Control of Toxic Chemicals in Puget Sound

Phase 2: Pollutant Loading Estimates for Surface Runoff and Roadways

DEPARTMENT OF ECOLOGY
State of Washington

EnviroVision Corp

HERRERA ENVIRONMENTAL CONSULTANTS

Control of Toxic Chemicals in Puget Sound

Phase 2: Improved Estimates of Loadings from Surface Runoff and Roadways

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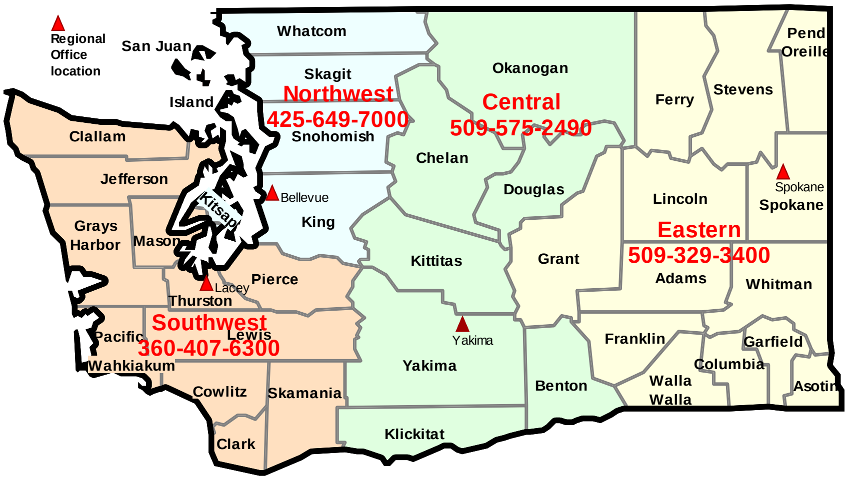

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Executive Summary

The Phase 1 Initial Estimate of Toxic Chemical Loadings to Puget Sound identified the surface runoff pathway as a significant source of toxics entering Puget Sound and recommended that the Washington Department of Ecology (Ecology) conduct further review to better understand the contribution from municipal and state roadways. In response, Ecology conducted this Phase 2 evaluation to estimate toxic chemical loadings from roadways and to refine further the surface runoff estimates with more recent land use data and alternate runoff coefficients.

This Phase 2 project included the following components:

- Literature review for information concerning toxic chemicals in roadway runoff, particularly from residential side streets, arterial/collector roads, highways, retail parking lots, and low-traffic parking lots.
- Geographic Information System (GIS) analyses to delineate and map roadway areas in the 14 upland study areas that link to Ecology's Puget Sound Box Model, a computerized tool for predicting contaminant effects within the Puget Sound ecosystem.
- Computation of loading estimates for 17 toxic chemicals of concern.

The project team found that although sufficient data existed to characterize some toxic chemicals in runoff from highways, adequate data were lacking for arterial and collector roads, side streets, and parking lots. Also, the team found relatively few data for some key toxic organic chemicals. Therefore, we calculated loading contributions from only highways and the four general land use categories assessed in Phase 1.

The project team calculated toxic chemical loading estimates for this Phase 2 analysis using the same general methodology that the Phase 1 analysis employed, except for the following differences:

(1) Separation of highways as a distinct land use. Where sufficient data were available for specific toxic chemicals, we computed toxic loading estimates for highways.

(2) Use of three different runoff coefficients in the loading calculations (0.90 for highways; 0.35 for agricultural, instead of 0.60; and 0.20 for forest/field/other, instead of 0.50).

(3) Use of the more current 2001 national land cover dataset, instead of the 1992 version.

For the entire Puget Sound Basin, total loading estimates were generally greatest for residential land use, which was the largest source for 14 of the 17 toxic chemicals of concern. Forest/field/other areas were the largest source for three toxic chemicals of concern (arsenic, mercury, and DDT and metabolites). For 10 of the toxic chemicals considered, highways had the lowest total loading estimates of all the land use categories. The total contribution of toxic chemical loadings from highways was between less than 1 percent to 14 percent of the total loading from surface runoff to Puget Sound, depending on the specific chemical.

