Effectiveness of PCB Procurement Policies & Certifications

Report Prepared by Braided River Consulting, LLC
for Spokane River Regional Toxics Task Force (SRRTTF)

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Abbreviations

BRC	Braided River Consulting, LLC
CoC(s)	Chemical(s) of concern
EPA	US Environmental Protection Agency
nd	non-detect
NGC	Northwest Green Chemistry
PCB(s)	Polychlorinated biphenyl(s)
PCB-XX	Specific PCB congener, as specified by the number replacing XX
ppm	parts per million
ppb	parts per billion
ppq	parts per quadrillion
RFP	Request for proposal
SRRTTF	Spokane River Regional Toxics Task Force
WA DES	Washington Department of Enterprise Services
WA DOE	Washington State Department of Ecology
WSDOT	Washington State Department of Transportation

Executive Summary

In an effort to decrease polychlorinated biphenyl (PCB) and other toxic chemical contamination in Washington waters, the Spokane River Regional Toxics Task Force (SRRTTF) is working on multifaceted approaches to reduce loading that include both regulatory and voluntary initiatives. The SRRTTF sought to build upon previous research projects by putting out an RFP. The objectives of the RFP were two-fold: 1) to investigate PCB procurement policies enacted by governments and companies, and 2) to understand current PCB considerations in various safety and sustainability certification programs. The original RFP sought to evaluate the efficacy of such policies, but the research team informed the task force that they believed there would not be enough data available to make such a determination at this time.

Instead, the research team worked to redefine the RFP and set additional parameters that would provide the task force with more information leading to possible recommendations. This report focuses on procurement policies that address polychlorinated biphenyls (PCBs), including both legacy and inadvertent PCBs. The additional research questions included in this study built upon the initial request for information (incorporated into research question 1) and include:

1. What are the similarities, differences, and impacts of PCB and iPCB procurement policies and certifications?
2. What strategy, based on what similar consortia have done, could SRRTTF set to advocate for effective public and company policies regarding PCBs?
3. What are the evidence-based practices for stakeholder engagement and intersectoral collaboration that SRRTTF could use to further its mission?

As previously understood by the task force, PCBs can be divided into two broad groups based on their origins: legacy and inadvertent. Legacy PCBs were intentionally manufactured for use in products from 1921-1977 and have been banned in the US since 1979 (EPA, 1979). However, they are still found in a variety of legacy products such as electrical equipment, lighting ballasts, and old caulking in buildings and may continue to be a source when leaked from contaminated sites (EPA, 2019). Inadvertent PCBs (iPCBs) are currently produced as byproducts from manufacturing other products. The concentration of iPCBs present in products must meet strict EPA limits as required under the Toxic Substances Control Act (TSCA).

The limited nature of publicly available data and the lack of accountability mechanisms for the implementation and evaluation of voluntary PCB policies currently do not allow for definitive conclusions regarding efficacy. The research team shares all gathered data and results of the review of procurement policies and certifications. Additional research is included on similar consortia's' attempts to implement PCB policies and recommendations for additional actions that the task force can consider to increase collective impact. It was concluded that government policies would benefit from improved education for procurement specialists and contractors, incentives to lessen the burden of testing, and extended solicitation times since testing is often time consuming.

The research team gathered information and interviewed representatives from three locations across the country: the Hudson River, Chesapeake Bay, and the San Francisco Bay. The additional consortia researched provide some insights for SRRTTF's strategy, though none have been as innovative as Washington State in using procurement policies as a lever for collective pollution prevention impact. The Hudson River Superfund site in New York State benefits from federal coordination due to its official designation as a Superfund site. The Chesapeake Bay Program has a unique structure that formalizes input and influence from multiple advisory committees (members are elected or appointed) including scientific/technical, citizen, and local government. They also have a strong performance improvement system due to a formalized annual review process where outcomes are measured against previously stated goals. Finally, in the San Francisco Bay, the Bay Area Municipal Stormwater Collaborative is an entity focused on uniting the efforts of various city, county, and regional water management entities. In doing so, they found that creating regional infrastructure for pollution prevention was 75%-95% more cost effective than addressing contamination issues jurisdiction by jurisdiction. Each consortium has a unique context, varying stakeholders, and different levels of coordinated effort but employ some of the smart and evidence-based practices described in the final part of this report.

In the hierarchy of evidence, there are three types of practices with differing levels of support in the academic literature. Promising Practices (PP) are emergent practices that have shown some real-world application benefits, but they do not have a large evidence base to support them. Smart Practices (SP) have been applied successfully in practical settings and have a growing evidence base in the academic literature. Evidence-Based Practices (EBP) are the gold standard. They have extensive practical application evaluation and have been validated by significant academic literature and meta-analysis. Only Smart and Evidence Based Practices are presented in the team's research for SRRTTF. Further details about each practice are included in the appropriate section.

Table 1: Evidence-Based Practices for Intersectoral Collaboration

Practice	Hierarchy of Evidence
1. Engage inclusive and diverse group of stakeholders	EBP
2. Engage in dialogue	EBP
3. Identify purpose and goals of collaboration	EBP
4. Define roles and responsibilities of participants	EBP
5. Set ground rules	EBP
6. Address imbalances in power or resources	EBP
7. Identify shared motivation	EBP
8. Establish commitment	EBP
9. Develop trust	EBP
10. Determine actions the collaboration seeks to take	EBP
11. Address any innovation/ intellectual property considerations	SP
12. Determine definitions for success and collective impact	SP
13. Support accountability	SP
14. Develop legitimacy	SP
15. Exhibit and share leadership	EBP

Sources: Allnock et al., 2006; Ansell & Gash, 2008; Bartlett, 2012; B. Becker, personal communication, February 29, 2016; Bryson, 2011; Bryson, Crosby, & Stone, 2006; Center for Collaborative Policy, n.d.a; Center for Collaborative Policy, n.d.b; D. Constable, personal communication, February 26, 2016; Crosby & Bryson, 2010; Emerson et al., 2011; Foster-Fishman et al., 2011; Iles & Mulvihill, 2012; Innes & Booher, 2004; Intersector Project, n.d.; Johnson et al., 2003; Khosla et al., 2013; W. Leach, personal communication, February 19, 2016; Leach & Sabatier, 2005; Linden, 2003; López & Montalvo, 2015; McDermott et al., 2011; Page, 2010; Provan & Milward, 1995; S. Rogers, personal communication, February 19, 2016; J. Tickner, personal communication, February 29, 2016; Walker & Senecah, 2011; Zalner, 2005

Table 2: Smart Practices for Stakeholder Engagement

Smart Practices for Stakeholder Engagement

Practice	Hierarchy of Evidence
1. Engage stakeholders early	SP
2. Use messaging targeted to different audiences	SP
3. Establish a collaboration champion	SP
4. Utilize a trusted facilitator	SP
5. Establish trust	EBP
6. Utilize collaborative governance	SP
7. Use a collaboration and communication management software	SP
8. Ensure strong collaboration leadership is in place	SP
9. Determine stakeholder motivations	SP

Sources: Ansell & Gash, 2008; Bartlett, 2012; B. Becker, personal communication, February 29, 2016; Boyte, 2008; Bryson, 2004; Bryson, 2011; Emerson et al., 2011; Getha-Taylor, 2008; Hage, Leroy, & Peterson, 2010; Hargrove, 1998; Innes & Booher, 2004; Intersector Project, n.d.; Leach, 2011; W. Leach, personal communication, February 19, 2016; McDermott et al., 2011; Reed, 2008; S. Rogers, personal communication, February 19, 2016; Sayce et al., 2013; J. Tickner, personal communication, January 26, 2016; Walker & Senecah, 2011; Waugh & Streib, 2006

SRRTTF can audit its use of Smart and Evidence-Based Practices and determine where it is doing well and where additional resources may leverage greater impact. In this process, it may revisit its list of stakeholders and note important changes to inform its stakeholder engagement strategy. SRRTTF can identify change champions that are likely to create, implement, or evaluate procurement policies in a meaningful way and provide a model and leadership to other stakeholders. Cultivating good relationships with these champions and creating shared messaging could improve compliance and efficacy with procurement policies. In doing so, it can partner with watchdog groups, encourage government agencies to conduct evaluation of implemented procurement policies, and collaborate with groups that educate consumers on how to exert market pressure.

Introduction

Polychlorinated biphenyls (PCBs) are a class of synthetic organic chemicals consisting only of carbon, hydrogen and chlorine atoms. The core of the compound is two linked benzene rings, and the number of chlorine atoms decorating the rings and their locations on the rings distinguishes the 209 PCB congeners.

Figure 1: A selection of PCB congeners.

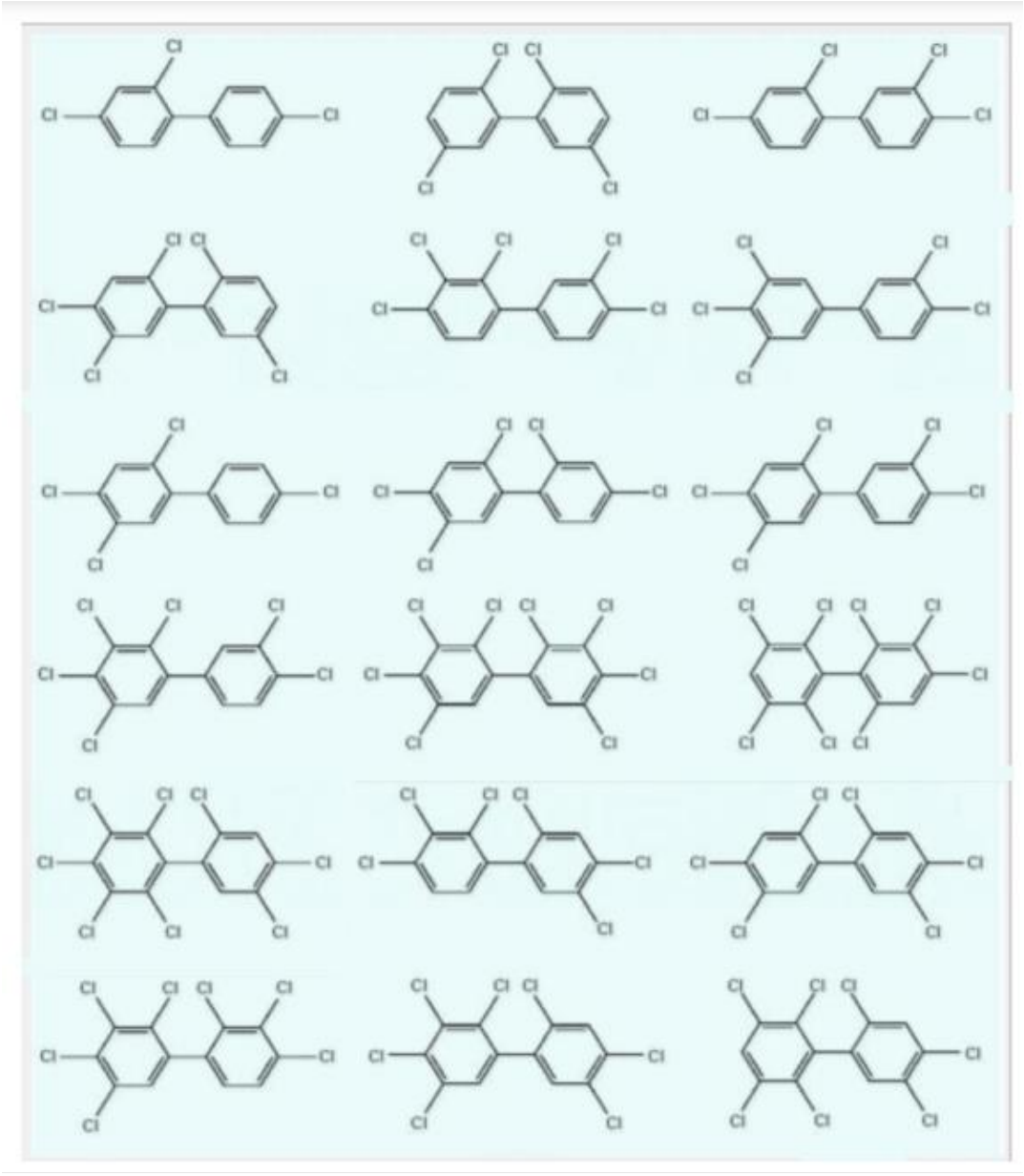


Image source: Plíšková et al., 2005

PCBs can be divided into two broad groups based on their origins: legacy and inadvertent PCBs. Legacy PCBs refer to those that were intentionally manufactured for use in products that are still either being used or are present in the environment. PCBs have excellent fire retardant, thermal conductivity, and electric insulation properties, which led to widespread use in applications such as transformers, capacitors, paint, and sealants (Regional Activity Center for Sustainable Consumption and Production (RAC/SPC), 2015). Inadvertent PCBs (iPCBs) refer to those that are produced as by-products or contaminants from manufacturing other products. Known potential inadvertent sources include waste incineration, cement production, metallurgy, and pigment synthesis (Anh, H.Q., et al. 2020; Gong et al., 2017).

PCBs may be inadvertently generated during pigment synthesis if chlorine is present, and which PCBs and the quantity of each PCB generated depend on the reagents and reaction conditions (Nestler, 2019). PCB11 is often used to signify iPCBs, as it was not used in legacy sources and it is associated with diarylide yellow pigments, as is PCB209, also not used in legacy sources and associated with phthalocyanine blue/green pigments and others (Mastin, 2022). Research continues to work on definitively identifying and quantifying sources for iPCBs found in the environment. With funding from SRRTTF, ChemForward is currently compiling a freely accessible searchable database of pigments that identifies which have chlorine present during synthesis (e.g., as a solvent or reagent), and thus, which have the potential to generate iPCBs during synthesis, and which do not (Heine, 2022; ETAD, 2021). This database will include additional complementary information, such as commercial availability in the US, product compatibility (e.g., printing, plastics), and presence on certain positive lists (e.g., US EPA's Safer Chemicals Ingredients List). Toxicity data was noted as an additional category and discussions are ongoing to determine what will be included.

Some PCB congeners are toxic, persistent, and bio accumulative – hazards that are well addressed in prior work. As early as the 1930s and 1940s, researchers had identified PCBs as a dermal irritant (Schwartz, 1936) and carcinogen (Des Ligneris, 1940). By the 1970s a body of literature outlining the toxic, persistent, and bio accumulative effects of PCBs warranted ban of their manufacture and limited most uses in the US (EPA, 1979). Their persistence means that legacy PCBs remain and continue to contribute to contamination alongside new releases of iPCBs. With the potential for bioaccumulation, some PCBs can magnify up the food chain, building up in species like salmon and posing a risk to populations consuming those species. Those for whom salmon and other fish traditionally comprise a large portion of their diets are particularly vulnerable to PCB contamination from fish caught from the Spokane River.

