Division of Science, Research and Technology
Research Project Summary
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PCB TMDLs, Pollution Minimization Plans and Source Trackdown in Camden City

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Abstract

A PCB Pilot Source trackdown study was performed in the sewer collection system of the Camden County Municipal Utility Authority (CCMUA) as part of a PCB TMDL. The goals were to evaluate the most appropriate sampling and analytical techniques for tracking down PCB contamination to the MUA collection system and to identify potential upland sources. Innovative field and analytical methods were evaluated including the use of PCB analytical Method 1668a to attain high sensitivity and low detection limits; the quantitation of over 124 separate PCB congeners as a mean to identify unique source signatures through pattern recognition; the use of passive in-situ continuous extraction sampler (PISCES) for sample integration over protracted time periods (14 days); and the use of electronic data collection systems interfaced with a geographic information system (GIS). PCBs were found at all sewer locations (i.e., both urban and suburban) and in all sampling media potentially from varied sources (i.e., as indicated by differences in PCB congener profiles between waste streams). PCBs were quantifiable in both 24-hour composites with a mean of 189 ng/l (Range: 33 ng/l to 784 ng/l) and grab samples with a mean of 41 ng/l (Range: 20 ng/l to 82 ng/l). Geographic analysis of sewer results indicated a concentration of potential PCB sources in the industrialized south-central area of Camden. We further evaluated desktop trackdown methods and innovative field methods using field methods (i.e., immunoassays e.g., SDI/ELISA) known to be quick, inexpensive and accurate; and approved by NJDEP's Site Remediation Program for site screening. The project was also designed to assist MUAs with CSOs in performing, TMDL required, PCB Pollution Minimization Plans (PMPs) through documentation of PCBs on city streets with a capacity to erode into storm drains, thereby localizing proximity of sources in sewersheds and at specific city blocks and for certain industry types. An addition goal was to explore how regulatory programs could inform the PMP process, since many PCB sources leading to storm drains could, potentially, not be directly regulated by a MUAs (e.g., Hazmat sites, NPS permitted facilities, orphan contaminated sites). Street soil results show PCBs on streets in front of most facilities with a mean of 0.6 ug/g - ppm (Range: 0.05 to 5.16 ug/g).Confirmatory analysis on select soil samples using HRGC/HRMS analysis (Method 1668A), confirmed relative accuracy of using ELISA for source screening. Decreasing mean PCB concentration in street soils near source categories (using ELISA) were: 1. HazMat (known contaminated sites); 2. metal reclamation (junkyards, shredders, smelters; 3. gas pipelines; 4. transportation; 5. drum cleaning; 6. manufacturing; 7. paper-pulping; 8. waste management; 9. electrical transmission; 10. aggregate processing (concrete); and 11. landfills. Overlapping management/policy issues with PMPs include analytical methods, stormwater management; CSOs permits; residuals (sludge); soil remediation standards; Brownfield Assessments; and Environmental Justice.

Introduction

The Delaware Estuary in New Jersey is listed by the new Jersey Department of Environmental Protection (NJDEP) as an impaired waterway due to PCB contamination in fish [1] [2]. Subsequently, in the spring of 2000, ninety-four dischargers (NPDES Permittees) to the Delaware Estuary from three different states were asked to conduct both continuous and stormwater discharge monitoring for eighty-one (81) PCB congeners. Results indicated that loadings of PCBs to the Delaware Estuary management zones (Figure 1) from point sources were significant and of such magnitude as to cause the water quality standards to be exceeded.

However, because of the high background levels and ubiquity of PCBs in the environment due to both historical discharges and ongoing approved uses, the Total Maximum Daily Load (TMDL) for Polychlorinated Biphenyls (PCBs) for Zones 2-5 of the Tidal Delaware River estuary [3] stipulates that facilities that discharge to the River, including its tributary streams, must develop and implement a pollution Minimization plan (PMP). This PMP shall include a list of all known and suspected point and non-point sources of PCBs; a description of studies used to trackdown PCBs; a description of actions to minimize the discharge of PCBs; a proposed time frame for PCB load reductions;

