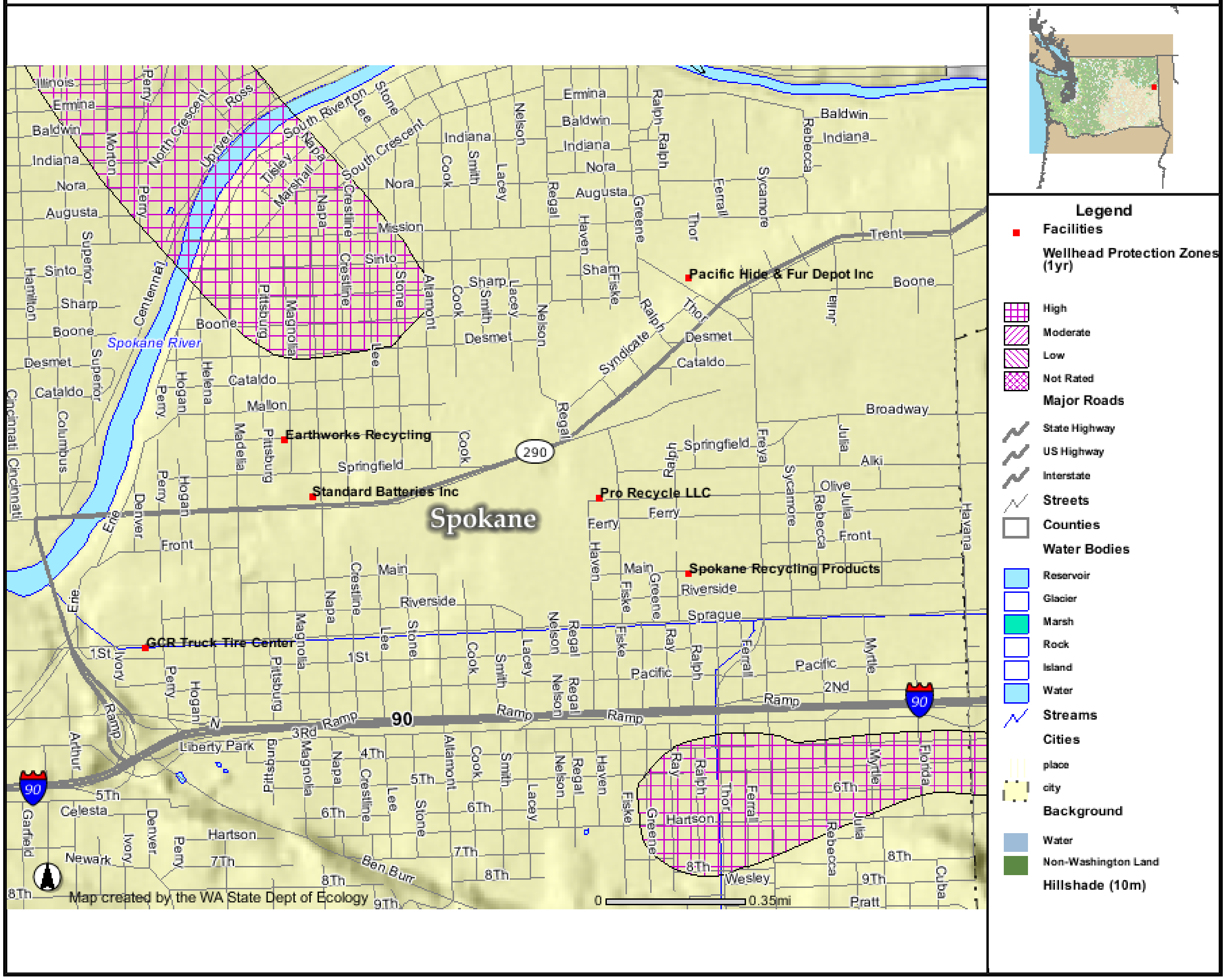
Appendix A

KNOWN CONTAMINATED SITES (ECOLOGY DATABASE)