Procurement policies are one of the myriad ways industry and governments address chemicals of concern (CoC's) outside regulatory action. Voluntary programs may include compliance with a rating system, like ENERGY STAR (EPA, 2019), a signed commitment to eliminate a CoC in products or processes, chemical industry initiatives to improve safety and sustainability such as Responsible Care ® (ICCA, 2022), or certifications like Leadership in Energy and Environmental Design (LEED) (USGBC, 2022). According to the Eastern Research Group (ERG) 2019 report on the Chesapeake Bay:

> "Research has found that firms join or participate in voluntary programs for a variety of reasons. Among those cited are:
>
> - To avoid regulation and its costs and uncertainties.
> - To claim program benefits (e.g., reduced inspection frequency).
> - To appeal to stakeholders.
> - To deflect attention from consumer groups and NGOs.
> - Programs align with management's values (they want to be viewed as a leader).
> - Opportunities to network with other industry leaders.

(Borck & Cognianese, 2009; Coglianese & Nash, 2016; Potoski & Prakash, 2005; Prakash & Potoski, 2011)" (ERG, 2019, p. 33).

The task force may wish to explore participation in voluntary programs and determine which, if any, align with its core mission, vision, and values. Voluntary policies and programs often arise in arenas where public debate is ongoing and regulatory action is stalled; yet they can also be more challenging to enforce and evaluate. This study highlights, across multiple sectors and diverse groups, the strengths and challenges of voluntary programs and policies concerning accountability, compliance, transparency, and efficacy.

Project Research Questions

The supplemental Excel spreadsheet contains the full initial set of questions from the SRRTTF original RFP. The RFP indicated the initial list as a jumping-off point for the research project and that additional research questions could be added to it, providing further information and recommendations. As agreed, the research team added all publicly available data to the spreadsheet to answer the following questions where possible:

1. What specific products have PCB procurement policies been applied to?
2. Is the procurement policy applied to each individual component that goes into a product, including its packaging, support materials such as instruction manuals, sales literature, etc.?
3. How is conformance determined (i.e.: is it done on a component-by-component basis or the product in its entirety, including packaging)?
4. Do these policies encourage technology or process changes to reduce iPCBs during the manufacturing of products?
5. How are limits being enforced?
6. What test methods are being used?
7. What initial and ongoing monitoring is being conducted?
8. How frequently is the ongoing monitoring being conducted?
9. What are the costs associated with the conformance requirements?
10. How have these policies affected manufacturer and product availability?
11. Has the specification caused a change in products being provided and have there been any concerns with quality and performance?
12. If replacement products that conform to the specification are being provided, are there any quality, performance, or other concerns with these replacement products?
13. What are some of the challenges in implementing and managing these lower procurement limit policies?

Using the above questions as a starting point, the researchers created a set of research questions and a table to further illustrate what information could be gathered and analyzed to provide insights into the Task Force's inquiry and actions:

1. What are the similarities, differences, and impacts of PCB and iPCB procurement policies and certifications?
2. What strategy, based on what similar consortia have done, could SRRTTF set to advocate for effective public and company policies regarding PCBs?
3. What is evidence-based practices for stakeholder engagement and intersectoral collaboration that SRRTTF could use to further its mission?

Table 3. Knowledge, Motivation, and Inter-Organizational Influences, Assessments, and Evidenced-Based Practices Impacting iPCB policies (Copied from BRC response to RFP)

Type of Influence	Assumed Influence	Influence Assessment	Evidence-Based Practices
Knowledge	SRRTTF needs knowledge of the procurement policies, certifications, and other interventions that are currently used to control PCBs.	Environmental scan involving the Interstate Chemicals Clearinghouse (IC2), industry association, and other sources to identify where this knowledge resides.	Benchmark each intervention on testing method, conformance compliance, enforcement, monitoring, successes, and challenges in implementation. Information will be gathered from surveys, interviews, and publicly available data.
	SRRTTF needs to know what makes an intervention to reduce chemicals of concern successful within an intersectoral collaboration.	Review of public policy, environmental law, implementation strategies, and intersectoral collaboration.	Literature review to reveal best and evidence-based practices with surveys and interviews from consortium members and similar groups.
Motivation	Are manufacturers and others in the supply chain motivated to reduce PCBs in products, packaging, and other materials used?	Determine if pressure and/or incentives from consumers, brands, government agencies, or others will change processes and products.	Evaluate what is working to reduce PCBs and other chemicals of concern.
	SRRTTF needs to find a way to dovetail or advocate its values into those held by members and the organizations and/or public they seek to influence.	Determine ways to communicate, educate, and influence the intersectoral stakeholders that can make changes.	Literature review on evidence-based practices for intersectoral stakeholder engagement.
Inter-organizational	SRRTTF needs to advocate for the creation/implementation of public policy, market incentives, industry or public awareness to achieve its goal.	Determine strategy and implementation plan based on benchmarks and other evidence-based practices revealed by this research project.	Recommendations from the research team to SRRTTF based on outcomes of this research project.

Procurement policies addressing PCBs

Procurement policies specify an organization's requirements and preferences in purchasing. We reviewed publicly available information about procurement policies, covering city and state governments and businesses, and followed up with interviews. The full database of procurement policies examined is available as a supplemental file (PCB Procurement Policies 2022 - SRRTTF - Braided River NGC).

Government procurement policies allow local, state, and federal agencies the ability to bring the significant spending power of government to bear to enact public policy goals and strategic objectives (Conway, 2012). They may be influenced by legislation or regulatory imperatives but they may also be used to address regional or geographically unique concerns. This is the case in Washington where PCB, both legacy and inadvertent, water quality rules are much more stringent at the local than national level. Environmentally friendly procurement policies have also been adopted in industry and often are influenced by government contracts or consumer demand for safer, more sustainable products (Min & Galle, 2001). Many procurement policies that address chemicals of concern or increase recycling have been successfully implemented, leading to a proliferation of states adopting multiple policies to meet safety and sustainability objectives (Conway, 2012; Min & Galle, 2001). However, as PCB procurement policies are enacted some have struggled to have the desired impact.

Procurement policies covering PCBs face some barriers to success that other procurement policies on hazardous chemicals do not. PCBs were widely used intentionally, and many procurement policies only address intentional PCBs despite broadly claiming that no PCBs are allowed. When PCBs as contaminants are addressed, the procuring organization may trust their suppliers instead of enforcing the policy with testing. If the supplier is unaware that pigments may be a source of iPCBs, they may erroneously believe the product is PCB-free and represent it as such to the procuring organization. The ink manufacturing supply chain is straightforward, from the pigment manufacturer to the ink formulator then to the printer. Yet misinformation along any step in the short supply chain can result in the use of non PCB-free pigments. Pigment manufacturers are very familiar with the possibility of iPCB generation during pigment synthesis. But pigment may undergo various formulations and furthermore pigment choice is driven by the requirements of print specifications, both of which can also affect the ultimate impact of pigments.

While this report focuses on pigments as a source of iPCBs, other sources may contribute such as titanium dioxide, and these will likely be overlooked by procurement policies that focus too heavily on pigments. However, testing can be expensive, and focused procurement policies minimize excessive testing on products unlikely to contain the contaminants of concern. Procuring organizations must balance these competing issues.

A procurement policy's success or failure is often predicated on how much the policy affects an organization's operations or its public perception. A new policy can spur suppliers to make changes such as different formulations and new sourcing. But this information is rarely publicly available and even governments with interest in public transparency may not have collected the necessary data to assess these kinds of changes. The impact of such policies goes beyond merely changing purchasing for a single organization. It can spur so-called "quiet compliance," in which businesses elect to alter product formulation or provide specifications to avoid negative perception. This is one underrecognized impact of California's Prop 65 Right-to-Know Law, where many products were reformulated nationally to avoid labeling in California (Polsky, 2021).

Procurement policies from a sufficiently large actor can also spur other groups to adopt similar policies. One of the key drivers for HP, Inc.'s PCB procurement policy was Washington State's PCB procurement policy; by ensuring all products comply with Washington's policy, they were able to support their sales team and get ahead of regulations (Nestler et al., 2019). Identifying these diverse routes to success reveals further impacts of procurement policies.

Business procurement policies addressing PCBs

The research team identified procurement policies for numerous businesses, focusing on printing and printing ink manufacturers (Supplemental Excel File). Only half of the procurement policies even address inadvertent PCBs. Of those, only HP, Inc, has addressed inadvertent PCBs beyond legal limits and provided test data. Apple and Fuji Xerox also have policies that include inadvertent PCBs, with limits beyond the legal limits, but there are insufficient details available to know the extent to which inadvertent PCBs, particularly those from pigments, are eliminated or minimized from their products as a result, or if there were changes needed to meet those goals at all.

Eleven printing and printing ink manufacturers were contacted for interviews. HP, Inc, in particular provided detailed information on their policy; Apple also provided some clarifications Table 4 summarizes general information retrieved about the procurement policies. See the supplemental Excel file to see full data collected, along with contact information. Further discussion on policies follows the table. Not every business listed sells inks to consumers, but every business does use inks and pigmented products and is involved in printing.

Table 4. Business procurement policies addressing PCBs

Business	Intentional PCBs addressed	Inadvertent PCBs addressed	Pigments mentioned as a potential source	Product examples only focused on intentional PCB use	Source
Apple	Y	Y	N	Y	(B, J., 2021)
Bed Bath and Beyond	Y	100 ppm	N	None listed	(Bed Bath and Beyond, 2013)
Brother	Y	Legal limit	Y	None listed	(Brother Industries, LTD., 2021)
Canon	Y	N	N	n/a	(Canon, 2021)
Dell	Y	nd	N	None listed	(Stutz, M., 2021)
Epson	Y	Legal limit	N	None listed	(Epson, 2021)
Fuji Xerox*	Y	Y	N	None listed	(Fuji Xerox Co., LTD, 2020)
HP	Y	0.1 ppm	N	None listed	(HP, 2021)
Lexmark	Y	nd	N	Y	(Lexmark, P.S., 2021)
Namiki	N	N	N	n/a	(Yaguchi, Y., 2021)
Nitto Kohki	Y	50 ppm	N	Y	(Kohki, N., 2021)
Samsung	Y	N	N	Y	(Samsung Electronics Co., Ltd., 2020)

* The Fuji Xerox Green Procurement Standard states to "Inform us if include[sic] PCBs as impurities" (Fuji Xerox Co., LTD, 2020, pg. 4).

HP

HP Inc.'s procurement policy leads in the industry by addressing iPCB contamination in pigments and inks. All suppliers agree to their General Specifications for the Environment (GSE), which does not allow intentionally added PCBs and limits iPCBs to 0.1 ppm. This limit is at the product level and only applies to components when they are individually purchased. HP Inc. has engaged with suppliers and customers on this issue, surveying suppliers for iPCB contamination and testing results, employing third-party testing, and providing samples to the Washington State Department

of Ecology (WA DOE) for testing. Results from WA DOE following EPA Method 1668c revealed that all HP samples were below the analysis reporting limit[1], when detected at all (WA DOE, 2021). Other testing from HP Inc. revealed that their common ink products were no or low PCB, with the majority testing as no detect (detection limit in ppb) with only a few specialty low-volume inks with <10 ppm but >0.1ppm PCB contamination. As a result, this policy has not resulted in changes to products or materials, in availability, composition, and price.

HP Inc. includes environmental considerations during the development phase as part of their Design for the Environment program. This can empower product designers to select safer materials early on and design with their tolerances and properties in mind. This provides more flexibility in design and material selection compared to workflows that review non-regulatory goals only after the design is finalized.

HP Inc. also focuses on digital printing, while most recycled paper products are printed using analog printing methods. In general, digital printing requires more exact specifications than analog printing and the current formulas have been co-optimized with the printing equipment. iPCB synthesis during certain pigment syntheses can be minimized by process controls in both digital and analog printing methods.

Apple

Apple's procurement policy for suppliers addresses both intentional PCBs and iPCBs. However, current testing and enforcement may not catch iPCB contamination, if present. Apple requires all suppliers to produce test reports showing that chlorine content is less than 900 ppm[2], and reserves the right to require additional testing, as needed.

Fuji Xerox

Fuji Xerox's procurement policy addresses both intentional PCBs and iPCBs. However, there are insufficient publicly available details to ascertain if testing and enforcement are occurring. The procurement policy does state, "Inform us if including PCBs as impurities" (Fuji Xerox Co., LTD, 2020, pg. 4), but does not mention pigments or other potential unintentional sources.

Additional Printing Ink Manufacturers

The research team searched for purchasing policies for several well-known printing ink manufacturers. While many had general purchasing agreements that required suppliers to comply with relevant laws, the researchers did not identify any policies that went beyond legal limits, except for Fuji Xerox. It is possible that internal policies at these manufacturers further address PCBs, but this information is not publicly facing and was not available upon request.

[1] While the specific value of the analysis reporting limit was not mentioned, estimated concentrations for HP samples with detections were all < 0.1 ppb).
[2] 900 ppm chlorine is equivalent to approximately 1250 - 4,800 ppm PCBs.

Printing ink manufacturers are in a different position in the supply chain than printers. In our survey, printers had some kind of separate public environmentally preferable purchasing policy that had details going beyond regulatory requirements, while printing ink manufacturers had more vague general purchasing agreements that included some environmentally preferable purchasing language, but also some did not. However, printing ink manufacturers and printers overlap significantly in their policy requirements.

Government procurement policies addressing PCBs

Governments ban intentional use of PCBs, but very few locales address iPCB contamination through procurement. In many countries, there are legal limits on iPCB contamination in products. In the European Union, there are legal maximum and action levels for food and feed products (Eurofins, n.d.). For example, "since 2012, a maximum level of 40 nanograms per gram of fat for harmful non dioxin-like PCBs in food such as poultry, beef, mutton, pork, cow's milk, eggs and mixed animal fats has applied throughout Europe, supplementing the regulations on maximum levels for dioxins and the sum of dioxins and dioxin-like PCBs" (BMUV, 2022). The European Union also set goals for the disposal and collection of equipment containing PCBs: "In 2019, all remaining PCBs within dielectric equipment in concentrations above 0.005% and in volumes greater than 50 ml must be destroyed or irreversibly transformed by the end of 2025 at the latest" (European Commission, n.d.). In Canada, PCB regulations first came into effect in 2008 with the most recent amendments coming into effect in January 2015 (Government of Canada, 2018). Regulations include "prohibitions on the manufacture, export, import, offer for sale, sale, processing, and use of PCBs and products containing PCBs; in addition, there are stated deadlines for end-of-use and destruction" (Government of Canada, 2018). In the United States, Washington State and the City of Spokane both have procurement policies that address iPCBs. Three government procurement groups were contacted, and all three were interviewed (City of Post Falls, Washington State, and the City of Spokane).