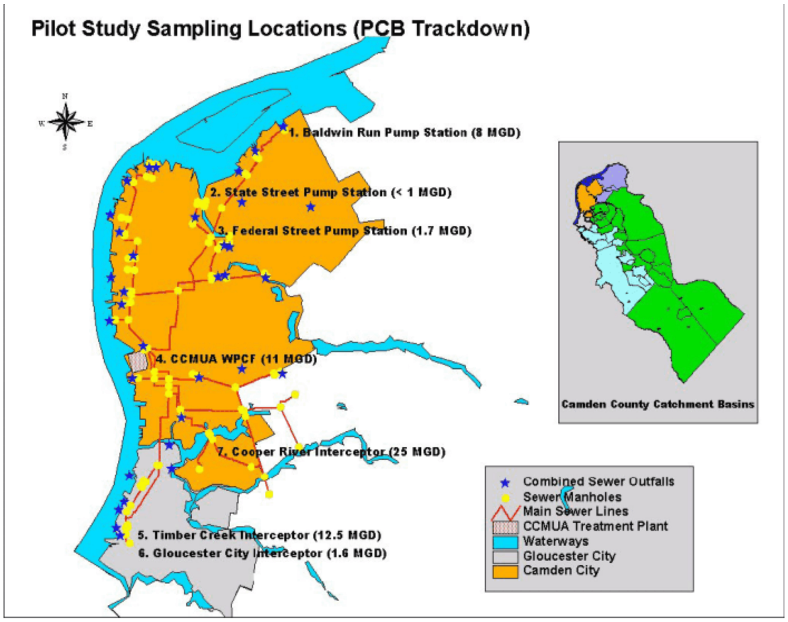

Figure 1. Sewer Sampling Locations - Phase 1

a method to demonstrate progress; and required PCB monitoring. These required items were subsequently codified in a DRBC Resolution [4] and guidance manual [5].

Yet trackdown of PCBs in a municipal utility authority's collection system is problematic due to the hundreds of miles of piping, the numerous industrial users, and more importantly due to the presence of combined sewers (combined stormwater and sewerage) in Camden City, which adds significant PCB loads from non-point sources and hazardous waste sites due to runoff. A field and lab methodology was therefore needed for MUAs to trackdown PCBs coming into their collection systems so as to initiate the load reduction strategies as required in the PMP. A cooperative agreement was developed between NJDEP, DRBC and CCMUA to perform a Pilot Trackdown Study. The primary goals of the Pilot Study were to evaluate the most appropriate sampling and analytical techniques for tracking down PCB contamination in CCMUA's Sewer-CSO collection system and to identify potential upland sources of PCBs for follow-up assessment/abatement.

Methods

Innovative methods explored in this study included the use of PCB analytical Method 1668a to attain high sensitivity in sampling including quantification of 124 separate PCB congeners as a mean to identify unique source signatures; the use of passive in-situ continuous extraction samplers (PISCES) for sample integration over long time periods (14 days); the use of inexpensive immunoassay techniques for sampling PCBs in street soils; and the use of NJDEP's hazardous waste site's electronic data collection system in conjunction with a geographic information system (GIS) to screen and isolate potential upland sources for further investigatory actions. The Pilot Study was carried out in two phases. Phase 1 involved only in-sewer sampling of wastewater to identify sewersheds with PCB hotspots (Figure 1). Phase 2 followed up on this sampling with additional in-sewer sampling but also with more detailed street soil sampling for PCBs in front of suspect facilities using inexpensive immunoassay techniques.

Results

PCBs were found at all sewer locations (i.e., both urban and suburban) and in all sampling media potentially from varied sources (i.e., as indicated by differences in PCB congener profiles between waste streams). PCBs were quantifiable in both 24-hour composites with a mean of 189 ng/l (Range: 33 ng/l to 784 ng/l) and grab samples with a mean of 41 ng/l (Range: 20 ng/l to 82 ng/l). Geographic analysis of sewer results indicated a concentration of potential PCB sources in the industrialized south-central area of Camden (Table 1).

Location	Area Served	Total PCBs, pg/L	Flow, mgd**	PCB Load, g/day	% of Total Load
Baldwin Run Pump Station PS	Northeast Camden and Pennsauken	53,839	8.0	1.63	4%
State St. PS	Northeast Camden Industrial Area	173,466	1.0	0.66	2%
Federal St. PS	Pavonia Yards	85,373	1.7	0.55	1%
Main Influent CCMUA +	Waterfront (West) & South Camden	798,081	11.0	30.94	77%
Cooper River	Camden County (East)	40,107	25.0	3.80	9%
Big Timber	Camden County (West)	32,763	12.5	1.60	4%
Gloucester City	Gloucester City	151,088	1.6	0.92	2%
TOTAL	--	--	60.8	40.04	100%

* 24 hr whole water composite samples analyzed by EPA Method 1668A.
** Estimated flows from CCMUA's CSO Modeling Report (CH2M Hill 1999).
+ Main Influent CCMUA sampling point includes loads from State St and Federal St pump stations. The pump station loads were subtracted from the actual WPCF loading to derive the West & South Camden loading [i.e., actual WPCF loading of 33.23 g/day minus the sum of the State St (1.63 g/day) and Federal St pump stations (0.66 g/day)].