All Toxics Cleanup Except UST

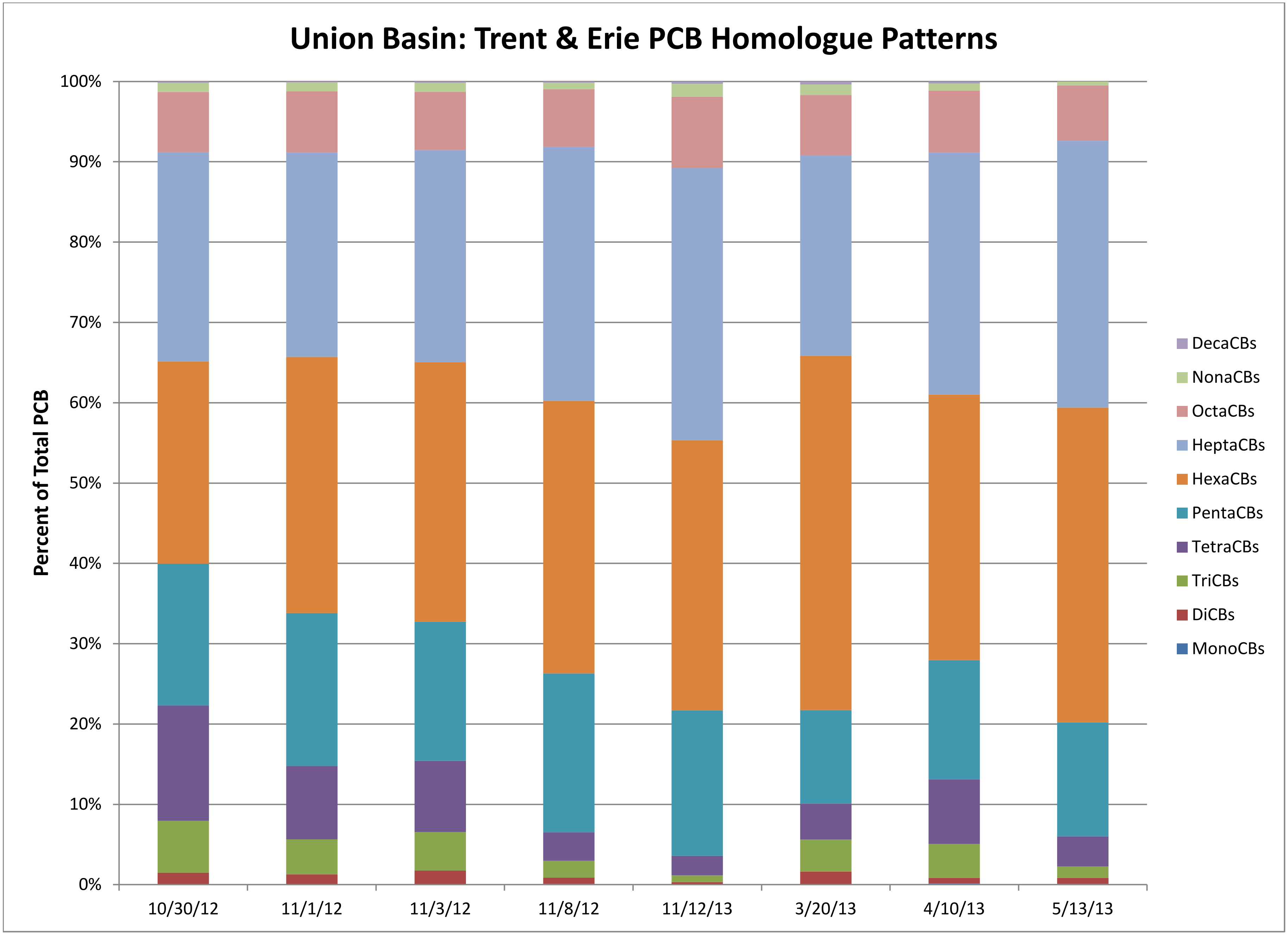


Solid Waste Facilities

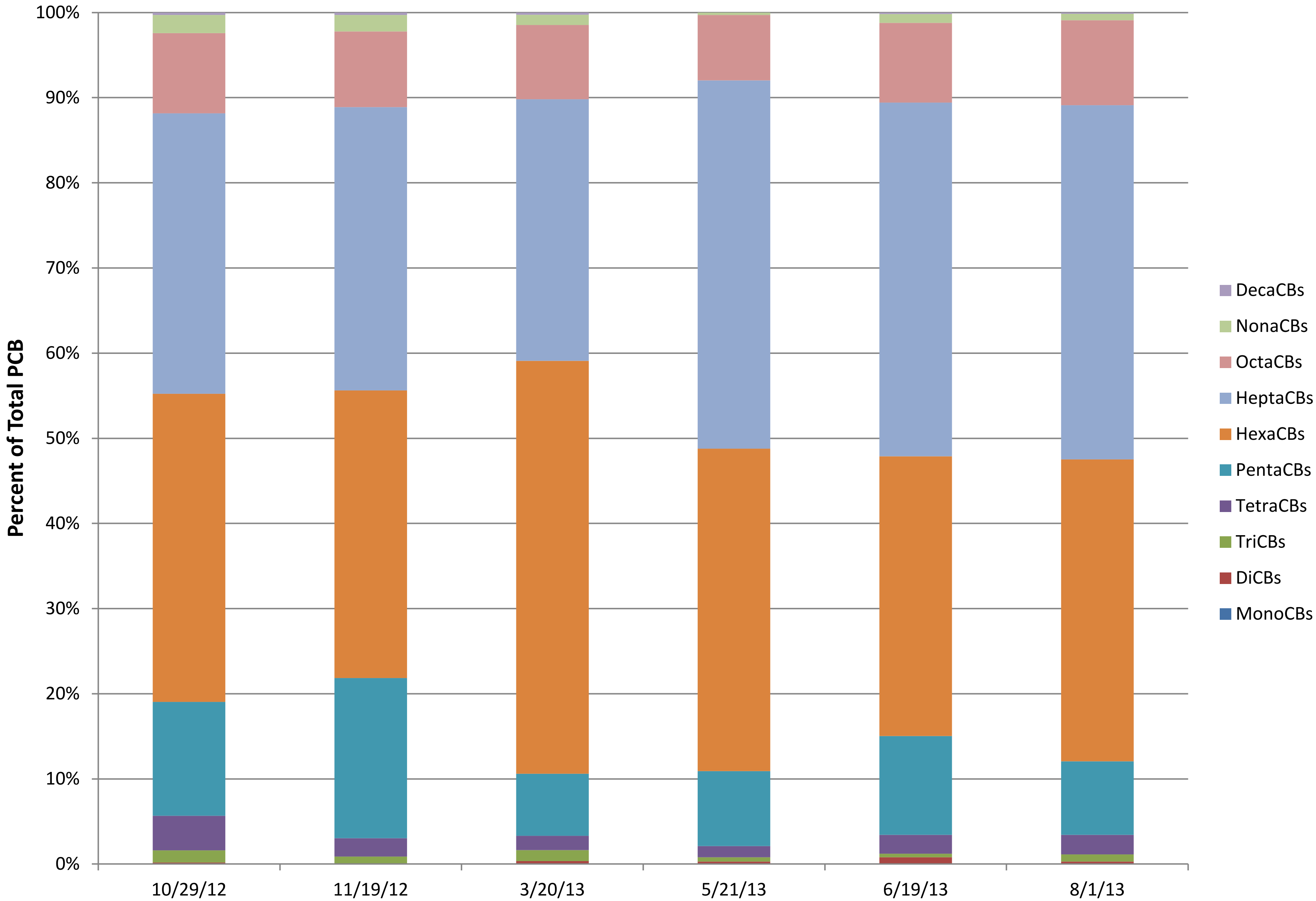


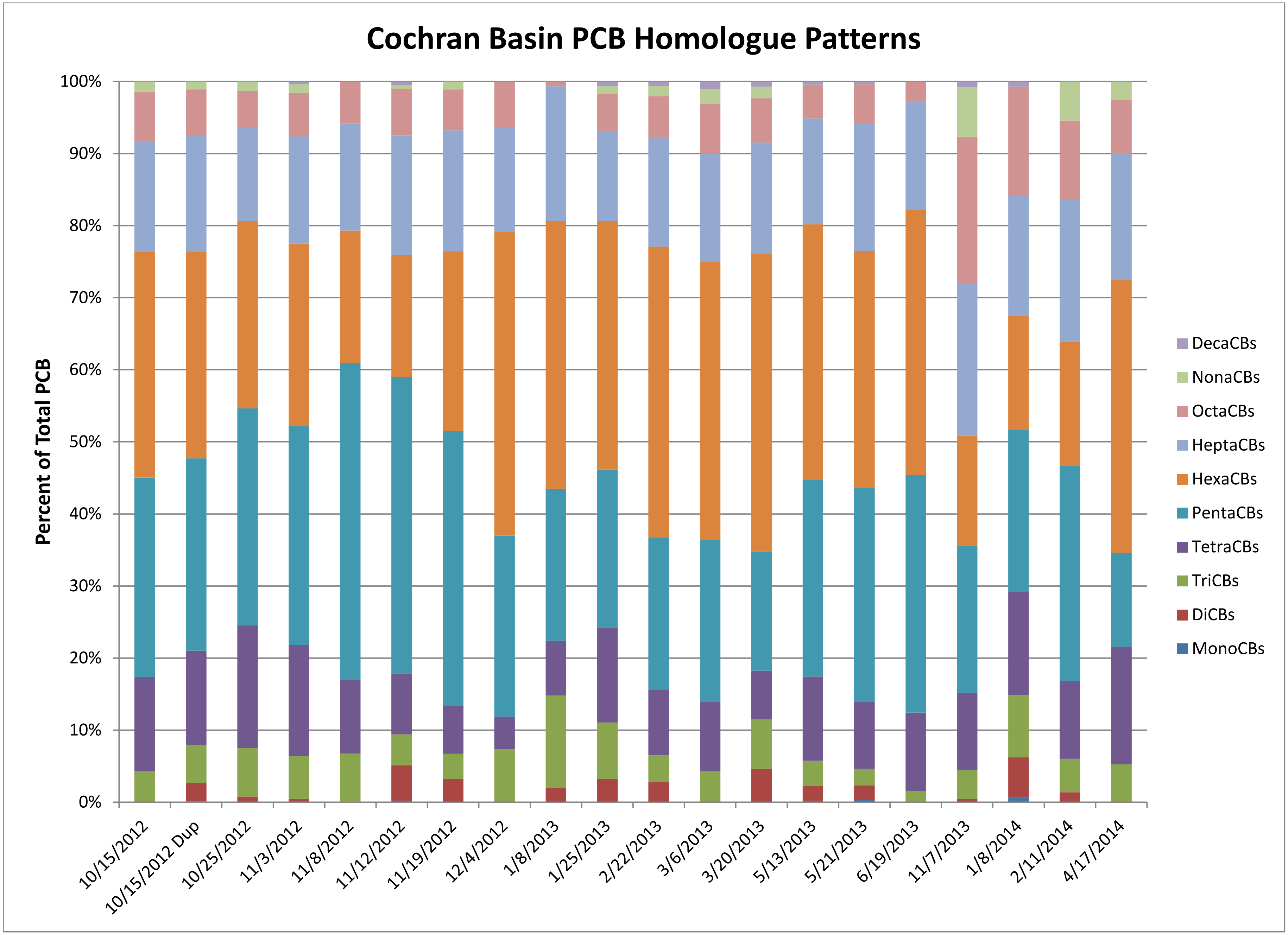
Appendix B

PCB HOMOLOGUE PATTERNS

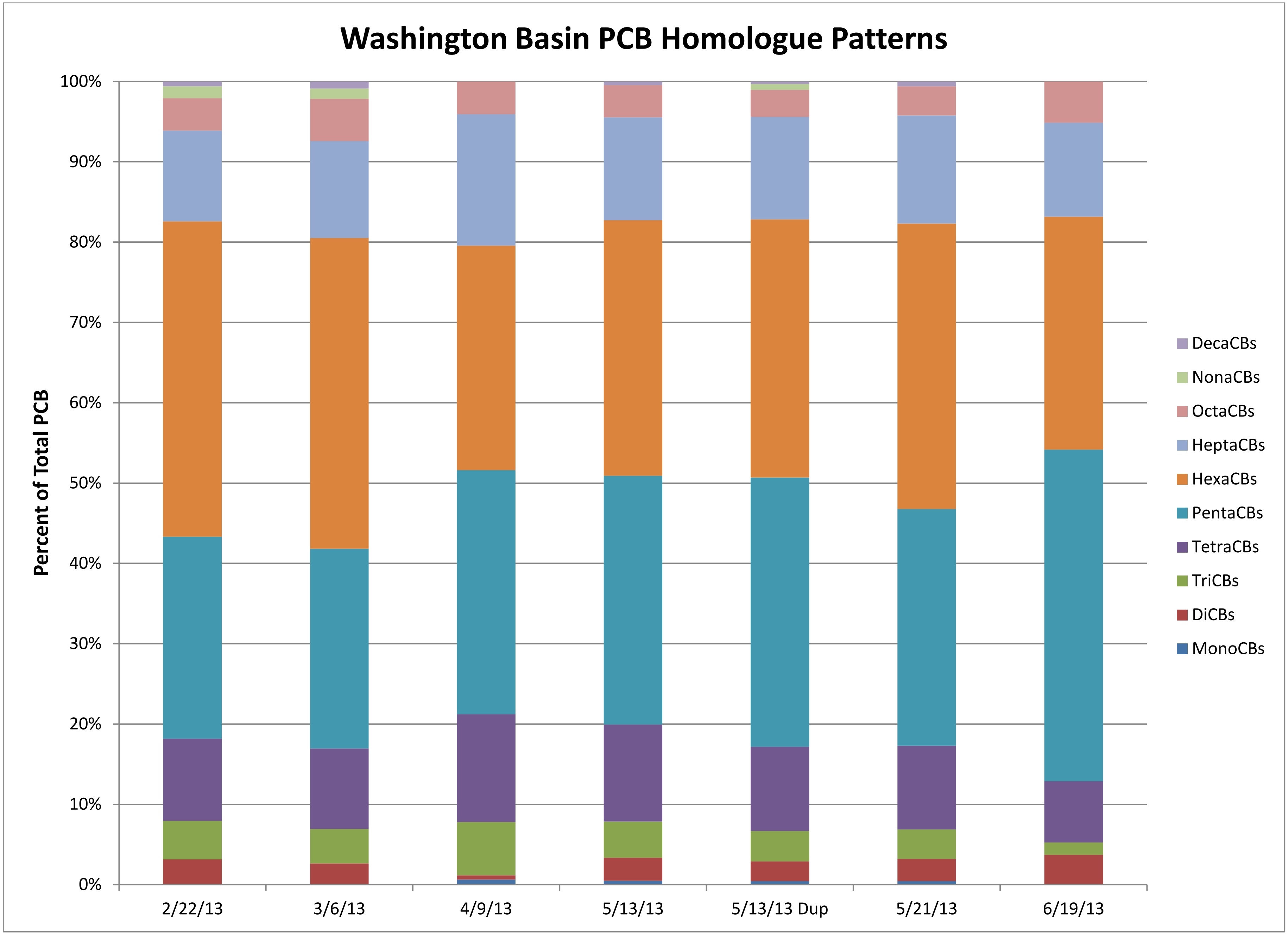

Union Basin: Trent & Erie PCB Homologue Patterns
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
10/30/12
11/1/12
11/3/12
11/8/12
11/12/13
3/20/13
4/10/13
5/13/13
DecaCBs
NonaCBs
OctaCBs
HeptaCBs
HexaCBs
PentaCBs
TetraCBs
TriCBs
DiCBs
MonoCBs