City of Spokane

In 2014, the City of Spokane implemented a preference for products and products in packaging that do not contain PCBs (City of Spokane Municipal Code Section 07.06.172). This followed the passage of the law in Washington State, but went into effect in 2014 while the Washington State policy did not go into effect until 2019. Overall, the policy has had little impact on purchasing by the city.

The Spokane policy indicates that when cost-effective and technically feasible, purchasers must select products or products in packaging that do not contain PCBs above the practical quantification limit. US EPA Method 1668 is specified for the practical quantification limit, but there is no requirement for testing every product. Cost effective means that compliance would not increase the price more than 25%.

Initially, suppliers were confused by the language included in the RFPs, and this communication barrier stymied implementation. Spokane is a relatively small purchaser compared to the expense

of the specified test, and suppliers were reluctant to invest in testing. However, once Washington State's policy went into effect and the state started publicly listing related information, Spokane was able to leverage their work and implement their policy. Generally speaking, Spokane continued to use the same vendors as previously, but some purchasing has changed. Spokane was not aware if formulations had been changed to meet the policy or if they remained the same.

State of Washington

The State of Washington has implemented the most comprehensive and detailed PCB procurement policy to date. In 2014, Washington State passed the Preferable Purchasing Law requiring development and implementation of a state agency procurement policy on PCBs in products and packaging (RCW 39.26.280). The Washington State Department of Enterprise Services (WA DES) developed the procurement policy in collaboration with the Washington State Department of Ecology (WA DOE).

Washington's policy divides products into risk categories based on a qualitative assessment of how likely it is that the product contains iPCBs. The online PCB Risk Calculator[3] is part of a training course for state employees though the content is publicly available. The PCB Risk Calculator can be used to calculate risk for a wide range of products including pigments, clothing, fluids, packaging, and more (WA DES, n.d.). The policy is based on all PCB congeners, but the risk calculator focuses on currently known sources and clarity for non-technical users, and includes consideration of exposure. Based on this determination, a section about PCB preference is included in the request. Purchasers are also encouraged to request more plain packaging and to consider whether there are alternatives that would fit a lower risk category. Some preference is allowed for products and packaging with the lowest level of PCBs.

WA DES has been tracking solicitations and awards in the Washington Electronic Business Solutions (WEBS) system. According to WEBS, statewide, from 1/1/19 to 6/30/21, the state put out 391 solicitations with the section on PCB preference, received 237 vendor responses claiming preference (out of 2602 total responses), and made 108 vendor awards (out of 898 total vendor awards) (Warnock, personal communication, 2022). It is unknown if these awards were the result of PCB preference, or if these awards represent a shift in product selection. Despite extensive training development, a lack of clarity remains for many procurement specialists and vendors. This has resulted in the section being included in solicitations where PCB contamination is not anticipated and can mean that some vendors receive preference on products where it is not relevant. Together, this means the data doesn't provide an accurate picture of how the policy is impacting purchasing, PCB levels in products, or PCB levels in manufacturing.

Time, cost, and lack of understanding have all been credited for the lack of engagement with PCB preference by vendors. Testing costs ~$1600 and requires ~20 days turnaround time. Solicitations are typically posted for 30 days; WA DES has extended this to 45 days more recently, but agencies

3 https://des.wa.gov/sites/default/files/public/documents/About/Procurement_reform/training/NonStateEmp/PCB/RiskCalculator/story_html5.html

are not constrained to a specific time. The vendor must discover the solicitation, read the fine print about PCB preference, access training to understand what that means, locate a lab, complete the testing, understand the results, and submit their bid. With almost half to two-thirds of the time taken up by the test itself, it's not surprising that time is a barrier. The policy would benefit from improved education of vendors (and procurement specialists), grants to help defray the expense (particularly for small businesses), and extended solicitation times. WA DES is currently engaged in outreach ahead of solicitations to help vendors engage with the PCB preference.

The PCB preference was not added retroactively to previous contracts, and contracts last multiple years. A typical master contract lasts six years. Many master contracts have yet to expire since the PCB policy was implemented. Brands are not interested in advertising that their products previously contained hazardous chemicals, regardless of the actual risk to consumers; they are unlikely to publicly advertise that they have reformulated to avoid iPCBs.

This policy has had impacts outside of these awards. The Washington State Department of Transport (WSDOT) piloted the program using road paint, and one of the companies awarded the contract did receive preference for having testing showing they do not contain PCBs. This resulted in increased awareness at WSDOT, and among manufacturers, and enabled staff at WSDOT to identify additional low-hanging fruit to address. For example, there is now language around pigment choice in their master contract (Nestler et al., 2019).

The policy sunsets on January 1, 2024. WA DES will initiate a stakeholder process in 2023 and revise the policy. Currently, WA DES is working to improve data collection to better inform revisions as well. Ultimately, it remains to be seen how much of an impact this policy will have.

Certification entities addressing PCBs

Certifications can provide opportunities to assure that a product meets a particular specification. The research team reviewed how select eco-standards address PCBs (Table 5). PCBs are be restricted in all cases; while some do not explicitly ban the intentional use of PCBs, the legal limits would still apply. All addressed PCBs as contaminants in some way, but for most, the limit is either unknown or higher than the legal limit. Some certifications already handle colorants (pigments and dyes) differently than other intentional ingredients, but do not yet call out inadvertent PCBs; only Cradle to Cradle Certified (C2CC) mentions iPCBs and pigments. None reviewed specifically called out other sources of inadvertent PCBs.

For many certifications, PCBs are considered contaminants, but the threshold is 100 ppm (0.01%). This is not specifically targeting PCBs from pigments. In others, PCBs may not be explicitly listed on an RSL, but the criteria used for exclusion would exclude all PCBs due to their presence on certain specific lists.

Table 5. Eco-standards and restrictions on PCBs

Eco-certification	Intentional PCBs addressed	Inadvertent PCBs addressed	Comments
Cradle to Cradle Certified (C2CC)	Y	Y, < 0.1 ppm	Testing required for products that are colorants, pigments, dyes, or inks containing diarylide yellow, orange, and red and phthalocyanine blue and greens pigment
EWG Verified	Y	Unknown	Focused on personal care products
Green Seal	N	Y, < 100 ppm	No specific prohibition of PCBs, but PCBs are prohibited as contaminants above 100 ppm in formulated product
GreenScreen Certified	Y	Y, < 100 ppm	These assessment methods do consider contaminants, but the standard threshold is 100 ppm
ToxFMD	Y	Y, < 100 ppm	
Made Safe	Y	Yes, limit unknown	Made Safe intentionally does not address intentional use of substances that are already illegal.

Cradle to Cradle Certified

Cradle to Cradle Certified (C2CC) is a leading certification in addressing iPCB contamination. They are the only eco-certification that has specific testing requirements for PCBs related to certain pigments as an inadvertent source: "If [PCBs are] present as an unintentional trace contaminant the substance must be present below detection with a detection limit of 0.1 ppm [limit based on Apple's Regulated Substances Specification 069-0135-K]. Testing is required for products that are colorants, pigments, dyes, or inks containing diarylide yellow, orange, and red and phthalocyanine blue and greens pigments." (All Products Sheet, G37). This does leave some gaps, as other pigments and materials can serve as potential iPCB sources. C2CC does not publish an explanation for why a given reference is selected.

EWG Verified

The EWG Verified Unacceptable List does identify PCBs, including the general entry with CAS# 1336-36-3 that covers the entire category of 209 congeners. They do not allow products to contain anything listed on the Unacceptable List. It is unknown if there is any enforcement or monitoring.

Made Safe

Made Safe does not address the intentional use of PCBs. This was done to increase focus on chemicals that are more likely to be used. Various PCBs are listed on the contaminant list. It is not clear from publicly available information whether this certification would address iPCBs with a low enough limit.

Results

The research team reviewed and analyzed procurement policies and certifications for how they handled PCBs, both intentionally added and as contaminants. Insufficient data has been collected in order to assess the efficacy of these policies, either by public change or via quiet compliance, at reducing PCB levels in purchased products, at increasing the availability of no- or low-PCB products, at reducing the amount of PCBs generated, or at reducing the amount of PCBs released into the environment. Certifications have yet to address iPCBs from pigments (only one of multiple important sources), with only one specifically looking at it at all. However, through reviewing the available data and interviews with those involved in procurement and the pigment supply chain, we were able to identify some general trends, challenges, and key considerations for procurement policies addressing PCBs moving forward.

Procurement policies varied greatly, with PCB restrictions ranging from legal limits to not present (non-detectable). Washington State requires test results to receive preference, and some organizations, like HP, Inc., have completed testing or required testing internally. Other than that, no organization reviewed engages in routine monitoring or verification that they will discuss publicly. Users are not able to perceive that there is any problem, as PCBs at these levels do not change the appearance or any other easy to sense property; expensive testing is required. As a result, these policies function on the honor system, trusting but rarely verifying.

Without assessing PCB levels before and after implementation of the procurement policy, it is challenging to accurately assess its effectiveness. Vendors are reticent to publicly announce changes that reduce or eliminate PCBs, even though the change is positive, as it may require them to admit that their products, either other products currently offered or previous versions of these products, contain(ed) PCBs. Quiet compliance removes the communications challenge of explaining this complex situation to customers. Washington State is currently collecting some data on how often the preference language has been used in RFPs, and how often preference is granted. A preliminary case study by WSDOT revealed some changes in product offerings.

Lack of awareness through the supply chain paired with lack of verification results in effectiveness challenges. Those who directly deal in pigments, including pigment manufacturers and ink and paint formulators, were aware of the issue due to the legal requirements on PCB contamination in pigments. This awareness did not necessarily extend any further into the supply chain, such that those dealing with disposal were surprised to learn that pigments could be a source of iPCBs.

Awareness challenges are confounded by the technical competence required to understand the issue. Procurement specialists must be trained so they can explain current PCB regulations and requirements to vendors. Vendors need to take this information back up the supply chain so determinations can be made regarding necessary formula or sourcing changes, if needed. Some vendors may dismiss language about iPCBs from pigments or other sources due to lack of understanding and a resulting assumption that it must not apply to their product(s). This could be simplified by requiring the language and testing for all products, even those unlikely to contain PCBs. However, that would increase costs and disadvantage smaller businesses relative to larger

ones. When paired with verification, this lack of awareness and lack of technical understanding can be revealed and addressed. Without verification, the extent is unknown.

Organizations have long focused on legacy PCB cleanup, and monitoring has often been limited to a subset of congeners that best represent these legacy sources. As legacy sources are addressed over time, and assuming no new intentional manufacturing of PCBs is inexplicably allowed, iPCBs will eventually be the greatest source of PCBs to the environment, if they are not already. Policies reviewed reflect this, with more addressing legacy PCBs than iPCBs.

While there has been significant focus on iPCBs from pigments due to high levels of pigment-associated PCB-11, it remains unclear which pigments are contaminated and at what levels. The ChemForward pigment database funded by SRRTTF helps address this, but it is possible that contamination levels could vary from batch to batch or manufacturer to manufacturer (Nestler, 2019). There are also other sources of iPCBs that need to be explored to fully address this issue.

Almost all organizations listed PCBs as banned from intentional use, and many that address iPCBs list 50 ppm as the threshold, essentially re-iterating one aspect of the legal limits. Beyond this, criteria vary, and businesses are left with potentially needing to test multiple times to meet the different organization's criteria. This can be particularly hard for small businesses to manage. Spokane was able to utilize Washington's new database, and further aligning criteria among different procurement policies and certifications can provide clear instruction to manufacturers and minimize expenses. Policy revisions should aim to utilize and improve upon this database. Certifications can also provide a mechanism for businesses to streamline verifications and be trusted by multiple organizations. This alignment can also help with the time constraints of the RFP.

Pigments, printing inks, and packaging all operate on thin margins, and these procurement policies and certifications all represent an increase in cost. Now is a potentially powerful time to engage the pigment and ink industries due to supply chain disruptions (Ink World, 2022). These increased costs and logistical challenges provide both an opportunity and a barrier for success. While increased costs and complexity can make it more difficult for a manufacturer to consider changing pigments to minimize or eliminate iPCBs, the necessity of change provides an opportunity to consider alternatives.

Diverse procurement policies handle PCBs, variously addressing them as intentional ingredients and/or unintentional contaminants. We reviewed procurement policies of 27 organizations and 9 different green material certifications. No organizations collected data that would accurately assess the efficacy of implemented policies, at least not that is shared publicly; WA DES has started collecting some relevant info and continues to work on improving the data available, and HP, Inc., has shared testing results. Few policies have clear accountability, with no enforcement or monitoring beyond the honor code; businesses may be enforcing or monitoring without sharing publicly. The length of the supply chain and disposal paths separates those making final product decisions from those with knowledge about the problem and the ability to potentially address PCB contamination.

Despite these challenges, we identified some strategies that may improve effectiveness, even for policies that are never truly successful. Organizations that align standards can build off each other's efforts, simplifying compliance for businesses; the City of Spokane was able to partially implement by relying on Washington State. Policies can be streamlined, minimizing testing requirements and improving communication up and down the supply chain, with data collection planned from implementation to allow for future research to make conclusive recommendations.

Consortia Addressing Chemicals of Concern in River Systems

Across the country, a number of consortia are dedicated to addressing the existence and reduction of chemicals of concern, including PCBs, in their local waterways. Specific consortia are examined in detail below, some of which were formed in response to Superfund designations and mitigation efforts. Each consortium is comprised of a distinct set of stakeholders and decision makers that perform a range of responsibilities and duties within their respective local contexts.

River System Profile: Hudson River, New York

The Hudson River, for greater than 200 miles below Hudson Falls, NY, is extensively contaminated with PCBs. Surface waters, sediments, floodplain soils, fish, birds, wildlife, and other biota are all contaminated with PCBs. PCB concentrations are generally highest in those areas that are closer to the GE facilities, which are responsible for the majority of the area's PCB contamination (Hudson River Natural Resource Trustees, 2013). Today, the EPA classifies 200 miles of the Hudson River as one of the largest Superfund sites in the country (EPA, 2022). In March 2021, a federal judge dismissed a New York State lawsuit against the EPA, which in 2019 issued General Electric a certificate of completion for Hudson River dredging remediation (NBC New York, 2021). The EPA is implementing a phased approach to address the Hudson River Superfund site, comprised of the following (EPA, 2019, p. 4-5):

1. In-place capping of exposed areas of PCB-contaminated sediments
2. Removal of PCB-contaminated sediments via environmental dredging within areas targeted for remediation, followed by placement of backfill or capping;
3. MNA (monitored natural attenuation) of PCB contamination that remains in the river after dredging;
4. Monitoring of fish, water, and sediment to determine when remediation goals are reached;
5. Habitat replacement and reconstruction and associated monitoring; and
6. Implementation of appropriate institutional controls such as fish consumption advisories and fishing restrictions by the responsible authorities.