*Table 1. PCB Results and Loadings for 24 Hour Composite Water Samples Collected at Pump Stations and Interceptors Served by CCMUA (Phase I - 2003)**

PCBs are a mixture of up to 209 distinct congeners making the laboratory analysis particularly challenging. Most PCBs were commercially produced in the United States as standard mixtures bearing the brand name Aroclor. The reaction and separation conditions for production of each Aroclor favor the synthesis of certain congeners, giving each Aroclor a unique signature or pattern based on its congener composition [6]. No Aroclor contains all 209 congeners; in fact, 110–120 congeners typically account for over 95% of the total mass in each Aroclor.

An analysis of PCB congener patterns in this study suggests varied potential sources since there are differences in PCB congener profiles between Integrators and sewersheds. For example, the Federal Street Integrator (Figure 2a) has an overwhelming makeup of the lower chlorinated PCB congeners (i.e., mono-, di- and tri-chlorinated) whereas the main influent Interceptor to CCMUA's treatment plant (Figure 2b), which receives flow from the Federal Street Integrator, is depauperate in these lower chlorinated PCBs but enriched with the more chlorinated PCB congeners. Apparently somewhere along the sewer line other PCBs were being released into the environment by other sources.

We further evaluated desktop trackdown methods and innovative field methods using field methods (i.e., immunoassays e.g., SDI/ELISA) known to be quick, inexpensive and accurate; and approved by NJDEP's Site Remediation Program for site screening [7] [8] [9] [10]. Street soil results show PCBs on streets in front of most facilities with a mean of 0.6 ug/g - ppm (Range: 0.05 to 5.16 ug/g).Confirmatory analysis on select soil samples using HRGC/HRMS analysis (Method 1668A), confirmed relative accuracy of using ELISA for source screening [11]. We also ranked PCB results by industrial source types and Standard Industrialization Codes (SIC) to facilitate possible follow-up by MUAs for PMP trackdown purposes (Table 2).

Table 2. PCB ELISA Results (mg/kg) in Street Soils Grouped by Industry Type

Rank	Industry Source Type	PCBs	(n)*
1.	HazMat (Contaminated Sites)	1.60	(5)
2.	Metal Scrap – Junkyards	1.41	(10)
3.	Metal Scrap – Shredders	0.50	(3)
4.	Meal Scrap – Smelters	0.47	(4)
5.	Paper & Pulping	0.42	(1)
6.	Transportation	0.42	(8)
7.	Gas Plant - Pipeline	0.40	(3)
8.	Drum Cleaning – Reconditioning	0.38	(10)
9.	Metal – Manufacturing	0.35	(3)
10.	Manufacturing - General	0.26	(15)
11.	Waste Management	0.24	(5)
12.	Electrical Transmission (Substations)	0.16	(7)
13.	Aggregates	0.05	(4)
14.	Landfill	0.05	(2)
15.	Background (Parks, Cemeteries)	0.05	(18)

* mean concentration; n = number samples

Phase I Results

The project was designed to assist MUAs with CSOs in performing, TMDL required, PCB Pollution Minimization Plans (PMPs) through documentation of PCBs on city streets with a capacity to erode into storm drains, thereby localizing proximity of sources in sewersheds and at specific city blocks and for certain industry types. An addition goal was to explore how regulatory programs could inform the PMP process, since many PCB sources leading to storm drains could, potentially, not be directly regulated by a MUAs (e.g., Hazmat sites, NPS permitted facilities, orphan contaminated sites).

All three of the sampling methods (24-hr composites, grab samples, and PISCES) can be used to effectively identify the presence of PCBs in a Municipal Utility Authority (MUA) waste stream. The benefits of each approach however must be weighed against the logistical aspects and the disadvantages for the second and possibly more critical goal of source identification. The PISCES sampling advantage of long-term media integration is offset by the difficulty of deployment (i.e., keeping a bulk sampler in place within a confined turbulent pipe) and its limited ability to identify the more highly chlorinated PCB congeners (i.e., usually transported on suspended solids).

The 24-hr composite samples which include both the aqueous and particulate wastewater fractions allow the most confidence in quantitative analytical results and congener patterns that may be more complete. This approach may also add significantly to any follow-up trackdown activities anticipated, since it's more complete and time integrated congener patterns may be the best means to match with upland soils, sediments or aqueous samples once a candidate site has been identified through HazSite/GIS screening. Grab samples, on the other hand, based on comparison with 24-hr composite samples taken concurrently are also good at identifying the presence of PCBs in wastewater. This approach allows a quick and less expensive mode of sampling, and a more practical means of identifying PCB presence in wastewater and the relative patterns of PCB congeners.

