Washington State Dioxin Source Assessment

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Introduction

As an initial step toward improving the management of persistent, bioaccumulative, and toxic pollutants, the Washington State Department of Ecology (Ecology) sponsored an effort to gather, consolidate and assess information about the sources of polychlorinated dioxins and furans (here referred to simply as "dioxins") in Washington State1. The federal Environmental Protection Agency (EPA) undertook a similar effort as part of a large national study.2,3 Although the EPA draft report provided much valuable information, it was not clear how relevant the information on sources was to Washington State.

Polychlorinated dioxins and furans belong to a class of pollutants that are persistent, toxic and bioaccumulative. Pollutants with these characteristics remain in the environment for decades, often moving from one media to another (e.g., from water or air to soil and sediment). They enter and are distributed through the food web, accumulating in the tissues of animals, including humans. Because these contaminants cross boundaries between environmental media, they are regulated by a variety of laws, regulations and programs. For all these reasons they raise unique, often difficult, management challenges.

The purpose of the Washington State Dioxin Source Assessment study (http://www.wa.gov/ecology/biblio/98320. html) was to identify actual ("confirmed") and potential in-state sources of dioxins. The magnitude of sources and importance of source categories were evaluated using existing information. Understanding the sources of dioxins is a logical first step towards an effective management strategy that will reduce their generation and dispersal.

The assessment:

- Summarized what Ecology *knows* and *does not know* about dioxin sources in Washington State.
- Recommended actions Ecology might take to (1) improve its understanding of dioxin sources and (2) reduce the magnitude and impact of these sources on the state's citizens and environment.

Dioxins are unintended byproducts formed during combustion of organic compounds in the presence of chloride, incineration of municipal and hospital wastes, and chlorine bleaching of wood pulp [4,5,6] The production of chlorinated organic chemicals can also produce dioxins; they are therefore contaminants in certain chlorinated organic products. Dioxins have no commercial or domestic applications and are not intentionally produced, except for small quantities used in research.[7, 8]

Methods and Materials

Known and potential sources of dioxin in Washington State were evaluated using of existing source-monitoring data. No resources were allocated for additional monitoring or modeling. We evaluated a range of environmental media: air, water, ash, and biosolids.

Source data were used to calculate *loads*. A *load* is the rate at which dioxin is generated or discharged. Loads are expressed in the assessment as milligrams of dioxin toxic equivalents (TEQs) per day. To calculate a load, we determined the TEQ for the material tested (e.g., air, water, ash), then multiplied this by the rate at which that material was generated and/or released.

Source loads were determined from actual analytical test data. Unlike EPA's source evaluation work this project did not develop "emission factors" to estimate the total load from a category of sources.

Where adequate data allow, we calculate loads for individual sources. "Confirmed source categories" are source categories that have at least one facility with data adequate to calculate a dioxin load. Both active and closed facilities with documented dioxin loads were included as "confirmed sources." In addition to confirmed source categories, the assessment provides information on "potential sources categories". These include sources for which there were dioxin data but available data did not allow calculation of dioxin loads; for instance, contaminated sites with confirmed dioxin contamination. Dioxin could be moving from sites not fully remediated, however, data were not available to quantify these loads.

We focused on sources located within Washington State's borders and used only data generated during the 10 years preceding the assessment. Preferential focus was placed on data reporting the full range of 2,3,7,8-substituted congeners. The quality of data used in the assessment was variable. Although detailed review of data quality was beyond the scope of the project, every attempt was made to use published data or data that were available from the public record.

Project limitations were largely associated with the relative paucity of data. Dioxin testing is expensive and results are not always divulged. Additionally, information needed to calculate loads (ash generation rates, off-site migration rates) is not always available. Despite these limitations, the assessment revealed useful perspectives that are helping to direct Ecology's efforts.

Results and Discussion

Available data allowed identification of 25 facilities or processes with measurable dioxin loads. At the completion of the assessment 21 were active and four were closed. Of the 25, 15 discharge to air, nine to water, and nine to land. (Several discharge to more than one environmental medium.)

The available data on dioxin sources in Washington State was relatively sparse. In part this is due to limitations in environmental agencies' lack authority to require testing. For example, wastewater loads could not be calculated for any of the approximately 250 municipal wastewater treatment plants in Washington, and biosolids loads were available for only one of the 250. Similarly, air loads were available for only 2 of 84 waste-wood boilers, while ash loads were available for 3 of 84.