A number of community stakeholders, nonprofit entities, and cross-functional government entities are involved with the Hudson River Superfund site. The EPA's designation as the lead agency for the cleanup of the site (Fact Sheet, n.d.), affords a level of involvement of the federal government that may not be present at non-Superfund sites. As lead agency, the EPA is the primary coordinator and contact for remediation efforts. The New York State Department of Environmental Conservation (NYSDEC) is the support agency, and federal trustee agencies (known as the Hudson River Natural

Trustees) include the New York State Department of Environmental Conservation (DEC), Department of Commerce/National Oceanic and Atmospheric Administration (NOAA), and the US Department of the Interior/US Fish and Wildlife Service (USFWS), and the National Park Service (NPS) (EPA, 2022a).

Each of the Trustee agencies has specific spheres of responsibility and coordinates its efforts to "select appropriate restoration options, avoid duplication, reduce the time required to restore natural resources, and save money" (Hudson River Trustee Council, 2002). Currently, the Trustees are engaged in Phase 2 of the Natural Resource Damage Assessments (NRDA) – "Injury Assessment/Restoration Planning" which consists of ongoing studies to document the level of harm PCBs have had on resources and what restoration needs to be completed (New York State Department of Environmental Conservation, n.d.).

In addition to the Trustees, the New York State Department of Health is involved with PCB monitoring efforts for the Hudson River in two ways. The Bureau of Toxic Substance Assessment sets the fish advisories for the entirety of New York State and the Bureau of Environmental Exposure Investigation works with both the DEC and EPA on Superfund and remediation sites around the state (A. Van Genechten, personal communication, 4/27/2022). The Hudson River Fish Advisory Outreach Project is a multi-year initiative of the NY State Department of Health (2021) and the project releases highlights of the program's annual Hudson River fish consumption survey; the 2019 data is expected to be released in late Spring 2022.

Lastly, the Community Advisory Group (CAG) for the Hudson River PCBs Superfund site provides continued engagement and information sharing among community entities and stakeholders. The Hudson River CAG serves "as a forum for the regular exchange of information between members of the community and EPA" (CAG, n.d.). The CAG has a defined set of operating procedures that define its member composition (15-25 seats), roles and responsibilities, and defined review processes (Hudson River PCB Superfund Community Advisory Group, 2019). The March 31, 2022 CAG meeting included presentations from three representatives from the EPA and one representative from the DEC and topics included Long-term Monitoring Program Updates and Routine Monitoring of the Fish Program (Hudson River PCBs Superfund Site, 2022). Meeting attendees also included representatives from prominent local stakeholders including the Sierra Club Atlantic Chapter, Riverkeeper, and Scenic Hudson, a Hudson Valley non-profit and advocacy group with an over 40-year history of advocacy and educational campaigns (Scenic Hudson, 2022). Hudson River Sloop Clearwater also has a decades-long history of involvement with Hudson River advocacy and clean-up efforts (Clearwater, 2001) and in the past has often aligned with other environmental groups to demand additional and more comprehensive PCB cleanup efforts to meet stated safety targets (Riverkeeper, 2017). The CAG meetings are ongoing with the next scheduled meeting to take place in May 2022.

Consortia Profile: Chesapeake Bay Program

The Chesapeake Bay Program was first formed in 1983 as a multi-agency, cross-jurisdictional cooperative partnership that has since evolved to establish a clear vision and strategy to "reduce

pollution, restore habitats, protect living resources, promote sound land-use practices and engage the public in Bay restoration" (Chesapeake Bay Program, 2022a). The Chesapeake Bay spans six states (Maryland, Virginia, Delaware, Pennsylvania, West Virginia, and New York) and the District of Columbia (Chesapeake Watershed Agreement, 2014); this large geography necessitates a concerted, managed effort across different levels of government, non-governmental organizations, and a wide variety of entities to achieve its goals. The 2014 Chesapeake Watershed Agreement established ten goals and 31 outcomes to restore the Bay. The Chesapeake Bay Program is uniquely organized and comprises an Executive Council, Staff Committee, goal implementation teams (GITs), workgroups, and action teams, as shown below in Figure 2.

Figure 2. Organizational Structure of the Chesapeake Bay Program

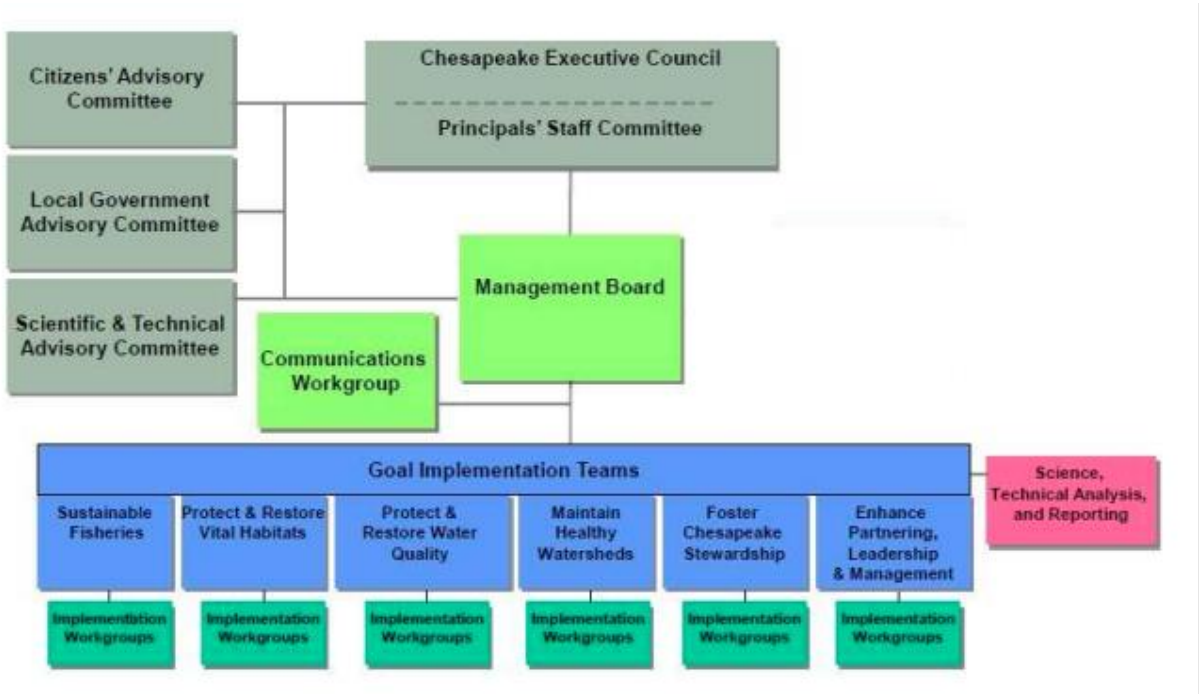


Image Source: (CPB Governance and Management Framework Document, 2021)

The structure and organization of the Chesapeake Bay Program allow for the establishment of overall policy direction and progress toward the execution of specific goal-directed activities. For example, the Executive Council is comprised of the governors of the six watershed states, the mayor of the District of Columbia, the chair of the Chesapeake Bay Commission and the administrator of the US Environmental Protection Agency (Chesapeake Bay Program, 2021). The three Advisory committees are comprised of "appointed and/or elected volunteers…provide independent perspectives from critical stakeholder groups" and the GITs furthermore have specific governance rules and procedures that are consistent across them (Chesapeake Bay Program, 2021). The activities and scope of the Water Quality Goal Implementation Team (WQGIT) is worthy of particular attention due to its specialization and charge to "evaluate, focus, and accelerate the implementation of practices, policies, programs that will restore water quality in the Chesapeake Bay" (Chesapeake Bay Program, 2022c).

The Water Quality GIT, also known as WQGIT or GIT3, is comprised of workgroups and voting members who report to the Management Board and Principal's Staff Committee. The WQGIT and WQGIT workgroups operate according to a Consensus Continuum, adapted from the Center for Leadership and Organizational Change (Chesapeake Bay Program, 2022c). The Toxic Contaminants Workgroup (TCW) is one within WQGIT that was established in 2014 after the signing of the Chesapeake Bay Watershed Agreement and exists to "accomplish the toxics contaminants goals and outcomes outlined in the Agreement" (Chesapeake Bay Program, 2022d). The TCW has developed Policy and Prevention Logic and Action Plans and Management Strategies that are released and available to the general public on their website; in addition, TCW members meet on a monthly basis. The 2022 TCW monthly meetings taking place in Q1 include presentations on topics ranging from contaminant trends, PCB TMDLs for Maryland[4] and Virginia[5], and the status of the TCW itself. The annual review of group goals and outcomes, in addition to the establishment of the year's priorities (TCW, 2022), strengthen alignment among the TCW's members and provide the opportunity to discuss what was learned from previous strategies and action plans. In 2022, among other goals, the group will update existing and expanded story maps for PCBs and other contaminants; and the group will undergo a progress review with the Management Board (TCW, 2022). The TCW, in addition to driving the Chesapeake Bay Program's PCB monitoring efforts, also prepares critical status reports and updates to leadership regarding ongoing PCB monitoring efforts – and most importantly, identify potential means of improvement.

In December 2021, the TCW released a response to the Chesapeake Bay Program Principal Staff Committee (PSC) summarizing potential enhanced monitoring of PCBs and emerging toxic contaminants (PFAS and microplastics) as two of the highest priorities (TCW, 2021).

Figure 3. Components of the PCB Monitoring Objective

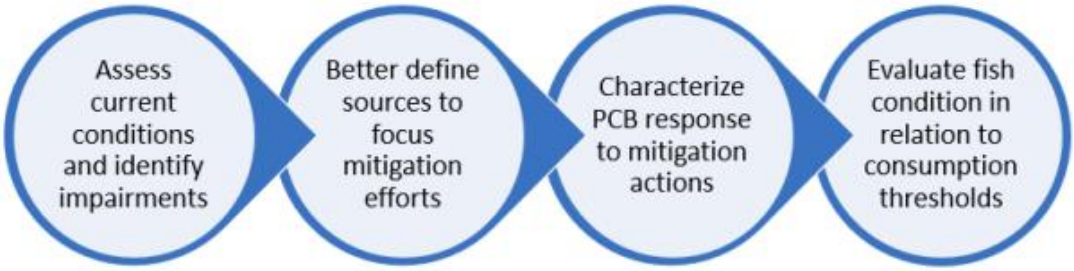
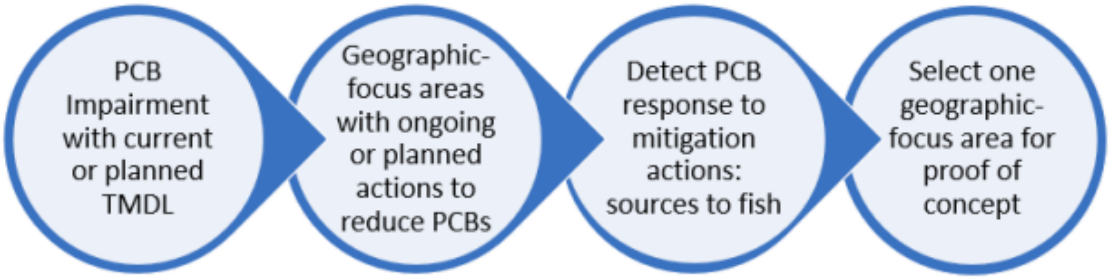


Figure 3 outlines the components of the PCB monitoring objective as developed by the TCW. Following a data inventory analysis of the four components, the TCW found adequate monitoring except for the third component; thus, it developed an overall approach for enhanced monitoring to help jurisdictions assess PCB response to mitigation, shown in Figure 4 (TCW, 2021).

[4] https://www.chesapeakebay.net/channel_files/44146/md_pcb_tmdl_development__implementation_030922.pdf
[5] https://www.chesapeakebay.net/channel_files/44146/mark_richards_va_pcb_tmdls.pdf

Figure 4. Selecting a geographic focus area and sampling approach



The TCW's systematic design and selection of a PCB monitoring process can help assist jurisdictions to meet the CBP's toxic contaminants goals and outcomes. The TCW plays a vital role in the Chesapeake Bay Program's ongoing efforts to ensure a safe and clean environment for years to come. The organizational structures and entities that make up the various workgroups, GITs, committees, Boards and Councils that make up the Chesapeake Bay Program may be complex. However, the specialization and inherent cross-collaborations that are maintained through specialized groups such as the TCW play a critical role in developing and executing strategies to effectively address PCBs in the Chesapeake Bay.

Consortia Profile: San Francisco Bay, California

The San Francisco Bay is a dynamic waterway that has played a critical part in the growth of communities in the surrounding Bay Area. However, a legacy of past PCB contamination and stormwater runoff continues to pose challenges to the health and safety of humans, fish, and wildlife that reside in or near San Francisco Bay (California Water Boards, n.d.). In 2010, the EPA approved a TMDL for PCBs in the San Francisco Bay Area; both the Regional Water Quality Control Board (Water Board) and State Water Resources Control Board adopted the San Francisco Bay PCB TMDL in 2008 and 2009 respectively (California Water Boards, 2022). The PCB TMDL contains key implementation actions to reduce PCBs through:

- municipal stormwater permits;
- discharge permits for municipal and industrial wastewater sources of PCBs;
- PCBs in cleanup, remediation, and spill sites; and
- fish consumption risk reduction activities (California Water Boards, 2022).

The Regional Monitoring Program (RMP) is a key monitoring component of PCBs within the water, sediment, and fish in the San Francisco Bay (SFEI, 2021). It is an initiative between the San Francisco Bay Regional Water Quality Control Board, the regulated discharger community, and the San Francisco Estuary Institute (SFEI, 2018). Through its two-year reporting, the RMP provides critical program area data for management decisions in areas such as:

- PCBs TMDL
- NPDES (National Pollutant Discharge Elimination System) Municipal Regional Stormwater Permit and wastewater permit requirements
- Focusing management actions and/or locations for reducing PCB impairment (upland)

- Determining cleanup priorities (in-Bay)
- Updating the fish consumption advisory (SFEI, 2021)

The RMP has been monitoring contaminants in Bay fish since 1997 and has documented that PCBs have shown only modest signs of long-term decline (SFEI, 2021). Cities and county entities must collaboratively engage and implement effective solutions to meet the commitments of the TMDL, address sites of historical contamination, and reduce contaminants (including PCBs) that continue to enter the Bay. The Bay Area Municipal Stormwater Collaborative (BAMSC) is one such entity that focuses on the continued cooperation of Bay Area municipal stormwater programs to achieve such goals.