Phase II Results

The Phase I geographic analysis of sewer results indicated a concentration of potential PCB sources in the industrialized south-central area of Camden. In Phase II we further evaluated desktop trackdown methods and innovative field methods to close in on the sources (i.e., PCB immunoassays kits). Our approach was to document suspect PCB sources within the central Camden sewersheds identified in Phase I from readily accessible regulatory datasets and then to sample street soils at storm drains in front of the suspected PCB source facilities. Using this approach we narrowed down the universe of potential PCB sources in CCMUA's collection system from a county-wide range of potential sources and municipalities to just a few specific neighborhoods, industry types and streets in Camden City (Figures 3 and 4).

This analysis showed metal reclamation operations (i.e., junkyards, shredders, smelters) to be one of the prime sources of PCBs in central Camden due to the potential for fugitive dust emissions. To evaluate the potential role of transportation and the likely-hood that truck traffic might re-mobilize and redistribute these PCB contaminated street dusts, we gridded out a three block by ten block area within Camden's Water Front South and sampled using ELISA analyses (Figure 4). Waterfront South encloses a number of these facilities including

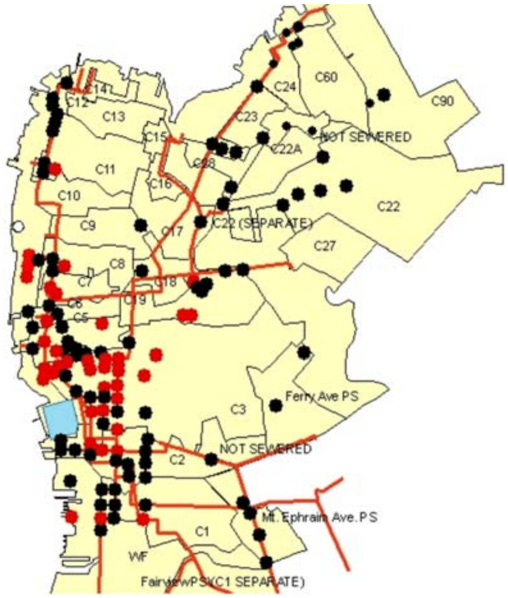

Figure 3a. PCB Sampling Locations in Street Soils for Camden NJ

(Red dot indicates PCB level greater that NJDEP Residential Soil Cleanup Criteria of 0.49 mk/kg using ELISA Method)

junk yards, an automobile shredder, and an automobile shredder residue (ASR) processing facility (i.e., ASR is the non-metallic components of shredded automobiles and white goods e.g., refrigerators, microwaves, etc). Street grid results show elevated levels of PCBs in street dusts throughout Waterfront South but especially those roads traveled by trucks loaded with ASR moving from the metal shredder on Atlantic Avenue to the ASR-processing facility on Sixth Street. Elevated PCB levels for our study were defined as being greater than NJDEP's 2006 Residential Soil Cleanup Criteria (RSCC) of 0.49 ppm PCBs (Note: the RSCC for PCBs subsequently was reduced to 0.20 ppm PCBs in 2008).

Discussion

When used in conjunction with a careful desktop review of readily available datasets and with a GIS-based data, ELISA can be a powerful tool for tracking down non-point sources of PCBs to MUAs. Conjoined with the in-sewer wastewater sampling it allows a means to reduce the universe of potential PCB sources, contaminated sewersheds, and industrial users to a manageable size for follow-up sampling and/or regulatory action as a part of a TMDL-related "Pollution Minimization Plan." Reduced costs are also a positive factor. Whereas typical GC-ECD or HRGC/HRMS PCB analysis can range in costs from $700 to $1,000; an individual ELISA test may costs as little as $35 per sample. The secondary utility of using ELISA in a trackdown investigation is its immediacy (i.e., real time, in-situ results) rather than waiting 2 weeks for samples at a lab.

Many of the facilities identified as potential PCB sources in this trackdown are not regulated by the MUAs directly (i.e., through NJDEP Pretreatment Rules), since they do not have direct industrial piping or connections to the MUA's collection system. Instead, secondary contamination of the combined sewers (i.e., stormwater pipes mixed with sanitary) probably occurs via stormwater runoff over PCB contaminated property, or else fugitive air emissions associated with onsite activities (e.g., shredding metal). For PMP purposes this disparity in sources and regulatory authority does not allow a meaningful way to reduce PCB loadings as part the TMDL process.

Figure 4. PCBs in Street Soils along Major Truck Routes through Waterfront South, Camden

* Number in Red exceed NJDEP Current Residential Soil Cleanup Criteria (0.49 ppm)

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