Union Basin: Lee & Springfield PCB Homologue Patterns

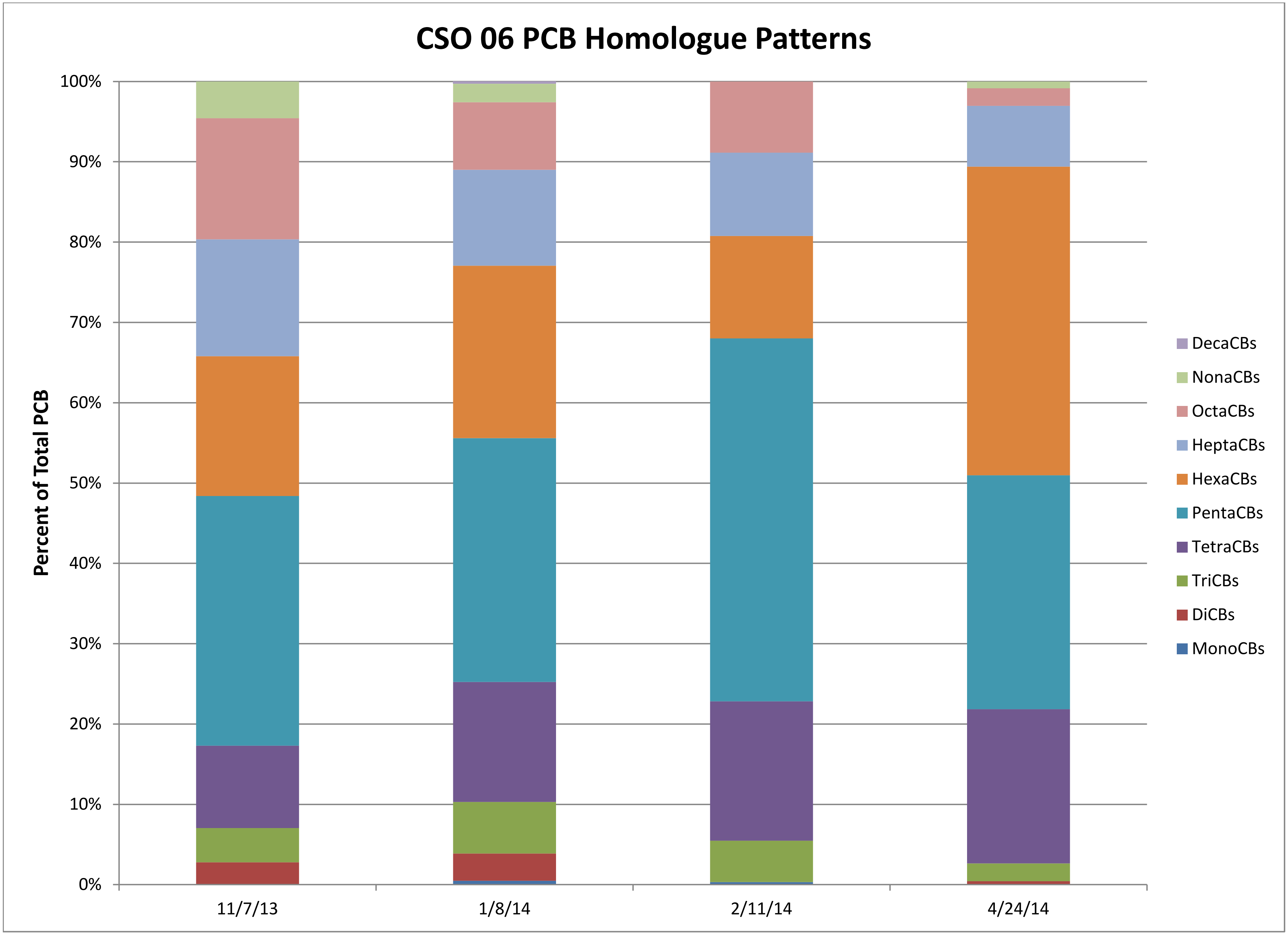


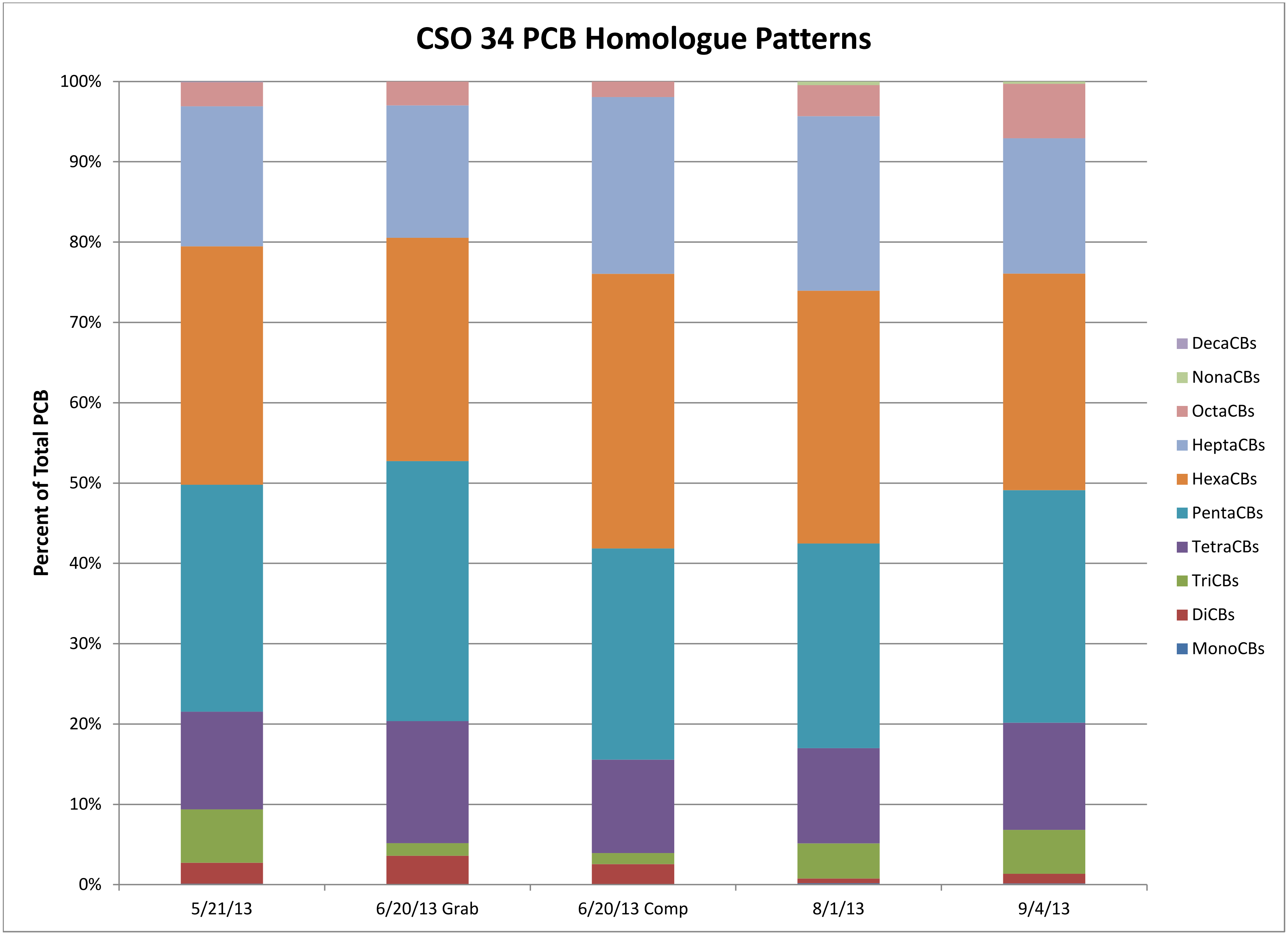


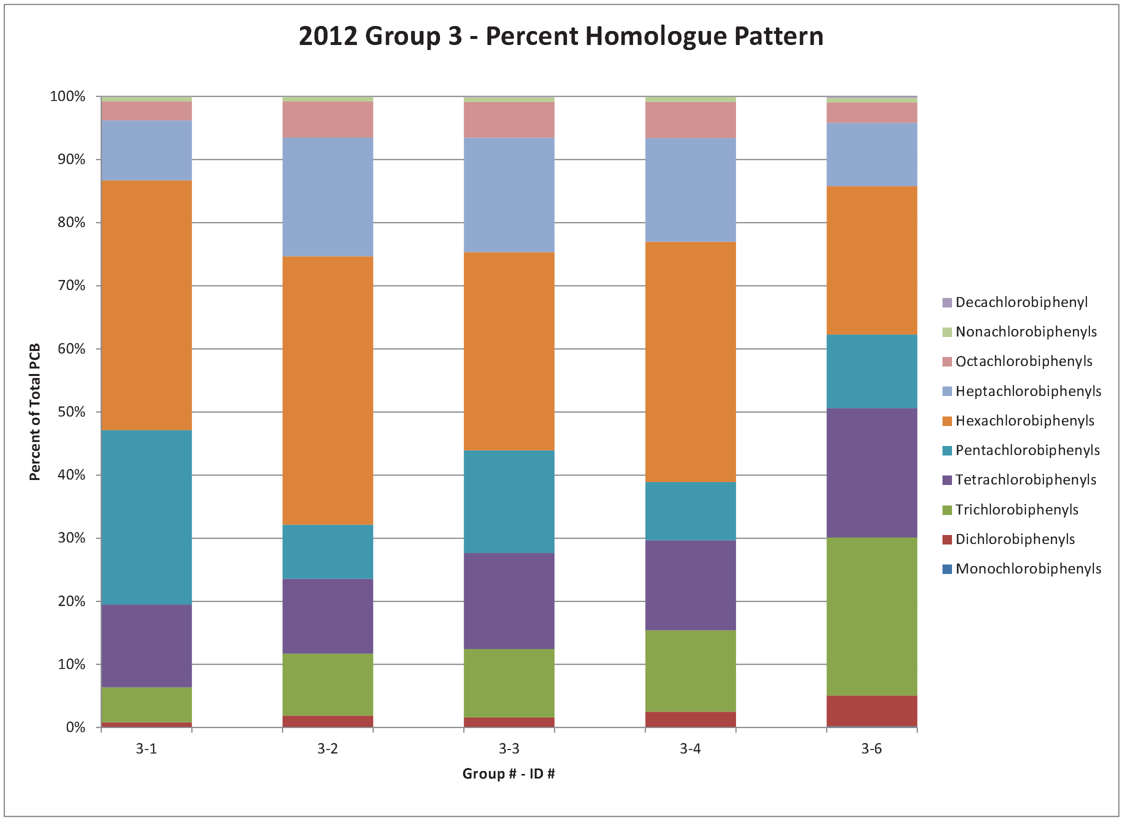
Cochran Basin PCB Homologue Patterns
Percent of Total PCB
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
10/15/2012
10/15/2012 Dup
10/25/2012
11/3/2012
11/8/2012
11/12/2012
11/19/2012
12/4/2012
1/8/2013
1/25/2013
2/22/2013
3/6/2013
3/20/2013
5/13/2013
5/21/2013