The unit area loading rates for the commercial/industrial land use area and highways were generally the largest. Highways had the largest unit area rates for six of the toxic chemicals (copper, lead, zinc, carcinogenic PAHs, bis(2-ethylhexyl)phthalate, and nonylphenol), and commercial/industrial areas also had the largest unit area rates for six toxic chemicals (arsenic, cadmium, mercury, high molecular weight PAHs, low molecular weight PAHs, and TPH). Residential areas generally had the third highest unit area loading rates.

Overall, the amount of residential land use was one of the most important determinants for predicting which study areas were the largest contributors of toxic chemical loadings to Puget Sound. This result was likely due in part to the following considerations:

- Residential areas occupied a relatively substantial portion (11.6 percent) of the total Puget Sound Basin.

- Representative concentrations of toxic chemicals in runoff from residential areas were greater than those of both agricultural and forest/field/other land use categories.

Although highways, themselves, have contributed relatively little to the total loading of toxic chemicals to Puget Sound, highways and other roadways often act as conduits for surface runoff that accelerate and ultimately increase the discharge of toxic chemicals from other land uses to Puget Sound.

The general pattern in the loading estimates between Phase 1 and Phase 2 likely reflects the continuing regional shift from agriculture and forest land use to residential land use between 1992 and 2001. However, some of the differences between the Phase 1 and Phase 2 loading estimates were also related to differences in the runoff coefficients. Several other issues also diminished the reliability of the total loading estimates, including:

- Commingling of surface runoff from multiple land use areas.
- Non-local locations of the samples with usable chemistry data.
- Few data and large ranges for some of the toxic chemicals reviewed.
- Study designs that may have biased the chemical concentrations in the runoff.
- Assumption of no attenuation of the pollutants.
- Effects of “non-detect” analytical results.

Ecology should consider how conversion of forested and agricultural lands to more developed and impervious urban or residential uses affects the water quality of surface runoff. Methods that Ecology should support to limit increases of toxic chemical loadings to Puget Sound include reducing the sources of contaminants and reducing direct discharges to surface waters by dispersing and infiltrating potentially contaminated surface runoff.

Ecology requires additional information to be able to prioritize the toxic threats from surface runoff into Puget Sound. This includes the following types of concentration data for toxic chemicals in surface runoff:

- From multiple locations at various times throughout the year.
- From multiple well-defined areas that represent specific land uses.
- That illustrate the attenuation effects of the various natural landscape and constructed features located between the original sources of surface runoff and the point of its final discharge to Puget Sound.

Ecology should focus on the following tasks to develop more definitive information for targeting specific land uses for pollution source control efforts:

a) Create a comprehensive conceptual model of the Puget Sound Basin, into which Ecology's Toxics Box Model will fit and against which other scientists can compare their assumptions, input data, and analytical methods.

b) Improve its estimates of the relative contribution of toxic chemicals from land use and roadway areas with additional data collected through studies of relatively small catchments.

c) Differentiate the loading contributions from potential pollutant sources within each land use category.

d) Increase the priority of monitoring organic toxic chemicals in surface runoff.

e) Require laboratory-reporting limits that are as low as analytically feasible for all monitoring of stormwater runoff.

f) Consolidate efforts to further assess toxic chemicals with the assessment of other contaminants, such as nutrients.

Introduction

As a consequence of the Governor's Puget Sound Initiative, the Washington Department of Ecology (Ecology), Puget Sound Partnership, United States Environmental Protection Agency (EPA), and other interested parties are collaborating to advance toxic chemical controls as part of a multi-year effort to protect and restore the overall health of the Puget Sound ecosystem. Ecology recently completed a Phase 1 project in support of this goal, an Initial Estimate of Toxic Chemical Loadings to Puget Sound. The report for the Phase 1 project (Hart Crowser et al. 2007) reviewed readily available information to characterize and quantify the loadings to Puget Sound for a list of key toxic chemicals released via the following pathways:

- Surface runoff
- Atmospheric deposition
- Wastewater discharge
- Combined sewer overflows
- Direct spills to aquatic systems

In that report, loadings for the surface runoff pathway were specifically estimated as a function of the following land use categories: commercial/industrial, residential, agricultural, and forest/field/other. However, the report did not distinguish estimates of loadings from the stormwater that discharged from these categories and the various types of roadways within them. Since stormwater runoff from municipal and state roadways is a potential source of toxic chemicals to Puget Sound, the report for the Phase 1 project recommended that Ecology conduct further analyses to refine its understanding of this pollutant loading pathway.