BAMSC was formed in 2021 following the dissolution of BASMAA (Bay Area Stormwater Agencies Association) in 2020; it serves to coordinate efforts across counties and state agencies (BASMAA, 2021a). BAMSC is comprised of a Steering Committee and five subcommittees as needed; its priorities for 2021-2022 include the re-issuance and implementation of Municipal Regional Permits and coordination with the Water Board and Caltrans (BASMAA, 2021a). Prior to the formation of BAMSC, BASMAA was a nonprofit entity whose board was comprised of directors from agencies and water districts neighboring the San Francisco Bay (BASMAA, 2021b). BASMAA led or was a grant recipient for a number of Bay Area water improvements projects such as Clean Watersheds for a Clean Bay (CW4CB) [6]and a project for managing PCBs during demolition that included outreach and training materials.[7] Following the spirit of BASMAA though in a more informal structure, BAMSC provides recommendations to Bay Area agencies, collects priorities, and shares key messaging among its members. One example of a local government entity that works in collaboration with BAMSC is the C/CAG (City/County Association of Governments) of San Mateo County.

The C/CAG of San Mateo County explored a Regional Collaborative Program Framework to better address and achieve objectives through regional-scale stormwater management (SMCWPPP, 2022). A Regional Collaborative Program would unite the efforts within San Mateo County with a goal "to cost effectively comply with water quality regulatory requirements" that would include PCB and mercury load reduction as a proposed metric/evaluation factor (SMCWPPP, 2022). One finding is that there would be "estimated cost savings of 75% to 95+% to achieve equivalent PCBs load reduction through green stormwater infrastructure" (GSI) compared to a jurisdiction-by-jurisdiction scenario (SMCWPPP, 2022). A regional collaborative program project currently under construction is the Orange Memorial Park Regional Stormwater Capture Project. The project will include water treatment and hundreds of acres greened, in addition to 10g of PCBs removed annually (SMCWPPP, 2022). The evidence indicates that regionally coordinated efforts within a single county can have a substantial impact and cost savings for local governments. In addition, multijurisdictional funding can be a critical component of success for large projects. A challenge when working with different jurisdictions is that municipalities may be willing to commit to different levels of intervention, whether the bare minimum required or more substantial actions. Within San Mateo County, the San Mateo Countywide Water Pollution Prevention Program

[6] https://basmaa.org/featured-programs-projects/clean-watersheds-for-a-clean-bay/
[7] https://basmaa.org/featured-programs-projects/pcbs-management-during-demolition/

(SMCWPPP) is itself a collaborative entity that unites the efforts of member agencies and cities to address water pollution concerns in the Bay.

The SMCWPPP was established in 1990 and its efforts encompass 20 cities and the county; its goal is to "reduce the pollution carried by stormwater into local creeks, the San Francisco Bay, and the Pacific Ocean" (Flows to Bay, 2022a). The public outreach arm, Flows to Bay, partners with local agencies to educate residents, businesses, and students on the effects of stormwater pollution and what actions they can take (Flows to Bay, 2022b). SMCWPPP has eight subcommittees to oversee specific areas of pollution prevention so the County can remain in compliance with the Municipal Regional Permit (MRP) (Flows to Bay, 2022c). The Stormwater Committee is "comprised of director-level appointees from each of C/CAG's member agencies and one non-voting member of the Regional Water Quality Control Board" (Flows to Bay, 2022c). The technical expertise of SMCWPPP members are powerful tools for not only relaying vital information to county leadership but also have direct impact on the community's health and safety. The SMCWPPP oversees four programs involving PCB work in the County:

1. Programmatic elements to reduce PCB loads from buildings
2. Electric utilities: oil-filled materials with PCBs and tracking replacements
3. Bridge replacements, e.g., PCBs present in old caulking
4. Source properties and abatements (R. Bogert, personal communication, 4/1/22)

SMCWPPP staff also provide important context and details of topics ranging from storm drain systems to municipal capital improvements and developments to the Regional Water Board (R. Bogert, personal communication, 4/1/22). These efforts are critical, especially during the period before the reissuance of the Regional Storm Permit (MRP 3.0), which is scheduled to occur in May 2022 (C/CAG Stormwater Committee, 2022). After the adoption of MRP 3.0, the SMCWPPP will continue to play a vital role in the development, coordination, and execution of PCB mitigation efforts both within the county and in the wider Bay Area.

The examples of consortia and locales highlighted above provide real-world examples of the power and benefits of intersectoral collaboration. Additionally, many communities are home to local environmental nonprofits and advocacy groups that have decades of experience with community organizing, outreach, and education initiatives. Engagement and collaboration are critical components of success, especially when long-lasting environmental harm has been done. Solutions lie in the united efforts across multiple levels of government, jurisdictions, and community entities. The following section provides further details of evidence and best practices for intersectoral collaboration and stakeholder engagement.

Intersectoral Collaboration and Stakeholder Engagement

Smart practices and evidence-based practices (EBPs) for intersectoral collaboration and stakeholder engagement have been identified by social science researchers and can aid SRRTTF in achieving its pollution prevention goals. Evaluation metrics and performance measurements may be applied to these practices to improve SRRTTF's impact. In this section, systems thinking and

applicable conceptual models are investigated, followed by a list of SRRTTF's stakeholders and a table of stakeholder interests, and finishes with a series of recommendations for action.

Intersectoral Collaboration: Smart and Evidence-Based Practices. Fifteen practices that are central to intersectoral collaboration success are indicated in the scientific literature. The findings for intersectoral collaboration are grouped by purpose; roles; actions; motivations; commitment; trust; inclusion and diversity; legitimacy; ground rules; power and resource imbalances; dialogue; innovation; accountability; success measures; and leadership.

Identification of Purpose, Roles, Actions, Motivation, & Commitment. Intersectoral collaboration benefits from strategies facilitating the creation and sustainability of collaborative processes (Center for Collaborative Policy, n.d.a). The purpose of the collaborative effort along with roles and responsibilities of participants should be clearly defined (Alexander, Comfort, and Weiner as cited in Ansell & Gash, 2008; Allnock, Akhurst, Tunstill, & NESS Research Team, 2006; Center for Collaborative Policy, n.d.b; Johnson, Zorn, Yung Tam, LaMontagne, & Johnson, 2003; Khosla, Marsteller, & Holtgrave, 2013). The common purpose creates the foundation to identify shared motivation and commitment among the participants (Emerson, Nabatchi, & Balogh, 2011; Ansell & Gash, 2008). The types of collaborative actions the stakeholders plan to take should also be determined as part of the process (Emerson et al., 2011). The SRRTTF determines its ongoing actions and review of research reports, such as this one, and the results of its advocacy at the state and national level.

Developing Trust. The development of trust among participants is an EBP and is important to intersectoral collaboration success (Ansell & Gash, 2008; Bartlett, 2012; Bryson, Crosby, & Stone, 2006; Emerson, et al., 2011; Foster-Fishman, Berkowitz, Lounsbury, Jacobson, & Allen, 2001; Johnson et al., 2003; McDermott et al., 2011; Walker & Senecah, 2011). Building trust is an especially important practice to enable stakeholder engagement in environmental disputes, particularly between stakeholder groups with imbalanced power (e.g. tribal groups and industry interests) and between competing stakeholder groups (e.g. competing companies) (J. Chiavara, personal communication, February 21, 2016; J. Tickner, personal communication, February 29, 2016). Working with stakeholders to ensure commitment to the collaborative process presents another critical strategy for success (Ansell & Gash, 2008; Emerson et al., 2011). Recognition of the interdependence that participants have in the collaborative process creates trust and builds commitment to collective action (Ansell & Gash, 2008; Intersector Project, n.d.). Regularly reaching out to both participants and nonparticipants establishes greater trust upfront, especially among stakeholders who may be critical or skeptical (McDermott et al., 2011).

Inclusive & Diverse Engagement. Collaborative processes should be inclusive and represent a diversity of stakeholders, including stakeholders representing differing opinions (Ansell & Gash, 2008; Emerson et al., 2011; Foster-Fishman et al., 2001; Iles & Mulvihill, 2012; S. Rogers, personal communication, February 19, 2016; Zahner, 2005). Engaging a diverse group of stakeholders is an EBP and helps a collaboration overcome hurdles, builds a consortium's sources of knowledge, and strengthens its credibility (McDermott et al., 2011; Zahner; 2005). Pollution prevention initiatives

bring together a variety of stakeholders involved with green chemistry including collaborators from "natural scientific, policy, social scientific, engineering, business, and public health disciplines" (Iles & Mulvihill, 2012, p. 5643). From local agencies to federal regulators, from industry associations to emitters, the Task Force continues to engage diverse groups in dialogue around its mission to reduce PCBs in the Spokane River, thereby demonstrating its commitment to evidence-based practices to reduce chemicals of concern.

Legitimacy, Ground Rules, Power & Resource Imbalances, Dialogue, & Innovation. The design or structure of the collaborative process also supports successful strategies (Ansell & Gash, 2008; Bryson, Crosby, & Stone, 2006). Steps that establish legitimacy for the collaboration, from both internal and external perspectives, lead to success (Bryson, Crosby, & Stone, 2006; Center for Collaborative Policy, n.d.b; Emerson et al., 2011; McDermott et al., 2011; Provan & Milward, 1995). Ground rules are another important part of the collaborative process and should be set collectively (Ansell & Gash, 2008; Center for Collaborative Policy, n.d.b; Emerson et al., 2011; Foster-Fishman et al., 2001; Linden, 2003; McDermott et al., 2011). If power and resource imbalances exist, steps should be taken to empower stakeholders and address such differentials (Allnock et al., 2006; Ansell & Gash, 2008; Bryson, Crosby, & Stone, 2006; Emerson et al., 2011; Linden, 2003; McDermott et al., 2011). The use of a trusted and neutral facilitator balances multiple perspectives and manages conflict within the collaboration (W. Leach, personal communication, February 21, 2016; J. Tickner, personal communication, February 29, 2016). Opportunities for participants to engage in "authentic dialogue" develop understanding and empower participants to improve group function (Ansell & Gash, 2008; Innes & Booher, 2004, p. 428; Intersector Project, n.d.).

Intellectual capital, combined with the creative resources that come with engaging diverse stakeholders, leads collaboratives to innovation (Pynes, 2013). One of the myriad ways SRRTTF has built intellectual capital is through engaging stakeholders at the iPCB conference held in October of 2019. During this event many stakeholders shared vital information, discussed public policy implementation complexities, and started working groups that addressed technical barriers to implementation of alternatives.

Accountability & Success Measures. Critical practices also involve establishing expectations and accountability for the group (Bryson, Crosby, & Stone, 2006; Crosby & Bryson, 2010; Emerson et al., 2011; Intersector Project, n.d.; Linden, 2003; S. Rogers, personal communication, February 19, 2016). Accountability includes determining how to define success for the collaboration and the impact sought (Bryson, Crosby, & Stone, 2006; Emerson et al., 2011; Intersector Project, n.d.). Formal agreements, such as Memoranda of Understanding, facilitate, define, or address the partnership's purpose and goals, accountability, legitimacy, ground rules, and power or resource imbalances (McDermott et al., 2011). The SRRTTF has several MOUs in place that ensure the accountability of each stakeholder member.

While MOUs help hold individual actors within the collaborative accountable it is important the collaborative is evaluating its success in achieving its mission. Formal evaluation of SRRTTF activities is recommended and further discussed in the evaluation section. Some organizations find

it helpful to employ an outside evaluator to provide more accurate and sophisticated methods or simply to ensure evaluation occurs when the organization has little internal capacity to conduct evaluation activities. Deciding on appropriate metrics is a key part of successful evaluation and somewhat difficult. Suggested metrics for SRRTTF are listed and can provide a helpful starting point.

In the context of this study, it is important to note that it is more difficult to exert influence over external stakeholders, especially those with voluntary policies to reduce processes and products that create or contain iPCBs and PCBs. In these instances, accountability must be established through advocacy and external pressure that is appropriate to the sector. For example, finding ways to encourage government agencies to engage in formative and summative evaluations of their procurement policy implementation and share results publicly. Company accountability for policy implementation may be accelerated by public demand for products and processes that avoid the creation of iPCBs. Advocacy watchdogs may be able to exert such pressure and could be collaborators in SRRTTF's efforts.

Leadership. Leadership, another EBP, is also essential in the creation and sustainability of intersectoral collaborations (Emerson et al., 2011). Many of the strategies previously discussed including determining ground rules, supporting the creation of trust, engaging in dialogue, and identifying common incentives and goals are enhanced by strong leadership (Allnock et al., 2006; Ansell & Gash, 2008; Johnson et al., 2003). The responsibilities of leaders in a consortium include "framing the agenda, convening stakeholders, and structuring deliberation" (Page, 2010, p. 248). Furthermore, leadership occurs in multiple ways, both formally and informally (Bradford, Lasker & Weiss as cited in Ansell & Gash, 2008; Bryson, Crosby, & Stone, 2006; McDermott et al., 2011). Collaboration champions, leader's that push the group agenda at their individual agencies, further the group's work, including the engagement of new stakeholders (Bryson, 2011; Intersector Project, n.d.; McDermott et al., 2011). SRRTTF can look to its current collaboration champions to find ways to exert pressure on external stakeholders involved in these voluntary policies.

Change Management. Intersectoral collaboration is designed to create change, therefore, change management leadership is critical to moving forward many of the collaboration and engagement strategies identified through the study. Good leadership aids the development of trust, addresses imbalances, secures an inclusive process, and creates opportunities for dialogue (Ansell & Gash, 2008). Outcomes of initiatives are improved by creating champions for change and developing shared leadership opportunities (Bradford and Lasker & Weiss as cited in Ansell & Gash, 2008; Bryson, 2011; Bryson, Crosby, & Stone, 2006; Intersector Project, n.d.; Kotter, 1998; McDermott et al., 2011). Leaders should also ensure diverse interests are represented along with essential expertise, skills and groups (Ansell & Gash, 2008; Intersector Project, n.d.; Kotter, 1998; Page, 2010). Similarly, any additional resources necessary to achieve goals should be identified (Intersector Project, n.d.; Walker & Senecah, 2011).

Identifying opportunities for change and creating a "sense of urgency" helps leaders facilitate change management (Kotter, 1998, p. 29; Tichy & Devanna in Denhardt, Denhardt, & Aristigueta,

2013). Leaders should also develop a structure to incorporate new changes into the organization or work of the collaboration (Kotter, 1998; Tichy & Devanna in Denhardt et al., 2013, p. 212). Furthermore, three key areas for leading change include: the content of the change, which could include structures, services, systems, technology or other items; people, including communication, engagement and other human factors related to change; and the process for making the changes (Anderson & Anderson, 2011).