6/19/2013
11/7/2013
1/8/2014
2/11/2014
4/17/2014
DecaCBs
NonaCBs
OctaCBs
HeptaCBs
HexaCBs
PentaCBs
TetraCBs
TriCBs
DiCBs
MonoCBs

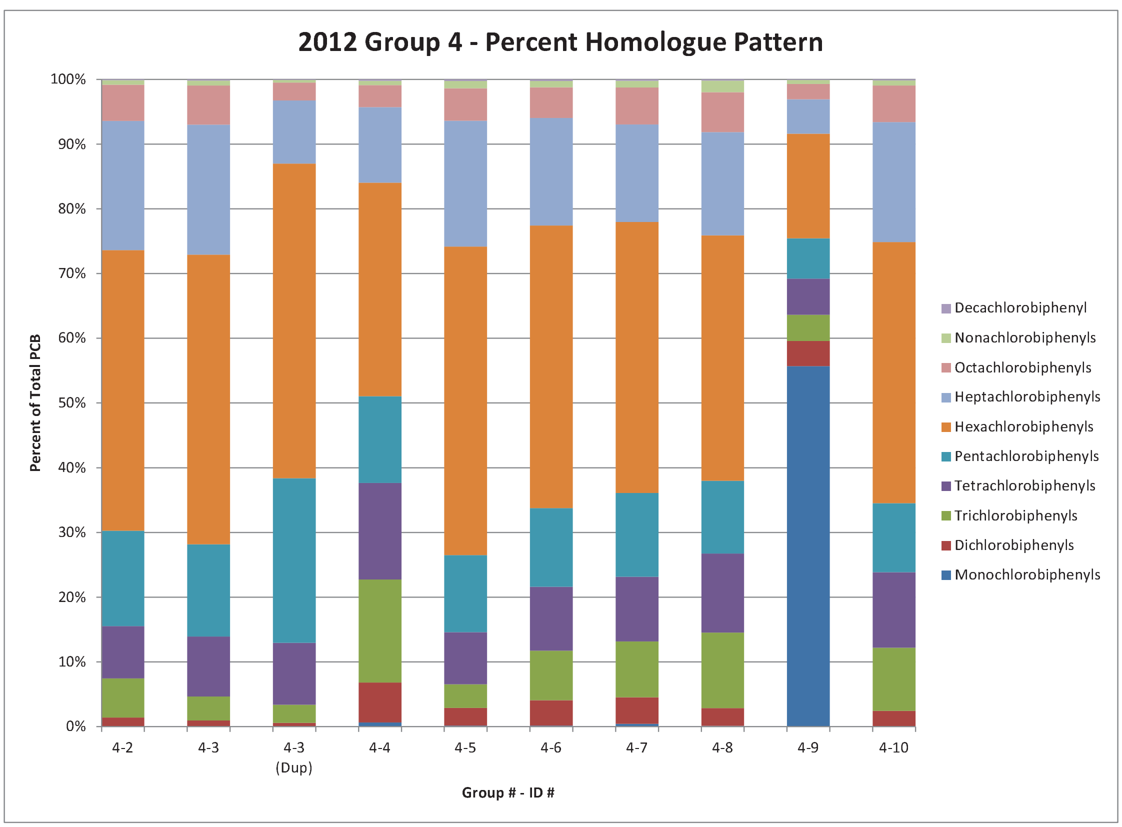


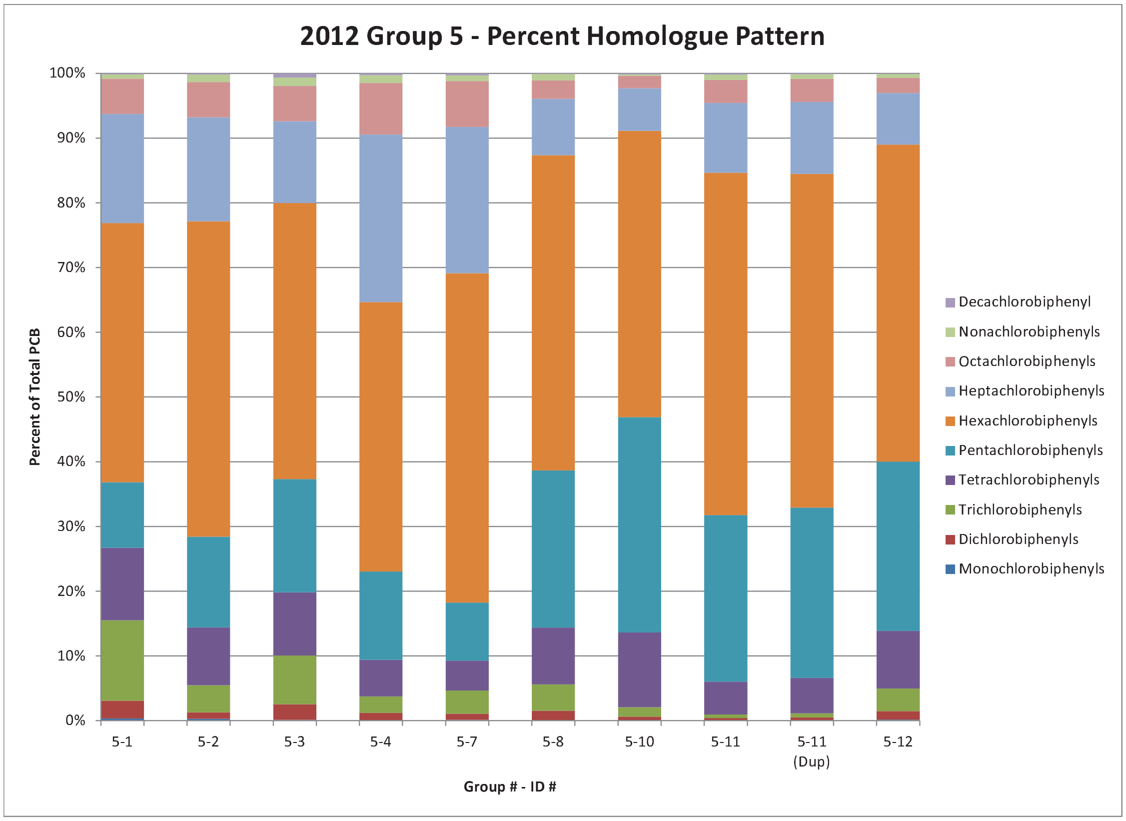
Washington Basin PCB Homologue Patterns
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2/22/13
3/6/13
4/9/13
5/13/13
5/13/13 Dup
5/21/13
6/19/13
DecaCBs
NonaCBs
OctaCBs
HeptaCBs
HexaCBs
PentaCBs
TetraCBs
TriCBs
DiCBs
MonoCBs