Previous studies by others have demonstrated that the types and amounts of pollutants in stormwater runoff from roadways vary depending on the usage of the roadway. Pitt and Bissonnette (1984) found that differences in the concentrations of lead, pesticides, and other metals in urban runoff in Bellevue, Washington, corresponded with the type of street (residential, or commercial and industrial arterials), the amount of auto traffic, and other land uses (e.g., streets, parking lots, yards, roofs). Bannerman et al (1994) determined that the mean concentrations of metals, total suspended solids (TSS) and E. coli varied among side streets, arterials, commercial parking, and industrial parking. Pitt et al (1995) assessed sheet flow concentrations of metals, TSS, polyaromatic hydrocarbons (PAHs), and toxicity in streets and parking areas. Prey (1999) noted different estimated loadings of metals and PAHs from a model comparing stormwater runoff from streets and commercial parking lots. Brandenberger et al (2007) found that the results of analyses of a variety of pollutants in stormwater depended in part on the average daily traffic volumes on highways and other roadways. Herrera (2007) determined that the concentrations of metals and TSS in stormwater runoff in Western Washington depended on the amount of traffic and certain weather characteristics.

In response to these studies and the recommendations of the Phase 1 toxics loading project, Ecology retained EnviroVision Corporation, who teamed with Herrera Environmental Consultants, Inc. (Herrera), to refine the initial toxic chemical loading estimates from the Phase 1 project and to incorporate information on toxic chemical loadings from roadways. The project team was composed of EnviroVision, Herrera, and Ecology, and received advice from the members of a technical project work group (listed on page iii). As part of this Phase 2 effort, the project team refined the land use classification completed for the Phase 1 analysis (Hart Crowser et al. 2007) to include information on roadway areas. Herrera also conducted a focused literature review to obtain data for characterizing concentrations of toxic chemicals in the runoff from different types of roadways and parking lots. Although sufficient data existed to quantify the concentrations of some toxic chemicals in runoff from highways, adequate data were lacking for arterial and collector roads, side streets, and parking lots. The project team used the updated land use classification and highway runoff data to recompute toxic chemical loading estimates for the four land use categories targeted in the Phase 1 analysis. Where sufficient data were available for specific parameters, we also computed toxic loading estimates for highways. Similar to the Phase 1 project, we generated these loading estimates for the entire Puget Sound Basin and 14 smaller upland study areas.

The original goal of this analysis was to provide Ecology and its partners with a better understanding of the contribution of toxic chemicals from roadways to Puget Sound. However, based on the large variability in the available concentration data and the numerous assumptions required for making loading estimates over this spatial scale, the numerical loading values presented in this study provided only a rough guide of the actual quantities of the specific chemicals released from different land use and roadway areas. The primary benefit from this study was a better understanding of the relative absolute and unit loading rates from these areas.

This report summarizes results from the Phase 2 analysis of toxic chemical loading to Puget Sound from surface runoff, with an emphasis on roadways. It begins with a description of the methods that were used to generate the pollutant loading estimates. The calculated loadings are then presented in a separate *Results* section with supporting tabular summaries provided as necessary. The results are presented in detail in the subsequent *Discussion* section. Finally, conclusions and the recommendations derived from these results are presented in the *Conclusions* and *Recommendations* sections.

Methods

This section describes the methods the project team (EnviroVision, Herrera, and Ecology) employed to generate toxic chemical loading estimates. These methods generally proceeded in three sequential steps:

- **Step 1 –** Literature review for toxic chemicals in roadway runoff
- **Step 2 –** GIS analyses to delineate and map roadway areas in the 14 study areas of Ecology's Puget Sound Box Model (Figure 1)
- **Step 3 –** Computation of toxic chemical loading estimates for the 17 toxic chemicals of concern listed in Table 1

The following subsections describe the specific activities that we performed at each step.