Intersectoral collaborations bring a variety of entities together and each sector offers unique perspectives and resources to the partnership (Intersector Project, n.d.). Recognition of and communicating the benefits of collaboration is crucial to success (Intersector Project, n.d.). Participants should also work to develop a vision for the collaboration's change efforts and leadership plays an important role in promoting the shared vision (Kotter, 1998; Bryson, 2011; Intersector Project, n.d.; Tichy & Devanna in Denhardt et al., 2013). Leaders should also identify opportunities to support communication efforts related to the vision, progress updates, and acknowledging successes of the collaboration (Intersector Project, n.d.; Kotter, 1998). Strong leaders know how to keep both the immediate progress of programs and the big picture goals for the future in mind (Kotter, 1998). Inspirational vision statements should be agreed upon among key decision-makers to create buy-in from all participants (Bryson, 2011; Intersector Project, n.d.).

A strong vision statement serves multiple purposes including a shared understanding among those involved and the opportunity to build excitement for the work being undertaken (Bryson, 2011; Intersector Project, n.d.; JISC, 2012). Alignment between individual and organizational values, expressed through the vision statement, enhances commitment to the organization and group (Finegan, 2000). Empirical studies tie vision statements to improved performance for individuals, teams, and organizations (Kirkpatrick, Wofford, & Baum, 2002).

Stakeholder Engagement: Smart and Evidence-Based Practices. Effective stakeholder engagement is accomplished through a variety of EBPs and smart practices. The practices revealed through research include early engagement strategies, targeted messaging, identifying and nurturing champions, and employing neutral facilitators (or having an organization act as a neutral convener). Trust recurs as an important factor, the role of collaborative governance is explored, and technology tools that coordinate stakeholders, are all required. Leadership's centrality in the elements for successful stakeholder engagement is also affirmed.

Stakeholder Participation. Stakeholder participation improves project quality through social learning, technical solutions, and increased networks (Luyet et al., 2012). Identification of stakeholders is an important starting point for engagement (Colvin et al., 2016). Stakeholder identification and analysis are often iterative processes and involve speaking with multiple individuals through various methods including focus groups, interviews, or a combination of approaches (Reed et al., 2009). The nature of wicked problems, like global pollution, requires diversity in stakeholder participation in order to enhance the understanding of policy decisions (Cuppen, 2012). Engaging stakeholders is particularly important in the pollution prevention field because no one sector has the power or ability to solve the global toxicity problem (Banerjee,

2002).

Identification and Analysis of SRRTTF's Stakeholders. Stakeholder identification will reveal current and potential stakeholders of SRRTTF. Capturing all stakeholders at any given time requires an ongoing dedication to data collection and interpretation. Ongoing effort informs engagement strategies in important ways. SRRTTF's role as a consortium in a collaborative impact endeavor means that keeping up on current and potential stakeholders and understanding their needs is paramount. An understanding of stakeholders is incomplete if the organization is not aware of the broader community in which it operates.

Champions & Facilitators. To inspire and motivate stakeholders involved in collaboration, it is important to designate a champion (Bryson, 2004; Intersector Project, n.d.; McDermott et al., 2011). This champion can be an individual or an entity, and the role of this champion is to build buy-in, credibility, and support for working together. Champions should be able to work with people in a way that brings out others' creativity and desire for change, be humble and deferential, speak in the language of the people they are working with, and have a network of experts to call upon (B. Becker, personal communication, February 29, 2016). Groups also need an internal facilitator considered to be trustworthy, approachable, and impartial by participants (Ansell & Gash, 2008; Reed, 2008, p. 2425). Trusted facilitation is especially important in situations in which conflict is likely, for example, between chemical companies and environmental advocates, or between competing companies (Reed, 2008). SRRTTF can identify change champions that are likely to create, implement, or evaluate procurement policies in a meaningful way and provide a model and leadership to other stakeholders.

Trust & Collaborative Governance. Trust between stakeholders is an EBP that allows stakeholders to feel comfortable sharing and contributing in a collaborative setting. In a study based on interviews of collaboration managers, trust-building was essential (Getha-Taylor, 2008). To build trust leaders must, "identify whatever common ground exists among partners and across sectors" (Getha-Taylor, 2012, p. 221). Commonly shared concerns included, "shared problems, decreased resources, and information gaps" (Getha-Taylor, 2012, p. 221). Trust is built by fostering open communication and personal connection between stakeholders Ansell(& Gash, 2008; Austin, 2000). Using collaborative governance engages stakeholders in the management of a collaborative effort and gives stakeholders ownership over the direction and strategies of the collaboration (Boyte, 2008; Innes & Booher, 2004; Leach, 2011). Collaborative governance allows leaders to raise issues that can be addressed using input from various stakeholders, create a space for these stakeholders to convene, explain relevant issues clearly and neutrally, and work to create agreements around solutions (Walker & Senecah, 2011).

Leadership. Leadership is an important aspect of stakeholder management as well as intersectoral collaboration. Collaboration leaders, "need to be capable of maintaining positive group dynamics, handling dominating or offensive individuals, encourage participants to question assumptions and re-evaluate entrenched positions, and get the most out of reticent individuals" (Reed, 2008, p. 2425). Strong leadership must be in place for trust-building, discussion facilitation, and enforcing

rules (Ansell & Gash, 2008). Collaboration leaders should ensure participants are actively contributing to the effort, manage group dynamics, and support continued progress toward shared goals (Ansell & Gash, 2008). The more diverse the intersectoral group, or if power imbalances are prevalent, the more leaders should focus on managing contributions and group dynamics.

Early Engagement & Targeted Messaging. Rather than interact with stakeholders near the end of collaborative efforts, stakeholders should be engaged early. Collaborators should begin with issues or decisions that will help facilitate the development of trust instead of issues that might be more challenging or divisive (Bartlett, 2012). Integration of both traditional and nontraditional outreach strategies also supports broader participation (Sayce et al., 2013). One exemplar, California Marine Life Protection Act Initiative, identified more than twenty outreach strategies used by different regions that also created opportunities for greater involvement beyond the initiative's stakeholder advisory groups (Sayce et al., 2013). The outreach strategies focused heavily on different forms of communication and engagement methods including electronic, written, and event-focused (Sayce et al., 2013). Outreach to stakeholders within pollution prevention should reflect each stakeholder or stakeholder group's motivations and should link these connections to the effort at hand (Ansell & Gash, 2008; Bryson, 2011; Emerson et al., 2011).

Communication. Communication with stakeholders is facilitated through multiple channels from websites to consensus-building forums. The level of involvement of a stakeholder determines which channels or methods of communication are appropriate and effective. To address these varying levels of involvement and ways to communicate, nonprofits use stakeholder engagement processes and plans.

Table 6. Template for Stakeholder Engagement Methods Matrix

LEVELS *of* STAKEHOLDER ENGAGEMENT	MAY BE APPROPRIATE WHEN:	IS NOT APPROPRIATE WHEN:
INFORM: This is essentially one-way 'communication'. Announcements, press releases, position statements, and prepared statements are all methods and tools for this level. Stakeholders receive information without an expectation of two-way dialogue.	• There is no avenue for alternative forms of action (e.g. legal boundaries) • You are reporting decisions or a course of action that doesn't affect others. • It is used at the start of a process, with the promise of more opportunity to participate later.	• People want more active involvement. • You are seeking to honor community interests and engage in discussion. • There are alternatives available for broader stakeholder participation.
CONSULT: Proposals and options are presented to stakeholders, who provide feedback that is incorporated in planning. This is most commonly done through focus groups, individual interviews or surveys. The goal is to benefit from stakeholders' greater knowledge of local conditions and opinions. Decision making, power and control remains completely with the agency leadership.	• You want to improve an existing service and need consumer feedback. • You have clear plans for a project, and there appear to be a limited range of options for change. • Local community interests can understand and relate to these options. • You are able to use feedback to choose between or modify options.	• Feedback is not going to be integrated into the final decisions. • You are seeking to empower community interests and engage discussion among a large range of stakeholders. • There are not clear options already developed and you are seeking a range of ideas before developing options.
INVOLVE: Stakeholders are authentically engaged in generating options and carrying out actions that emerge from their input, but their participation falls short of sharing formal decision-making authority.	• You need to tap into stakeholder skills and experience in order to carry out plans. • Stakeholders have a strong desire to participate in the proposed work.	• You have little room for implementing broader input and participation. • You don't have the resources or skills to carry out the proposal with stakeholders.
COLLABORATE/EMPOWER: Deciding and acting together with stakeholders based upon shared goals. It is a longer, more complex process, which requires more preparation and support for stakeholder involvement.	• It is important that stakeholders 'own' the development and implementation processes. • The various interests involved all get some extra benefit from acting together. • There is commitment to the time and effort needed to develop a partnership. • There is enough time.	• Time is very limited. • The commitment to partnership is only superficial (e.g. One party holds all the power/resources and uses this to impose its own solutions.) • Participants want to be part of making decisions, but do not share a long-term stake in carrying out solutions.

Image Source: WPCWI Center, 2013, p. 11

The level and degree of communication and engagement increase through these levels from one-way communication at the 'inform' level, to action at the 'collaborate/empower' level (WPCWI Center, 2013). The degree of communication and involvement in engagement strategies allow consortia to create authentic dialogue, one of the critical elements of a successful collaborative process (Innes & Booher, 2004). Moreover, authentic dialogue leads to trust, new ideas, and solutions developed together among participants (Innes & Booher, 2004). It may be helpful for SRRTTF to revisit its list of stakeholders, perform a stakeholder analysis, and revise its strategic engagement matrix every 3-5 years as the landscape of public policy, the market, and SRRTTF's environment change.

Collective Impact. Nonprofits and government agencies use intersectoral collaboration as an intervention strategy when faced with wicked problems to create collective impact (Kania & Kramer, 2011). Instead of each organization acting on its own, within silos of sectors or disciplines, organizations and agencies come together with business partners to share knowledge, resources, and accountability with the goal of creating collective impact (Turner et al., 2012). Organizations

that work alone do not make traction on major change, whereas, working together, organizations make a noticeable difference in previously intractable problems. Collective impact is only possible when large groups of organizations and leaders work together toward change. Empirical studies demonstrate that collaboration improves outcomes for target populations and organizational capacity (Hallinger & Heck, 2010). Group learning leads to innovation and coordinated action that will attract funding and supporters (Turner et al., 2012). Figure 5: How Collective Impact is Created Through Collaboration shows the structure and process of change.

Figure 5. How Collective Impact is Created Through Collaboration

A backbone organization, like SRRTTF, acts as a central, neutral convener and provides administration, coordination, and leadership to the collaboration (Collaboration for Impact, n.d.). The use of systems analysis enables backbone organizations to better understand the interactions and dependencies between stakeholders in a particular field. Intersectoral collaboration can be used to bring key stakeholders together to coordinate efforts and resources towards a shared goal. Stakeholder analysis is used to better understand stakeholders' motivations, resources, and potential to add value to collaborative efforts, and stakeholder engagement practices can ensure that stakeholders are actively contributing to collaboration. Finally, evaluation helps backbone organizations assess the success of collaborative efforts and indicate where a change in the collaboration process is needed to improve performance. Evaluation metrics appropriate for SRRTTF, including creating intellectual, political, social, and economic capital are discussed further in the evaluation section of this paper.

Collective Impact in Pollution Prevention. The intended collective impact of pollution prevention is improved human and environmental health and economic opportunity through innovation. Collective impact is achieved when environmental stakeholders "reduce or eliminate the generation of hazardous substances" (EPA, 2016, n.d.). A primary motivation for pursuing collaborations is that partnerships "provide more effective remedies" than individual efforts do, and "partners may have additional expertise, technology, relationships, and financial resources that can be deployed in a joint endeavor" (Bryson et al., 2015, p. 652). Organizations that engage in partnerships encourage group learning and the additional creative input can spur innovation (Etzkowitz, 2003; López & Montalvo, 2015). With knowledge-intensive organizations, such as SRRTTF, primary assets are the skills of its stakeholders and the knowledge created by collaborators in the network (Etzkowitz,

2003; Hidalgo & Albors, 2008). Collective knowledge, innovation, investment, and integration of pollution prevention create collective impact, moving the needle to reduce hazardous chemicals in the environment and to improve human health.

Collective Impact: Case Statement. Case statements are often created to communicate the collective impact of an organization concisely and persuasively. A case statement is a primary tool for fundraising and stakeholder engagement. The case statement covers organizational history, constituents, an issue statement, theory of change, and goals for the future (Burrows, 2006). Table 7: Case Statement Components include descriptions of content used to craft a case statement. SRRTTF's case statement should articulate the organization's unique contribution to pollution prevention as a consortium. Some of this information is clearly articulated on SRRTTF existing website but putting all the relevant data and information into one, easy to read, brief document, would improve fundraising and outreach efforts.

Table 7. Case Statement Components

Goals of a case statement:

- *How does this organization help people?*
- *Who do we help?*
- *What vital services do we offer?*
- *What is our organization's track record?*
- *What are our plans for the future?*
- *How do we use our money?*
- *Why do we deserve support?*

CASE STATEMENT COMPONENT	DETAILS
Organization History	• *Founded when and by whom* • *Major accomplishments* • *Milestones in the organization's history*
Whom does the organization serve?	• *Demographic information* • *Description of a real person who benefits from the organization-share testimonial or anecdotal true-life experiences.*
What needs confront the people served by the organization?	• *What pressing problems does the organization address?* • *What challenges do the people served face?*
How does the organization address these challenges?	• *What programs does the organization offer?* • *What services are provided for people in need?*
What is the organization's reputation for managerial and business discernment?	• *What evidence can be offered pertaining to the organization's stability?* • *What evidence can be offered pertaining to the fiscal responsibility--for example, year of deficit-free operations?*

How is the planning process described?	• *Who participated in the strategic planning process?* • *How broad-based was the process?* • *How thorough was the planning process?*
What are the goals for the future?	• *What are the program, financial, facility, technology, administrative, governance, human resource and diversity goals?* • *How will those in need be served better?*
How will the donor's investment be used and acknowledged?	• *Why is the fundraising campaign being conducted?* • *What are the organization's key budget items?* • *How do these expenditures relate to the organization's mission and services to people in need?* • *Describe gift opportunities* • *Describe the intangible benefit the donor receives by this philanthropic investment*

Image Source: Burrows, 2006, pp. 1-2

Table 8. Illuminating Elements of a Case Statement

Section On	Establishes
Mission	Why the organization exists
Goals	What it will do about why it exists
Objectives	How it will accomplish the goals
History or Track record	Credibility, showing which objectives have been accomplished already
Structure	Who is involved, showing consistency of personnel with the goals
Fundraising Plan	That the organization has a number of well managed and appropriate income streams that will enable it to fulfill its mission over the long term
Budget	That salaries, benefits, rent, and other costs are consistent with the mission, and that the organization knows how much it will cost to do the job they have set out to do

Image Source: From Fundraising for Social Change (Klein & Yogi, 2022)

Identification of evaluation metrics and performance measurements. Evaluation is needed to support a case statement and to determine organizational and collaborative efficacy. Reporting organization's services will allow SRRTTF to communicate its value proposition to stakeholders, funders, and the public (Rossi et al., 2004). Multiple metrics were identified in primary and secondary research including social, intellectual, political, and financial capital; involvement and retention of new stakeholders; creating shared, concrete goals; and testing the adaptability and

resilience of the collaboration itself (Bryson, Crosby, & Stone, 2006; Firehock, 2011; Innes & Booher, 1999; Leach & Sabatier, 2005).