Each confirmed source category was evaluated to determine 1) the importance of obtaining additional data and 2) the importance of source reduction and control. Information used in this evaluation included:

- Data on the amount of dioxin generated by, or released by, sources in each category.
- Potential for dioxin generated by facilities to be dispersed or contained.

- Number of facilities in each category and the relative data coverage (e.g., the proportion of facilities in each source category having dioxin data).
- Whether the calculated dioxin loads were from facilities that continue to operate, or from facilities that are now closed.
- National rank, estimated from the relative magnitude of each source category, based on EPA's 1994 national dioxin source assessment.

Table 1summarizes the importance rankings for confirmed source categories.

Table 1. Importance of Additional Data Collection and Source Control: Confirmed Sources

Source Category	Importance of Additional Data	Importance of Source Reduction/Control
Incinerators	High	Variable (importance of sequestering fly ash - high.)
Hog Fuel (Wood Waste) Boilers	High	Potentially High
Bleached Pulp and Paper	Medium	Medium
Cement Kilns	Medium/Low	Medium/Low
Activated Carbon Regeneration	Medium/High	Low
Municipal Wastewater Treatment	High	Potentially Medium

For some source categories (called *potential* source categories) available data showed concentrations of dioxins associated with the source, but these data were inadequate to calculate the amount of dioxin being generated or released. Potential source categories include cleanup sites, wood treating facilities using pentachlorophenol, and oil refineries. The importance rankings of these sources are shown in Table 2.

Table 2. Evaluation of the "Importance" of Other Source Categories

Source Category	Importance of Additional Data Collection
Wood Treaters	High
Cleanup Sites	Variable
Oil Refineries	Medium

Conclusions and associated recommendations, many of which were based on the importance ratings shown above, were as follows:

Conclusion 1. Dioxin data are incomplete.

Recommendations: A series of recommendations to fill high priority data gaps were provided. These recommendations focus on improving the quantity and quality of dioxin data available for waste-wood boilers, incinerators, bleached pulp mills, fertilizers, biosolids, and wood-treating facilities using pentachlorophenol.

Conclusion 2. Two of the facilities with some of the highest estimated dioxin loads ceased operation in 1997.

Recommendations: Carry out follow-up dioxin monitoring in the vicinity of these facilities to evaluate the extent of off-site contamination and provide a sound basis for cleanup.

Conclusion 3. Wood-waste boilers and incinerators rate highest in importance for further source reduction.

Recommendations: Steps to reduce dioxin loads from these source categories were provided.

Conclusion 4. Compiling existing data on dioxin detected in Washington State's environment will help put these source data in context.

Recommendations: Compile soil, sediment, fish and shellfish dioxin data. Based on the results of this compilation, conduct monitoring to fill critical data gaps and track key environmental indicators. These indicators will show the effectiveness of actions taken to reduce dioxin in the environment.

Conclusion 5. This dioxin source assessment provides a major first step in implementing Ecology's strategy for managing bioaccumulative, persistent and toxic compounds.

Recommendation: Use information from this and subsequent PBT projects to advance and improve strategies that address the management and elimination of bioaccumulative pollutants.

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References

[1] Yake, B., Singleton, S., and Erickson, K. (1998) Washington State Dioxin Source Assessment. Washington State Department of Ecology, Publication No. 98-320.

[2] EPA (1994) Health Assessment Document for 2,3,7,4-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds. Volume 1. (External Review Draft). EPA/600/BR-92/001a.

[3] EPA (1994) Estimating Exposures to Dioxin-Like Compounds. Volume II: Properties, Sources, Occurrence and Background Exposures. (External Review Draft). EPA/600/6-88/005Cb.

[4] Alcock R.E. and Jones K.C. (1996) Environ. Sci. & Technol. 30 (11), 3133.

[5] Birnbaum L.S. (1994). Environ. Health Perspectives, 102(9), 157.

[6] Rappe, C. (1984) Environ. Sci. & Technol., 18 (3), 78A.

[7] ATSDR (1989) Toxicological Profile for 2,3,7,8-Tetrachlorodibenzo-p-dioxin, ATSDR/TP-88/23.

[8] Federal Register (May 7, 1997) 62(88), 24887.