Literature Review for Toxic Chemicals in Roadway Runoff

Methods of the Literature Review

Herrera performed a literature review to compile relevant data on key toxic chemicals in roadway runoff. The key toxic chemicals targeted in this literature review are listed in Table 1. Herrera subsequently presented results and recommendations from this review in a summary report to Ecology (Herrera 2008).

The goal of the literature review was to obtain available data for characterizing the concentrations of key toxic chemicals in runoff from the following roadway categories:

- Residential side streets
- Arterial/collector roads
- Highways
- Retail parking lots
- Low-traffic parking lots

In this review, Herrera focused on data from local and regional sources to reflect trends that were most applicable to the Puget Sound region. However, Herrera also obtained data from national sources if no local data were available for a particular roadway type or chemical parameter. The specific data sources that were queried in this effort included the Thomson Scientific Web of Science database, which provides electronic access to more than 8,500 scientific journals encompassing all fields of environmental science. Herrera also queried publicly available internet search engines to obtain available "grey-literature" relating to roadway runoff water quality. Finally, Herrera obtained additional data from the International Stormwater Best Management Practice (ISBMP) Database (2008), which contains results from more than 300 studies of BMP treatment performance. In particular, Herrera screened this database to identify studies that specifically examined the effectiveness of BMPs at treating runoff from roadways.

Herrera then compiled data from influent monitoring stations associated with these studies by roadway type for use in this effort.

Herrera subsequently summarized data obtained from specific studies of roadway runoff that were identified through this literature review in a spreadsheet that included fields with the following information:

- Parameter
- Study reference
- Roadway category
- Sample type
- Sample location
- Number of samples
- Number of non-detect values
- Minimum value
- Maximum value
- Mean value
- Standard deviation
- Data usability score (see description below)
- Sampling period

Key Findings of the Literature Review

In the Phase 2 literature review, several general data limitations diminished the overall value of the compiled data for use in estimating toxic chemical loadings to Puget Sound from roadways:

- Relatively few data were found for the key toxic organic chemicals identified in Table 1 across all five of the targeted roadway categories. In particular, few data were found for individual polyaromatic hydrocarbons (PAHs). Where these data were available for any particular roadway category, the majority of the reported values were less than the analytical method detection limits.

- Except for highways, relatively few data were found for the remaining four roadway categories (i.e., residential side streets, arterial/collector roads, retail parking lots, and low-traffic parking lots) from controlled studies of roadway runoff; rather, the majority of the data were obtained from stormwater conveyance systems with mixed runoff from roadways that was commingled with other non-roadway land uses.

Recognizing these data limitations, the project team developed an approach for integrating information on toxic chemicals in roadway runoff with the loading estimates that were developed previously through the Phase 1 project. The key attributes of this approach are summarized as follows:

- To ensure the respective results from the Phase 1 and Phase 2 analyses were consistent and comparable, the Phase 2 project team computed pollutant loadings using the same methodology that was used for Phase 1.
- In the Phase 1 analysis, Ecology identified 17 separate parameters as key toxic chemicals (Table 1). For the Phase 2 literature review, Ecology requested that the 16 individual constituents of the three PAH classes be considered separately (individual PAHs in each class are listed in Table 1). However, Herrera found relatively few data for these individual PAHs in the Phase 2 literature review. In addition, most of the reported values obtained for these PAHs through this review were at or below the analytical method detection limits. Therefore, for the Phase 2 analysis we computed loads for only the original 17 parameters if data were available.
- The majority of data compiled for residential side streets, arterial/collector roads, and parking lots were unrepresentative of actual pollutant concentrations from these roadway surfaces because they reflected runoff after it had commingled with runoff from other land uses. Therefore, we did not attempt to generate loading estimates for these three types of roadways.
- Unlike residential side streets and arterial/collector roads, the majority of the data compiled for highways through the Phase 2 literature review came from samples collected at the edge-of-pavement as opposed to samples from a stormwater conveyance system. Since the available data were generally representative of the stormwater runoff from only the pavement surface, the project team used them to estimate pollutant loadings for highways. However, Herrera was unable to find any data for characterizing concentrations of the following toxic chemicals in highway runoff: total PCBs, total PBDEs, total dioxin TEQs, DDT and metabolites, and triclopyr. Therefore, we did not attempt to generate loading estimates for this subset of chemicals.