Social Capital. Social capital is built on trust, persuasive communication, and shared experience that increases the likelihood of collective action (Heikkila & Gerlak, 2005). Trust is a central component of effective intersectoral involvement. Collaboration initiators lower the transaction costs of coordinated action through social capital (Lubell, 2014). Therefore, social capital is one of many important metrics that should be part of an evaluation plan. Social capital is increased through interaction, facilitated activity designed to foster cooperation, and the networks that actors within the collaboration bring to the group. SRRTTF could create a network map to identify some of its social capital and compare changes over time to see fluctuation in this metric.

Intellectual Capital. Intellectual capital is also increased through networks such as intersectoral collaborations. Knowledge management requires organizations with organic, flexible structures that incubate creativity and remove barriers to innovation both internally and externally (Hidalgo & Albors, 2008). In the knowledge economy, innovation occurs not just in research centers such as universities, but throughout the industry. The phenomenon is defined as "convergenomics," a process where diverse and disparate entities come together to drive innovation forward (Lee, Olson, & Trimi, 2012). Once located, collaborators are leveraged to increase organizational impact. Collective intelligence increasingly informs breakthroughs, allowing organizations and collaborations to become more effective, efficient, and responsive (Lee et al., 2012). Within pollution prevention, stakeholders build consensus about innovative approaches to alternatives and use shared resources to pursue solutions by working together (B. Jensen, personal communication, February 29, 2016; S. Rogers, personal communication, February 19, 2016). SRRTTF creates new intellectual capital through its various committees, research reports, working groups, and conferences.

Innovation and collaboration are also enhanced by Joint Fact-Finding (JFF). JFF is a process where stakeholders work together to define issues, establish facts, share values, and evaluate results. The process of JFF is illustrated in Figure 6, Conditions and Steps of Joint Fact-Finding.

Figure 6. Conditions and Steps of Joint Fact-Finding

Image source: Chan, Montgomery, Williams, & Yedalian, 2015 adapted from Karl et al., 2007

JFF is an EBP that ensures collaborators come to a written agreement on how science and stakeholder values will be combined to create the basis of collective action (Karl, Susskind, & Wallace, 2007). JFF involves in-person interaction (facilitated dialogue) with all parties (representation) bringing information to the forum (McCreary, Gamman, & Brooks, 2001). JFF has the potential to improve engagement among stakeholders by fostering mutual understanding (Schultz, 2003).

Political Capital. Political capital is built through partnerships with government agencies, advocacy efforts, relationships with politicians, and an understanding of constraining and enabling structures (Hill & Lynn, 2009; Renz & Associates, 2010). Researchers urge environmental collaboratives to perform program evaluation based on the congruence of policy with desired outcomes and the cost-effectiveness of the intervention (Margerum, 2008). Political capital can be very effective to influence other parties when there are no lines of authority and within an Exchange Model where mutual exchange happens (Cohen & Bradford, 2017). This is particularly important in getting consensus around voluntary activity and compliance to reduce PCB pollution. Together with the network map from a social capital evaluation, SRRTTF could decide on actions that would increase its political capital to initiate compliance or policy changes with agencies and organizations not represented in the collaborative.

Additionally, evaluators are encouraged to look at the capacity of the collaboration as a whole to perform activities through created intellectual, social, and political capital, and funding (Margerum, 2008). Goal definition, attracting new stakeholders, and examining resilience and adaptability, are additional qualitative measures of collaboration success that are recommended for environmental

intervention organizations like SRRTTF (Bryson, Crosby, & Stone, 2006; Firehock, 2011; Innes & Booher, 1999; Leach & Sabatier, 2005).

Metrics for Pollution Prevention. Quantitative metrics for evaluation are prevalent in pollution prevention. Research supported metrics include adoption rates of chemical substitutes; funding available for collaborative intervention; reduction of toxicity in the environment; congruence between desired outcomes and policy; integration of green chemistry principles into the value chain; toxicity class requirements in university chemistry programs; industry participation rates; cost-effectiveness of collaborative intervention; reaction mass efficiency; and mass intensity (Constable, Curzons, & Cunningham, 2002; Leahy, Tucker, Mergelsberg, Dunn, Kopach, & Purohit, 2013; Margerum, 2008). Further detail on green chemistry metrics is available in Dicks and Hent's (2014) guidebook.

Evaluation Tools. With strong evaluation metrics and the capacity to measure outcomes, SRRTTF and other groups working toward pollution prevention can communicate how their activities and methods contribute to collective impact. One method to communicate how an organization intends to create public value and collective impact is through a logic model. A logic model is a visual representation of the organization's theory of change, or the formal process of accomplishing its mission (Frumkin, 2010). Logic models, unlike case statements, are internal-facing documents. Figure 7: W. K. Kellogg Foundation Logic Model provides a guide for understanding logic models. Causation is demonstrated by moving from left to right through the individual components of the model.

Figure 7: W. K. Kellogg Foundation Logic Model

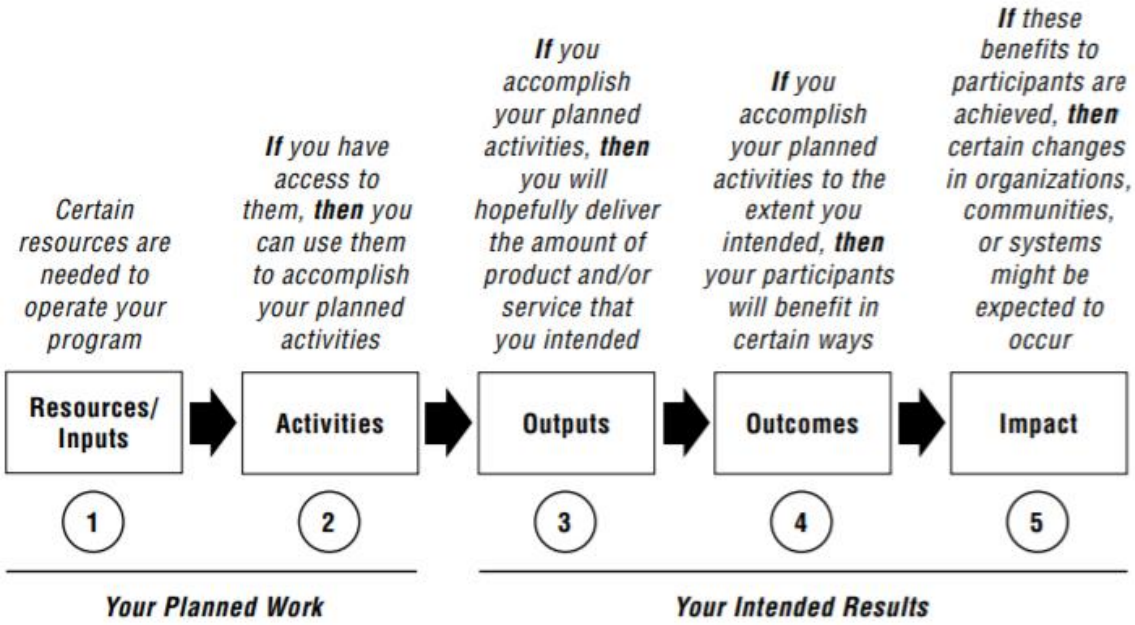
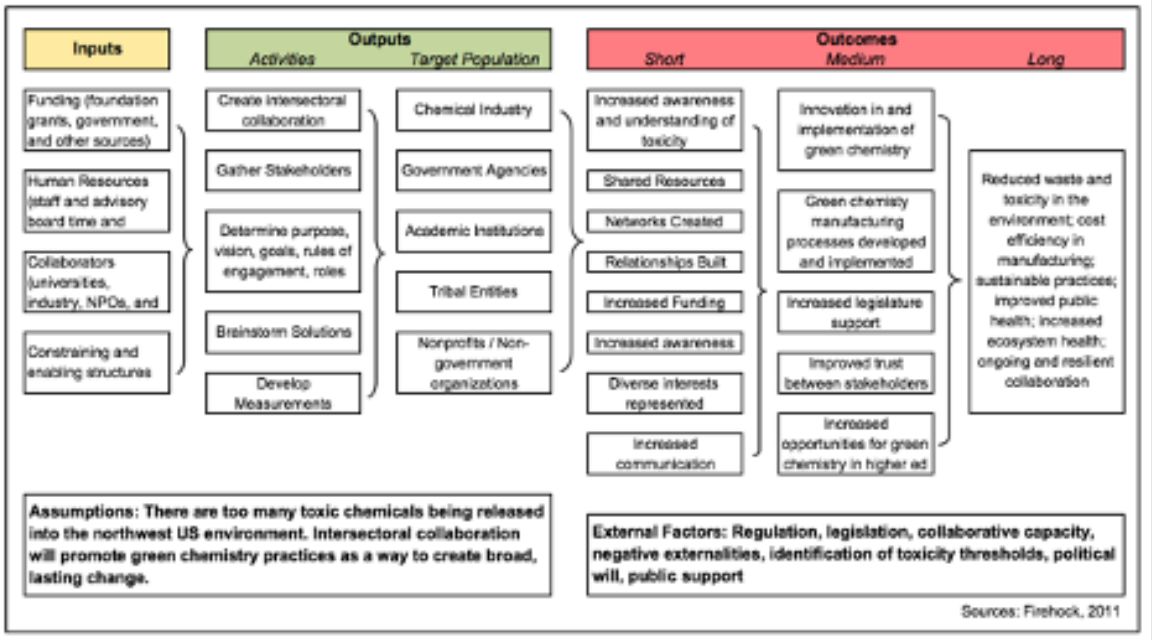


Image Source: W. K. Kellogg Foundation, 2004, p. 3

Logic models function as a simple and coherent way to structure an often complex organization consisting of various interrelated components, linking resources to long-term impact (Savaya & Waysman, 2005). The included elements demonstrate the causal relationships between organizational resources, program activities, outputs, short-term outcomes, and long-term impact (W. K. Kellogg Foundation, 2004). Organizations often gain value and clarity simply through the creation and development of the logic model components (W. K. Kellogg Foundation, 2004). SRRTTF can use the following model as an exemplar and customize it to suit its purposes.



Evaluation Plan Design. Once clarity has been achieved through a logic model, an organization can create an evaluation plan. Figure 8: System Model of How Evaluation Fits into Organizational Planning demonstrates the process of planning.

Figure 8: System Model of How Evaluation Fits into Organizational Planning

Image Source: (FHWA, n.d.)

In the diagram, monitoring, evaluation, and reporting create a feedback loop into organizational goals and objectives, and performance measures (Federal Highway Administration (FHWA), n.d.). The evaluation also informs resource allocation, program development, and overall strategic planning. To move from the logic model to an implementable evaluation plan, tools such as Figure 9: Sample Program Evaluation Design Matrix, may be used.

Figure 9: Sample Program Evaluation Design Matrix

Sample Program Goals, Objective, and Metrics

GOAL	OBJECTIVES	METRIC
Achieve energy and cost savings and improve quality of life through residential energy efficiency upgrades	Reduce annual electricity use by an average of 15% in upgraded homes	Average percent change in annual kilowatt-hours consumed post-upgrade, compared to pre-upgrade baseline
	Upgrade 1,000 homes in two years	Number of homes upgraded through your program
	Conduct upgrades for 50% of all customers receiving assessments	Customers conducting upgrades divided by customers receiving an assessment

Source: U.S. Department of Energy, 2014.

The Figure 9: Sample Program Evaluation Design Matrix offers a less rigorous approach that is useful for short-term projects. An evaluation template allows an organization to think through all the steps and create a custom logic model in the process. The evaluation plan template outlines a step-by-step process to design evaluation for any program. Following the process, evaluators will define the program to be evaluated, along with identifying key stakeholders, and developing a logic model. The plan also facilitates the identification of research questions, measurable outcomes, and an implementation guide. A customized evaluation template has been created for SRRTTF based on the research study with tips from recent scholarship, a customized logic model, and specific metrics and performance measures.

Evaluation examines the effectiveness and efficiency of an organization's interventions. Understanding the environment within which an organization functions and all the ways diverse actors impact that environment, is key to knowing which interventions to employ and where to target them. Systems analysis brings value to organizational knowledge, learning, and strategic planning, through the identification of interdependencies and intervention places. Systems analysis starts by examining the system of which the organization is a part and creating a picture of how the system works and how all the parts are interconnected.

Systems Analysis & Conceptual Model. Systems thinking is required for complex, dynamic, and interconnected problems (Wulun, 2007). Environmental policy and intervention issues are defined by complex interdependent social, political, economic, and environmental systems. Soft systems methodology (SSM) arose out of systems thinking in the 1960s as an alternative to hard systems that only take quantitative data and analysis into account. Hard systems analysis proved to be ineffective in providing solutions for systems involving people (Checkland, 2000; Williams, 2005). SSM is an appreciative method that allows participants to process and record perceptions, facts, values, relationships and make decisions about interventions based on subjective and objective information (Cundill et al., 2012).

Checkland (2000) brought the human element into the equation of systems modeling, arguing that people take action meaningful to them. The meaningful purpose for stakeholders emerges from

interrelationships, the sense that a particular situation is problematic, and the ability to find desirable and feasible actions within historical, social, economic, and political context (Checkland, 2000; Cundill et al., 2012). SSM is particularly applicable to meta-problems that require intersectoral intervention through collaboration (Selsky & Parker, 2010). Research links SSM to various environmental policy issues and adaptive management. SSM has successfully been applied to ecological issues, environmental policy, and natural resource management because it allows for uncertainty and employs multi-stakeholder methods (Bosch et al., 2007; Cundill et al., 2012; Davis & Stroink, 2015). Table 9: Soft Systems Methodology: Seven Stage Iterative Process walks through a basic overview of the general stages of SSM.

Table 9: Soft Systems Methodology: Seven Stage Iterative Process

Seven Stages of the Soft Systems Methodology
1. Explore the issue (may evolve through study, becoming more or less bounded);
2. Express the problematic situation (in picture form including structures, processes, climate, people, issues expressed by people, and conflicts);
3. Identify key perspectives that are the value base for evaluation and determine what will affect the possibility for success;
4. Create a conceptual model of the issue;
5. Compare conceptual model with the real world through multiple means;
6. List the desirable and feasible interventions according to context;
7. Recommendations are made.