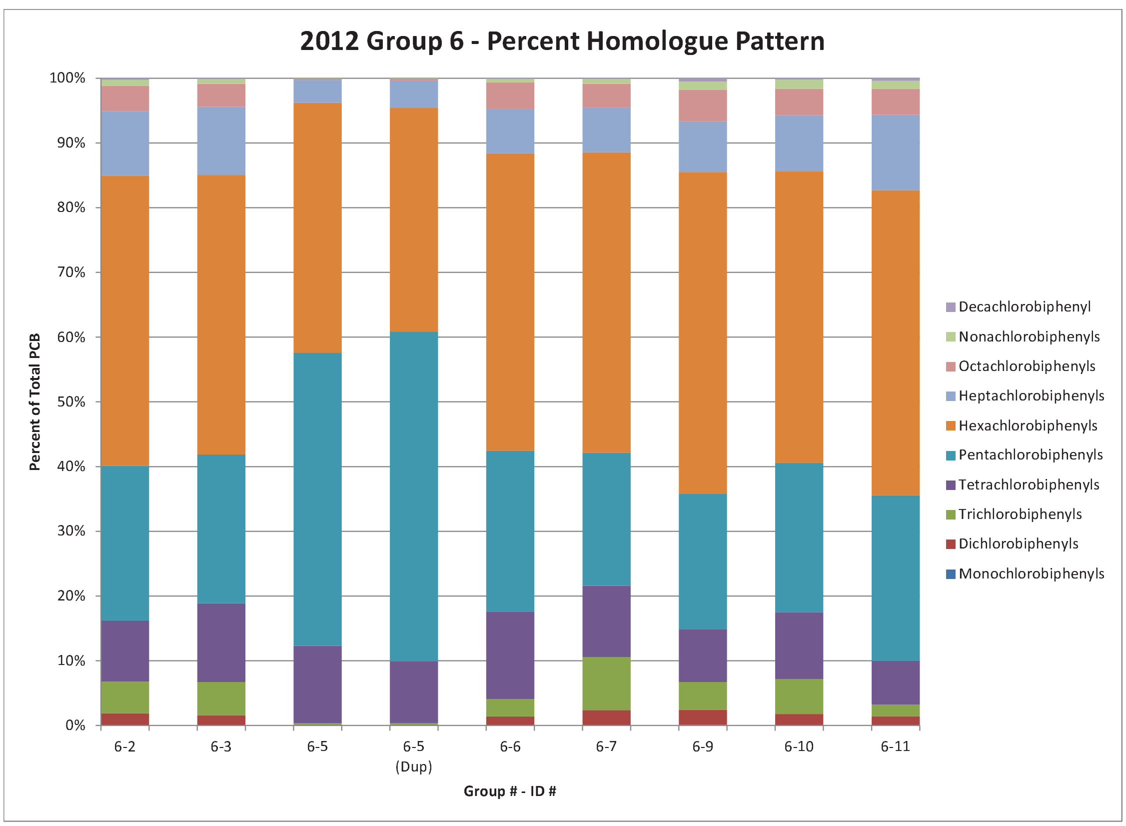

CSO 06 PCB Homologue Patterns
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
11/7/13
1/8/14
2/11/14
4/24/14
DecaCBs
NonaCBs
OctaCBs
HeptaCBs
HexaCBs
PentaCBs
TetraCBs
TriCBs
DiCBs
MonoCBs

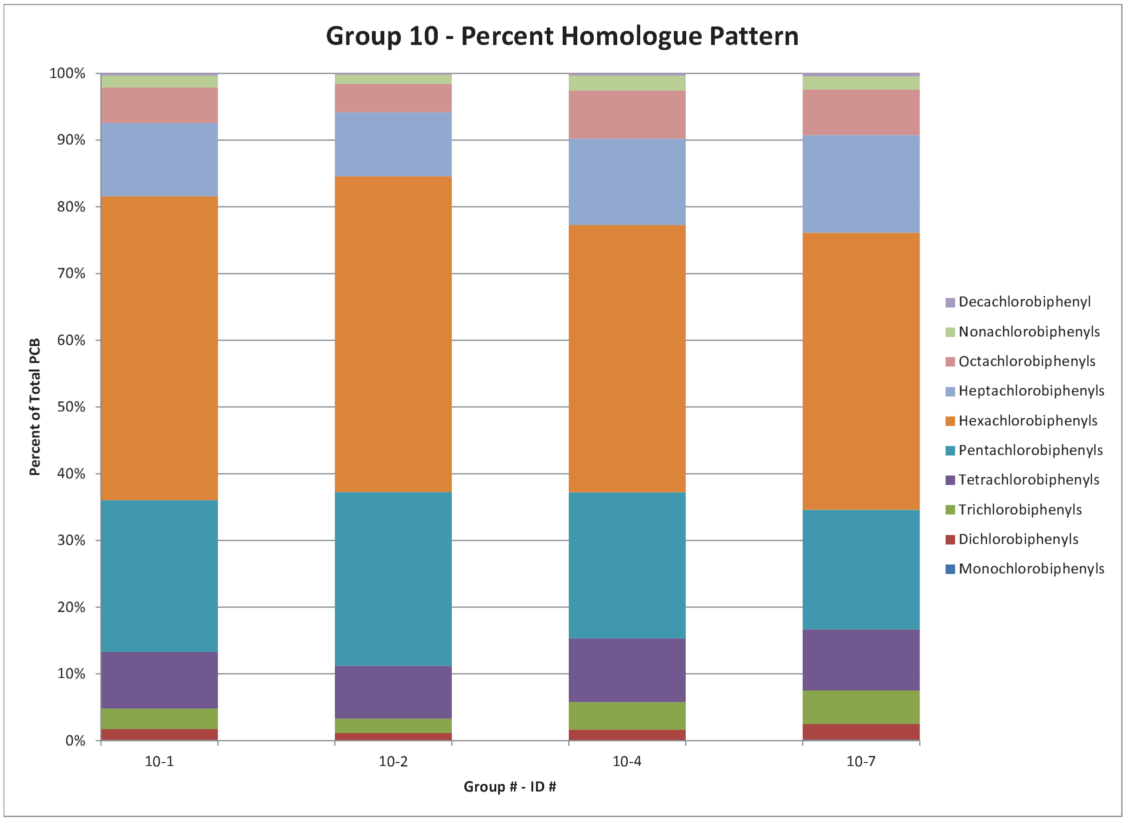

CSO 34 PCB Homologue Patterns
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
5/21/13
6/20/13 Grab
6/20/13 Comp
8/1/13
9/4/13
DecaCBs
NonaCBs
OctaCBs
HeptaCBs
HexaCBs
PentaCBs
TetraCBs
TriCBs
DiCBs
MonoCBs

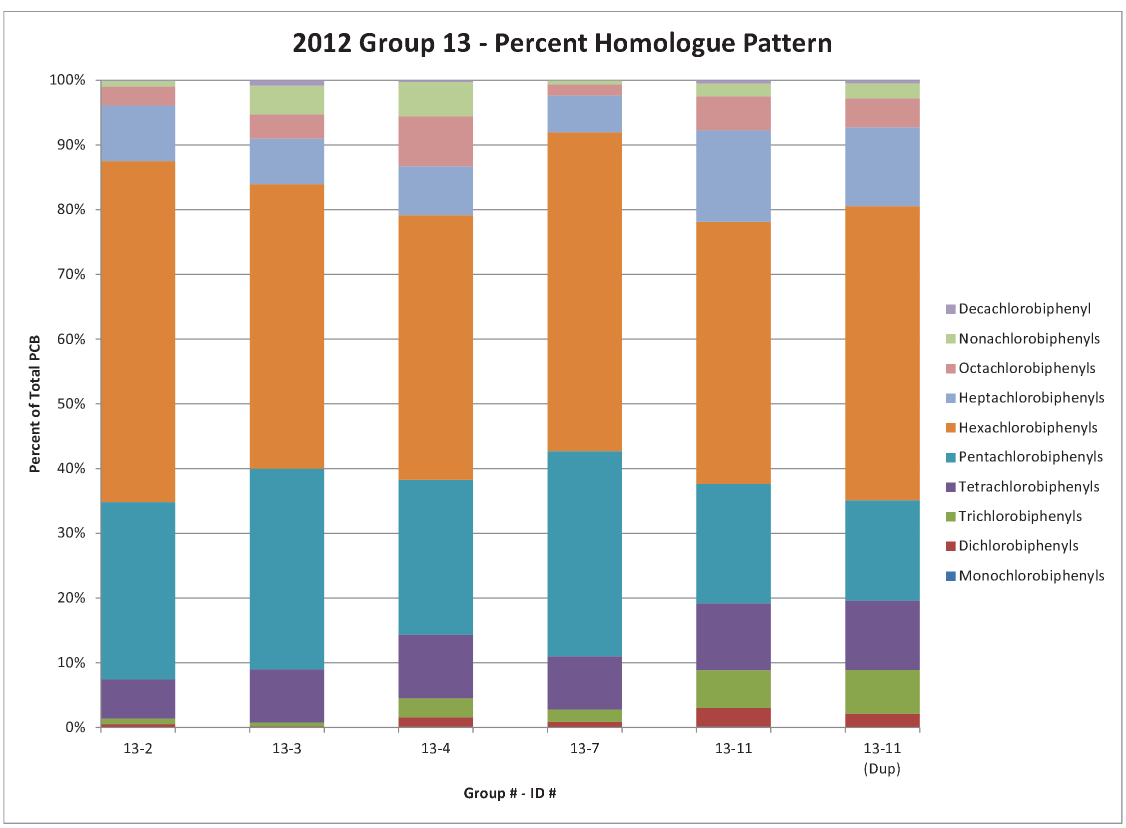

2012 Group 3 - Percent Homologue Pattern
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Total PCB
3-1
3-2
3-3
3-4
3-6
Group # - ID #
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls

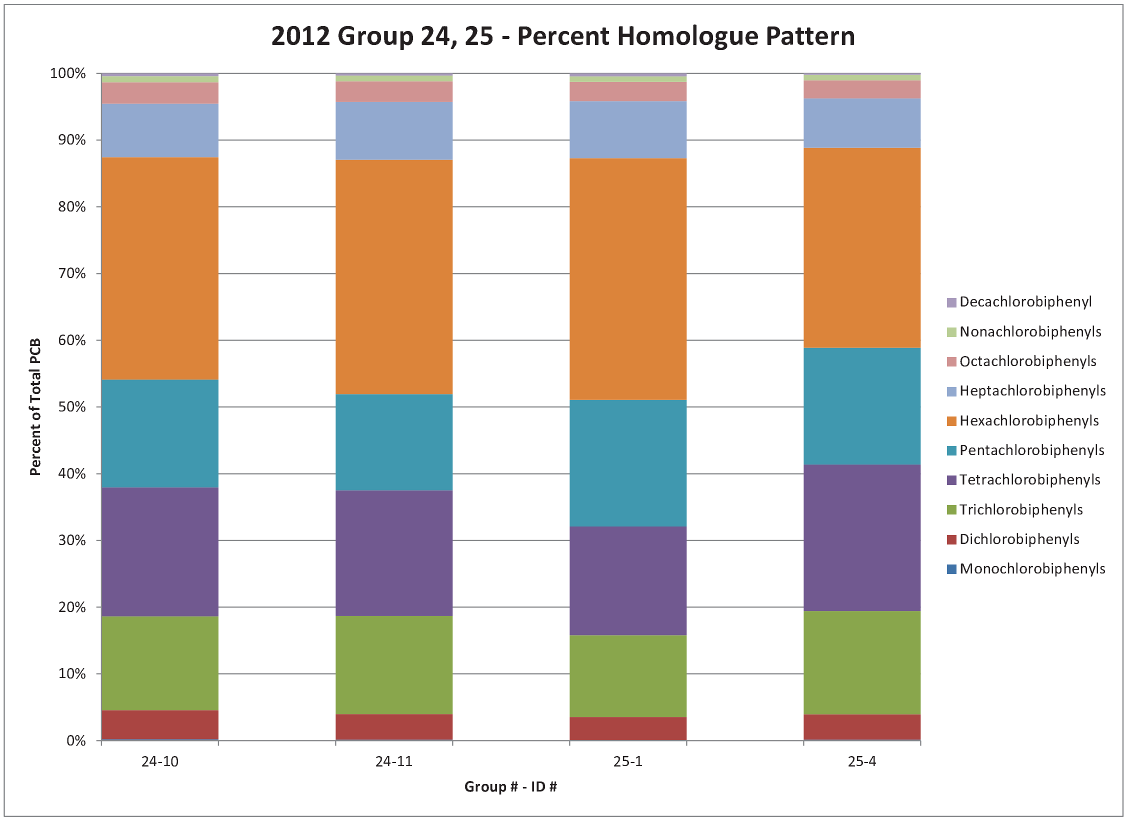

2012 Group 4 - Percent Homologue Pattern
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Total PCB
4-2
4-3
4-3 (Dup)
4-4
4-5
4-6
4-7
4-8
4-9
4-10
Group # - ID #
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls

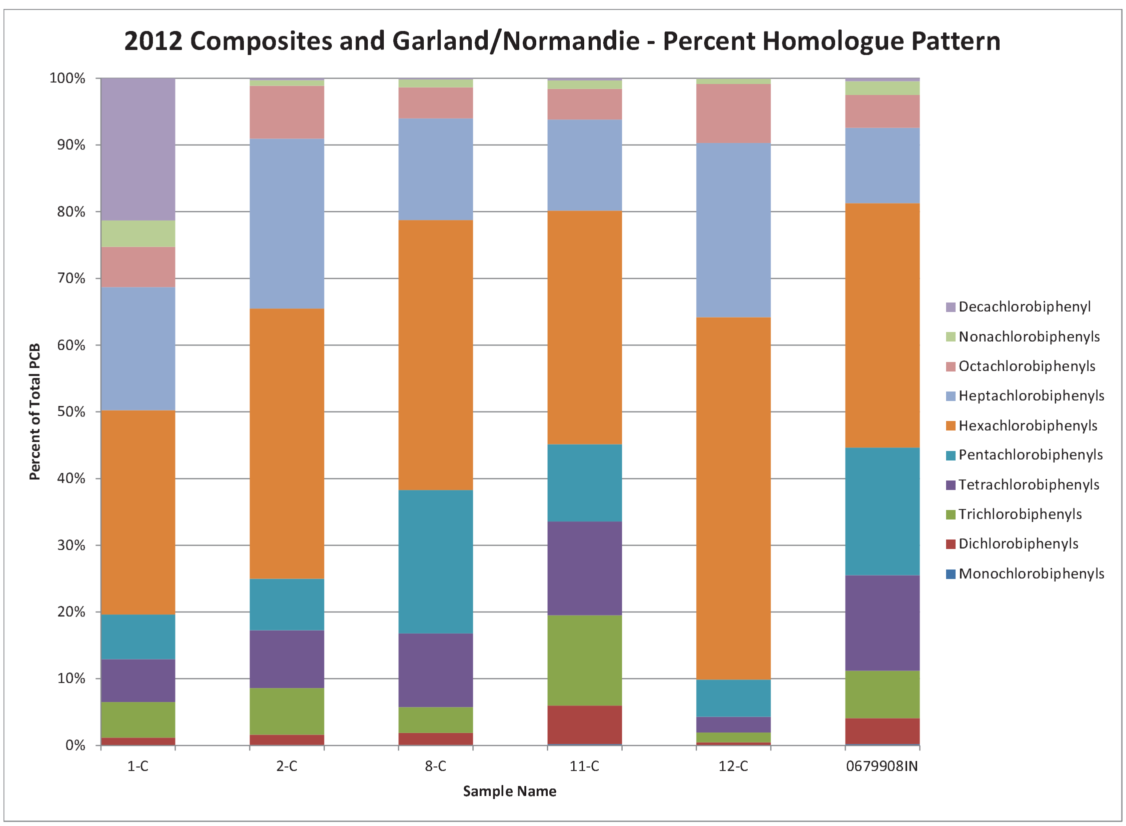

2012 Group 5 - Percent Homologue Pattern
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Total PCB
5-1
5-2
5-3
5-4
5-7
5-8
5-10
5-11
5-11 (Dup)
5-12
Group # - ID #
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls

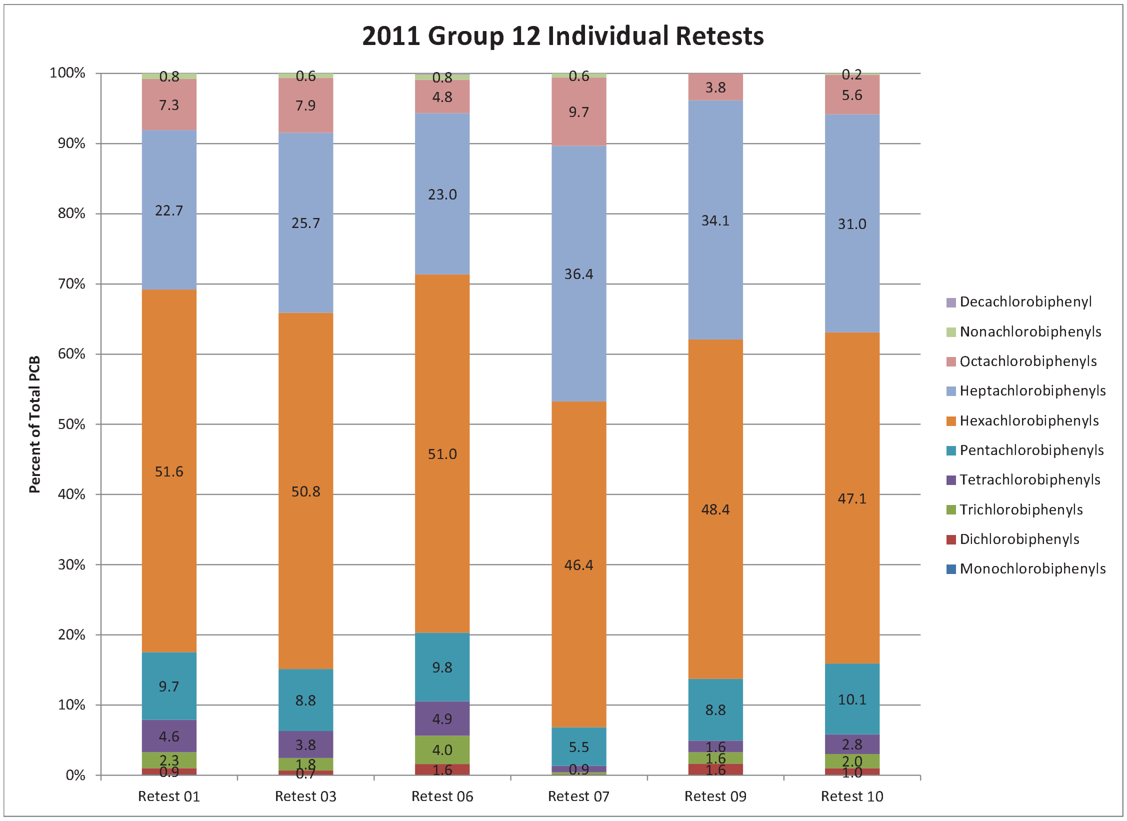

2012 Group 6 - Percent Homologue Pattern
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Total PCB
6-2
6-3
6-5
6-5 (Dup)
6-6
6-7
6-9
6-10
6-11
Group # - ID #
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls


Group 10 - Percent Homologue Pattern
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
10-1
10-2
10-4
10-7
Group # - ID #
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls

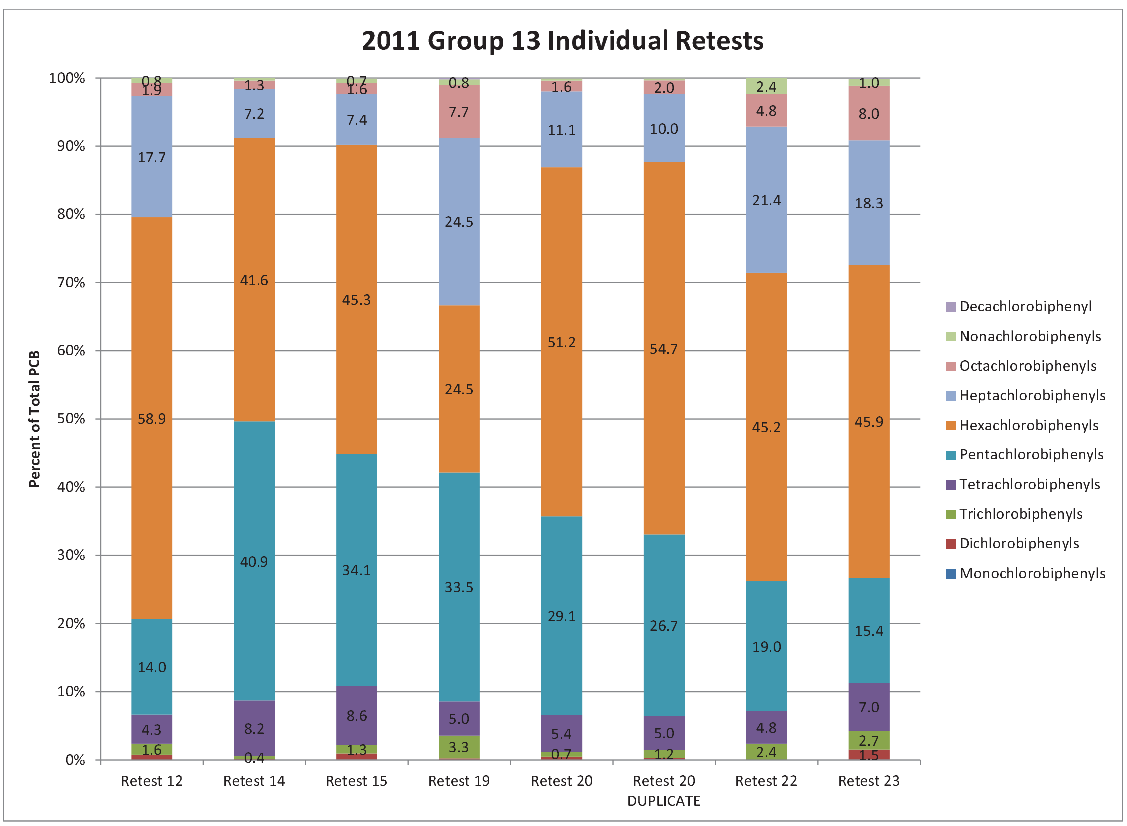

2012 Group 13 - Percent Homologue Pattern
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
13-2
13-3
13-4
13-7
13-11
13-11 (Dup)
Group # - ID #
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls


2012 Group 24, 25 - Percent Homologue Pattern
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Total PCB
24-10
24-11
25-1
25-4
Group # - ID #
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls

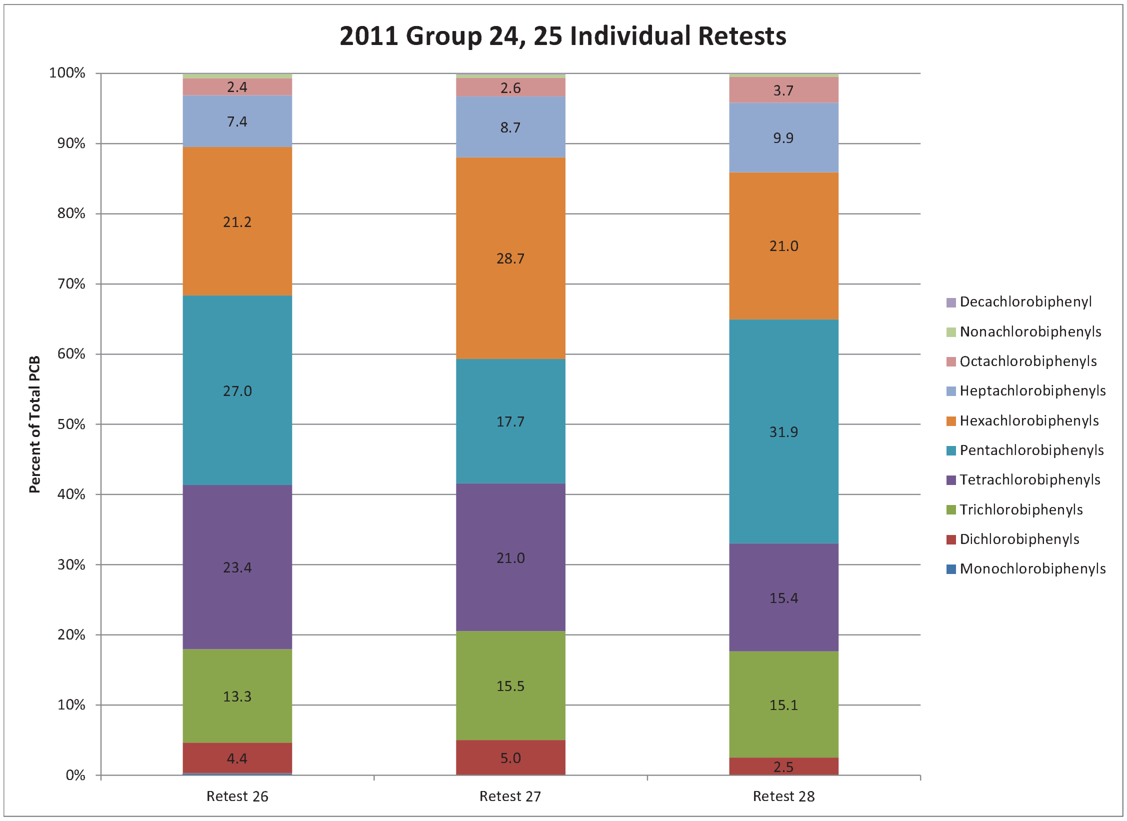

2012 Composites and Garland/Normandie - Percent Homologue Pattern
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Total PCB
1-C
2-C
8-C
11-C
12-C
0679908IN
Sample Name
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls

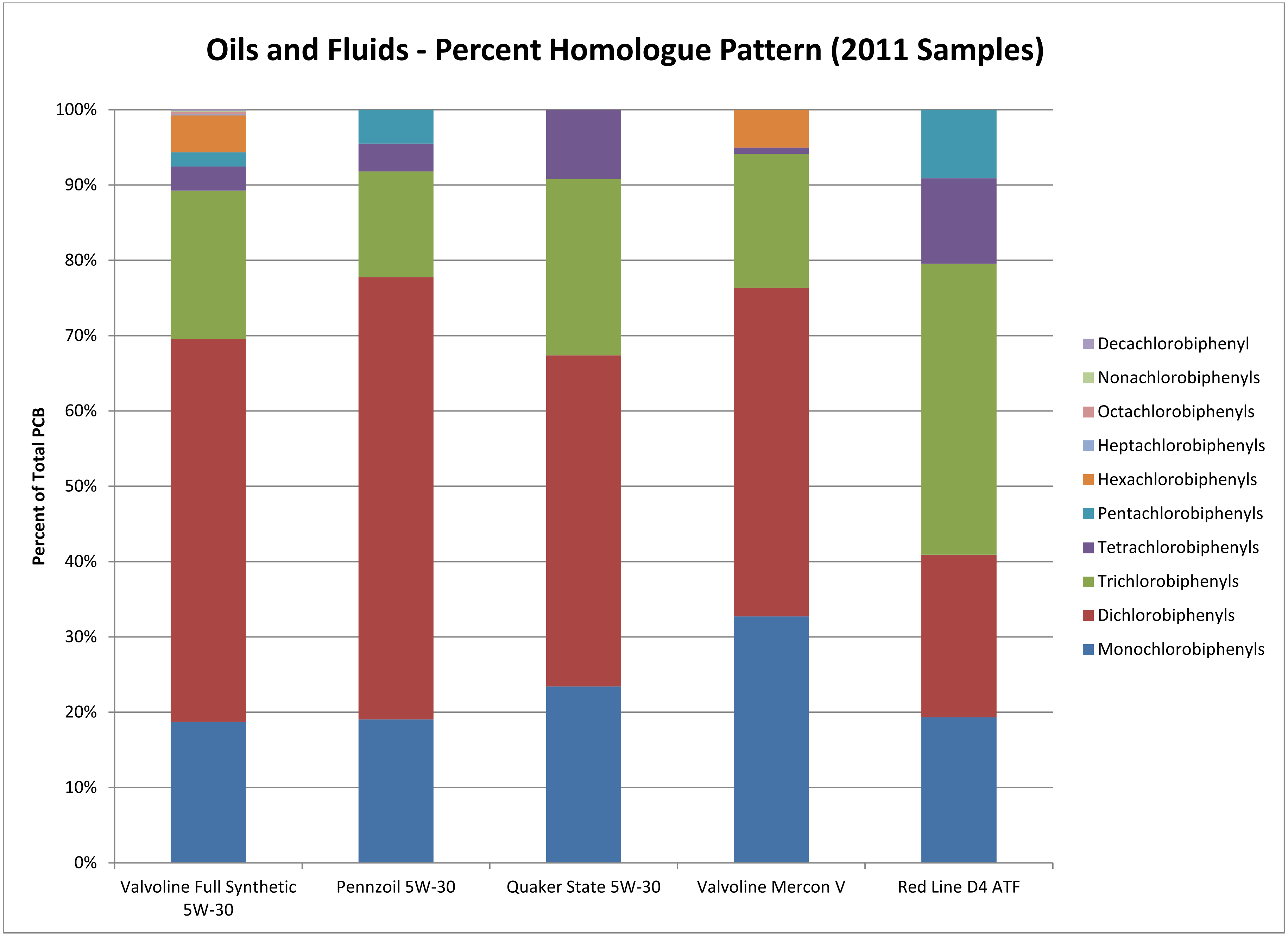


2011 Group 12 Individual Retests
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Retest 01
Retest 03
Retest 06
Retest 07
Retest 09
Retest 10
0.8
7.3
22.7
51.6
9.7
4.6
2.3
0.9
0.6
7.9
25.7
50.8
8.8
3.8
1.8
0.7
0.8
4.8
23.0
51.0
9.8
4.9
4.0
1.6
0.6
9.7
36.4
46.4
5.5
0.9
3.8
34.1
48.4
8.8
1.6
1.6
1.6
0.2
5.6
31.0
47.1
10.1
2.8
2.0
1.0
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls

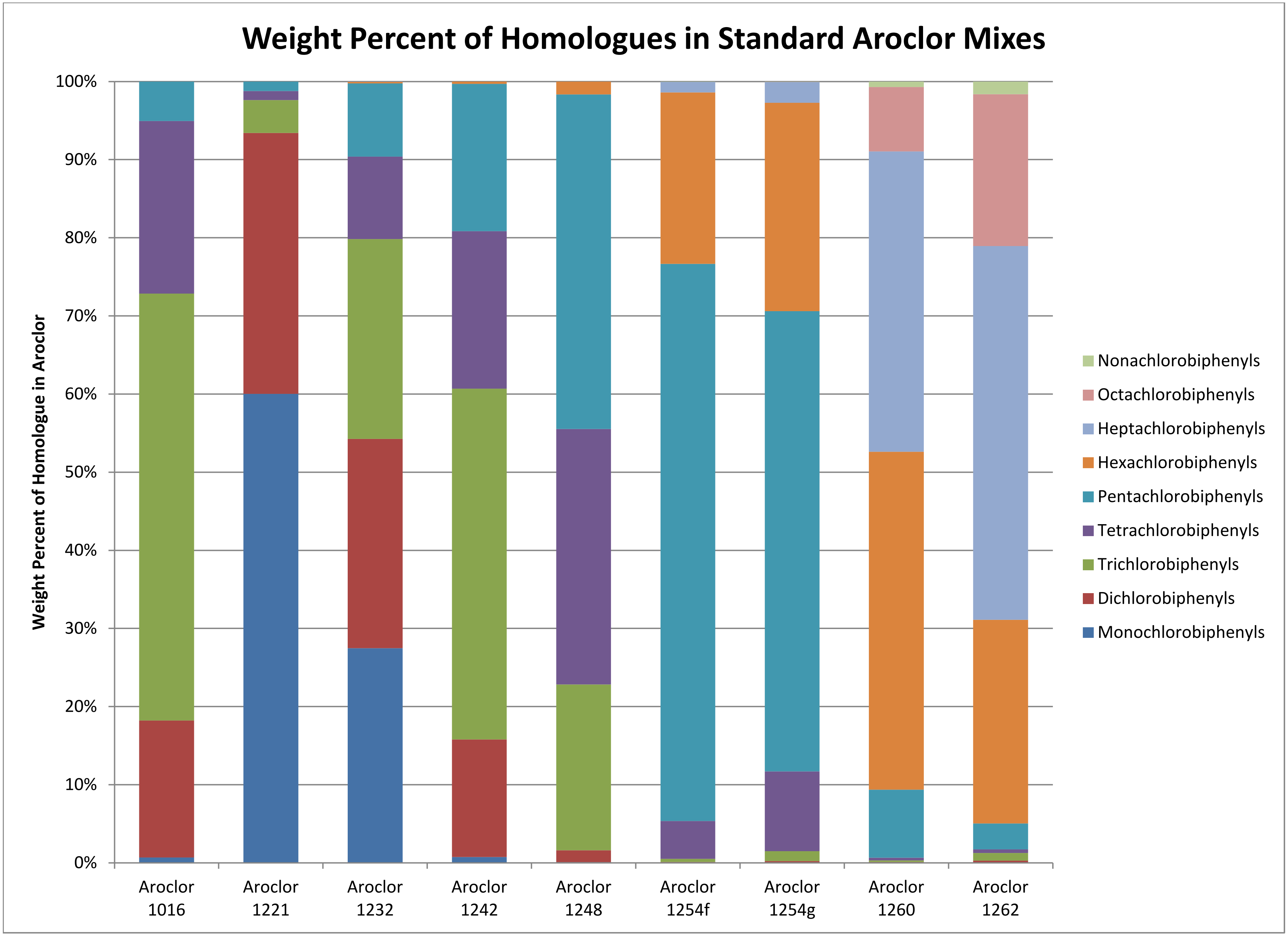


2011 Group 13 Individual Retests
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Retest 12
Retest 14
Retest 15
Retest 19
Retest 20
Retest 20 DUPLICATE
Retest 22
Retest 23
0.8
1.9
17.7
58.9
14.0
4.3
1.6
1.3
7.2
41.6
40.9
8.2
0.4
0.7
1.6
7.4
45.3
34.1
8.6
1.3
0.8
7.7
24.5
24.5
33.5
5.0
3.3
1.6
11.1
51.2
29.1
5.4
0.7
2.0
10.0
54.7
26.7
5.0
1.2
2.4
4.8
21.4
45.2
19.0
4.8
2.4
1.0
8.0
18.3
45.9
15.4
7.0
2.7
1.5
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls


2011 Group 24, 25 Individual Retests
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Total PCB
2.4
7.4
21.2
27.0
23.4
13.3
4.4
2.6
8.7
28.7
17.7
21.0
15.5
5.0
3.7
9.9
21.0
31.9
15.4
15.1
2.5
Retest 26
Retest 27
Retest 28
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls



Oils and Fluids - Percent Homologue Pattern (2011 Samples)
Percent of Total PCB
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Valvoline Full Synthetic 5W-30
Pennzoil 5W-30
Quaker State 5W-30
Valvoline Mercon V
Red Line D4 ATF
Decachlorobiphenyl
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls


Weight Percent of Homologues in Standard Aroclor Mixes
Weight Percent of Homologue in Aroclor
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254f
Aroclor 1254g
Aroclor 1260
Aroclor 1262
Nonachlorobiphenyls
Octachlorobiphenyls
Heptachlorobiphenyls
Hexachlorobiphenyls
Pentachlorobiphenyls
Tetrachlorobiphenyls
Trichlorobiphenyls
Dichlorobiphenyls
Monochlorobiphenyls