(Checkland, 2000; Williams, 2005)

SSM was applied to the research questions. Through the process of inquiry, several types of conceptual models that have been used for environmental issues similar to SRRTTF's foci were identified. The types of SSM conceptual models included in the research study are the triple value model; representation of innovation in the chemicals industry over time; adaptive management models; and various mathematical and predictive models.

Figure 10: Triple Value Models

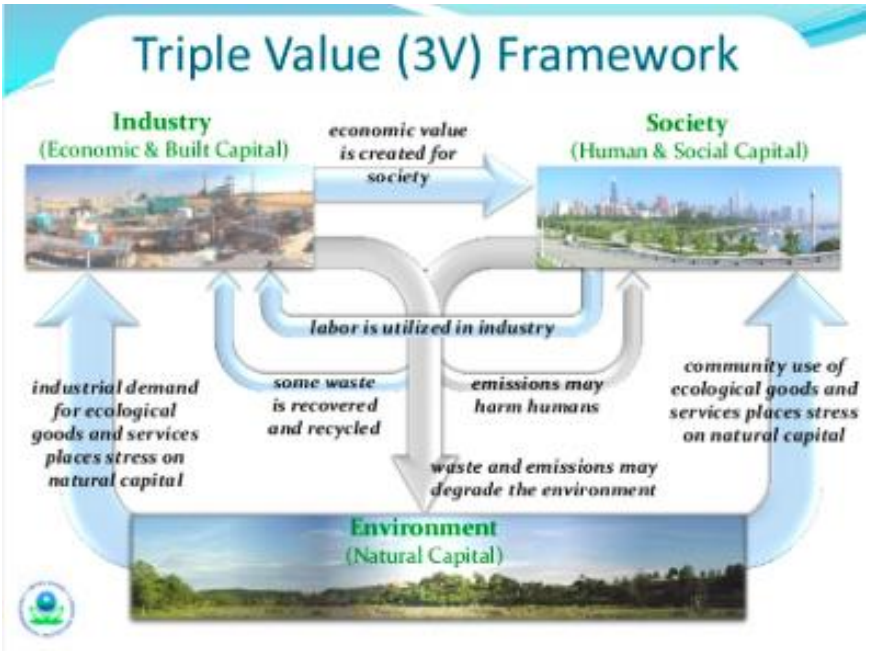


Image Source: Fiksel et al., 2014, p. 694

The EPA model in Figure 10 was developed from a type of SSM called the Triple Value Model (TVM) (Fiksel et al., 2014). TVM creates a conceptual systems model made up of industry, societal, and environmental perspectives (Fiksel et al., 2014). Figure 10 is an example that shows how economic capital, social capital, and natural capital interact and are impacted by one another through arrows that indicate the interdependencies created through the system. EPA's models are particularly applicable to the goals, mission, and vision of SRRTTF. Figure 11: Triple Value (3V) Framework, Micro Example is a more granular version of the EPA TVM in Figure 10.

Figure 11: Triple Value (3V) Framework, Micro Example

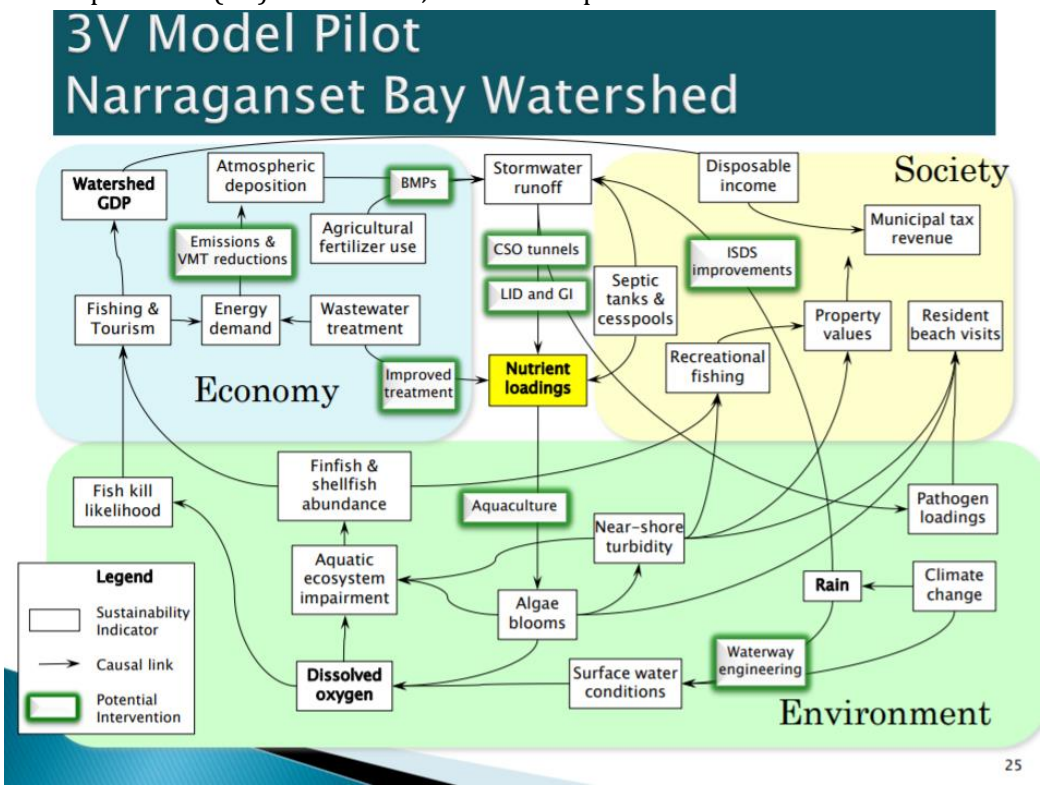


Image Source: Unger, 2014, p. 25

Figure 11 indicates the specific interrelationships and processes within the social, economic, and natural spheres of the Narraganset Bay Watershed (Unger, 2014). The example model indicates how the big picture conceptual model can be created on a local level, with greater detail. Potential intervention points in the system are highlighted to demonstrate how to create positive impacts. A detailed Triple Value Framework model could be particularly helpful to the SRRTTF as it continues to identify the desired collective impact and acknowledge the interests of its stakeholders.

Innovation Model. Soft systems methodologies stimulate learning and creativity, provide feedback loops, and produce change, thereby enhancing innovation efforts (Cundill et al., 2012). SRRTTF has been on the innovative edge of technical and public policy solutions due its response to unique water quality standards. Based on the innovation aspect of SRRTTF, another conceptual model was identified. Figure 12: Conceptual Model of the Evolution of Eco-Innovation illustrates progress made in the chemical industry over the past century (López & Montalvo, 2015).

Figure 12: Conceptual Model of the Evolution of Eco-Innovation

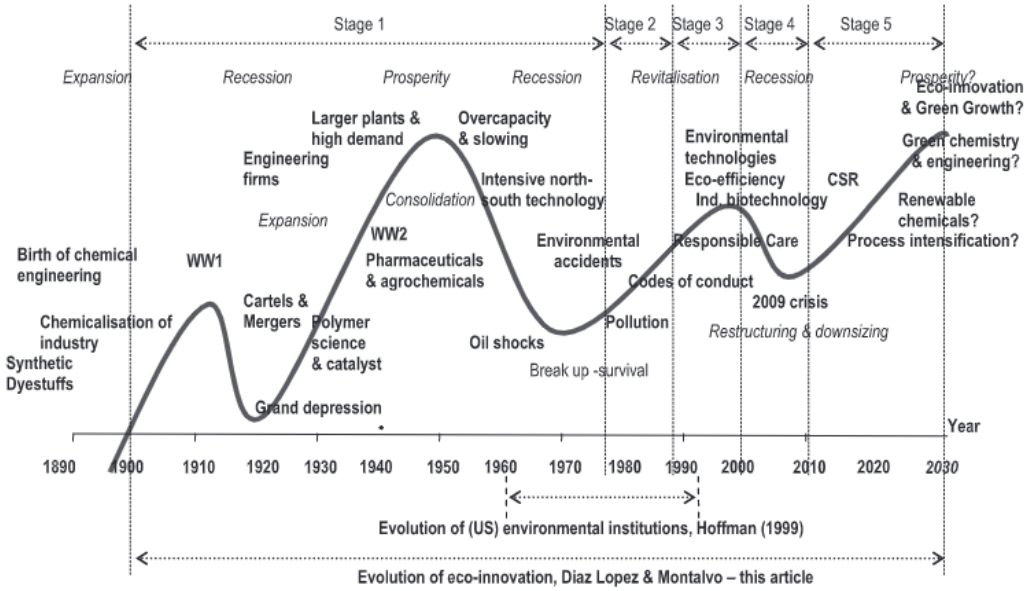


Image Source: López & Montalvo, 2015, p. 34

Figure 12 introduces the element of time into the conceptual model. Factors that propelled or stalled innovation in the chemical industry are included in the timeline. The progression of innovation is then categorized into stages for conceptual clarity. SRRTTF could review its work over the past decades and incorporate time into a conceptual framework of its activities and impacts to achieve additional insight into what has driven or impeded technical or policy innovation.

Adaptive Management Model. Another source of SSM conceptual models came from adaptive management, a policy strategy designed to address wicked problems. Adaptive management is, "bioregional in scope, and collaborative in governance, as well as adaptive in managerial perspective" (Lee, 2001, p. 3). Adaptive management models are designed to be used in dynamic systems where collaboration and organizational learning are ongoing. Features that indicate the complex interaction among actors and elements are more apt for representing problems like the one SRRTTF's faces (Janssen et al., 2000; Rammel, Stagl, & Wilfing, 2007). Figure 13: Adaptive Co-Management Model indicates how an ecosystem is impacted by human activity.

Figure 13: Adaptive Co-Management Model

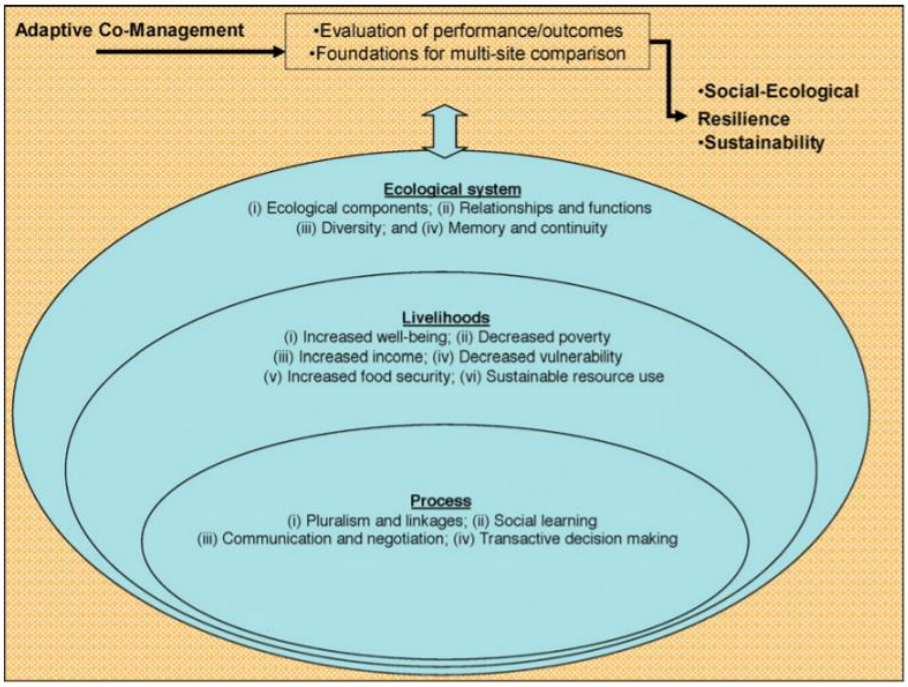


Image Source: Plummer & Armitage, 2007, p.66

Figure 13 illustrates a Venn diagram of adaptive co-management that takes into consideration the role of group learning and pluralist viewpoints in getting to sustainable outcomes. Human needs are clearly represented, nested in ecological processes. In between the policy process and desired outcomes, negotiation, human well-being, and the reality of environmental systems play a part in influencing socio-ecological resilience and sustainability.

Importance of SSM. SSM is important to SRRTTF because of SSM's applicability for the communications, programs, and collaborations that SRRTTF engages. SRRTTF's goals are to transform, not merely make more efficient, the chemical and engineering process to keep toxins from entering the environment. Transformation goals make soft systems analysis especially appropriate (Wilson & Van Haperen, 2015). Innovation is a core aspect of the collaboration between SRRTTF, industry, and universities, and soft systems methods and adaptive management stimulate learning, creativity, provide feedback loops, and produce change (Cundill et al., 2012). Research has demonstrated that people who adopt a systems thinking mindset are more likely to view the world through the lens of ecology, providing them with an understanding of the interconnections in nature, to express environmental ethics, and act from these values more than people without a systems thinking mindset (Davis & Stroink, 2015). To create a useful SSM conceptual model identification and analysis of SRRTTF's stakeholder input will be required.

Recommendations from Smart and Evidence-Based Practices

There are several recommendations from the previous sections on smart and evidence-based practices, case statements, evaluation, and soft-systems models. SRRTTF can take several actions that will strengthen its organizational capacity and lead to greater collective impact in its pollution prevention activities. These include:

1. SRRTTF can revisit its list of stakeholders every 3-5 years and note important changes that inform its strategy of stakeholder engagement and its overall strategic plan.
2. It is difficult to hold external stakeholders (like many of those that adopt and implement procurement policies or create certifications) accountable. By partnering with watchdog groups, encouraging government agencies to conduct evaluation of implemented procurement policies, and collaborating with groups that educate consumers on how to exert market pressure it can better achieve its goal of reducing iPCB pollution.
3. SRRTTF can identify change champions that are likely to create, implement, or evaluate procurement policies in a meaningful way and provide a model and leadership to other stakeholders. Cultivating good relationships with these champions and creating shared messaging could improve compliance and efficacy with procurement policies.
4. Creating a clear and concise Case Statement will help external stakeholders understand the scope and limitation of the consortium while illuminating its important outcomes and why its work should be funded outside its state allocation.
5. A strong evaluation plan with metrics that capture the creation of intellectual, social, political, and economic capital will help SRRTTF understand its impact and better communicate it to external stakeholders.
6. SRRTTF can create a SSM to help strengthen its logic model and increase the efficacy of collective impact in the region.
7. In general, it may be helpful for SRRTTF at this point in its history to audit its use of Smart and Evidence-Based Practices and determine where it is doing well and where additional resources may leverage greater impact.

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