GIS Analyses to Delineate and Map Roadway Areas

The Phase 2 project team performed a Geographic Information System (GIS) analysis to refine the land use classification completed for the Phase 1 analysis (Hart Crowser et al. 2007) to include information on roadway areas. We broke out roadway area information for all three types of roadway (side streets, arterial/collector roads, and highways) even though we later determined loading estimates for only the highways due to the limited amount of chemical concentration data for the other roadway types. Toxic chemical contributions from side streets and arterial/collector roads were included in the loadings from the general land use categories (commercial/industrial, residential, agricultural, and forest/field/other) simply by not subtracting their areas from the total areas of the land use categories (similar to how parking lots were treated). To facilitate comparison of results from Phases 1 and 2, we followed as much as possible the methods used in Hart Crowser et al. (2007).

Ecology's Puget Sound Box Model represents Puget Sound as ten interconnected boxes with inflows and outflows of water from upland rivers and the Straits of Juan de Fuca and Georgia. The model simulates the movement of marine waters among different areas of the Sound and of pollutants in the water, sediment, and biota of the Sound. Managers can use the box model to evaluate the expected response of pollutant concentrations in water, sediment, and biota to various strategies for control of pollutant sources. The model distributes the inflow of freshwater, including surface runoff, to its ten boxes and represents all of the watersheds of the entire Puget Sound Basin among 14 upland study areas. Each study area contributes a specific loading input from surface runoff to the box model. Figure 1 illustrates the 14 study areas.

The project team used the shapefiles of each of the 14 upland study areas in the Puget Sound Basin as spatial analysis masks in the land use and roadway analyses. We compiled roadway centerline data for the 14 study areas and categorized the roadways as arterial/collector roads, highways, or residential side streets based on the county and state definitions. After classifying all GIS roadway line data, we next calculated the areas of the various roadway types within each land use category. Since the classified roadway data depicted only the road centerline, it was necessary to determine the width of each roadway and convert the roadways to polygons so that their areas could be calculated and combined with the four land use categories.

For the Puget Sound Basin and each of the 14 study areas, the project team calculated percentages of land area in 16 land use subclasses. The 16 subclasses were an intersection of the four land use categories (residential, commercial/industrial, agricultural, and forest/field/others) with the four roadway types (non-road, side streets, arterial/collector road, and highway). While the Phase 1 analysis used the 1992 national land cover dataset (MRLC 1992), this Phase 2 analysis used the more current 2001 national land cover dataset (MRLC 2001). Tables 2 and 3 show land use areas and percentages, respectively, for the Puget Sound Basin and each study area. Appendix A provides detailed documentation of the GIS procedures used in these analyses.

Computation of Toxic Chemical Loading Estimates

As described above, the project team calculated toxic chemical loading estimates for the Phase 2 analysis using the same methodology that was employed in the Phase 1 analysis. Specifically, we calculated the runoff volume associated with each land use category based on the runoff coefficient method (Chow 1964) using the following equation:

$$q_i = r_i f_i Q$$

Where: q_i = Total discharge rate (volume/time) from land use category *i*
r_i = Relative runoff rate for land use category *i*
f_i = Fraction of total study area represented by land use category *i*
Q = Study area discharge rate (from Hart Crowser 2007)

We computed the values for r_i using the following equations:

$$r_1 f_1 + r_2 f_2 + r_3 f_3 + r_4 f_4 + r_5 f_5 = 1$$

and:

$$r_1 / r_2 = (RC)_1 / (RC)_2$$

$$r_1 / r_3 = (RC)_1 / (RC)_3$$

$$r_1 / r_4 = (RC)_1 / (RC)_4$$

$$r_1 / r_5 = (RC)_1 / (RC)_5$$

Where: $(RC)_i$ = Runoff coefficient (fraction between 0 and 1) for land use category *i*.

We computed toxic chemical loading estimates to Puget Sound using the following equation:

$$m_i = q_i c_i$$

Where: m_i = Toxic chemical loading estimate to Puget Sound for land use category *i*
c_i = Best estimate of representative toxic chemical concentration in the runoff from land use category *i*.

The sections below describe how each of the specific inputs to these equations was developed and applied.

Fraction of Total Study Area Represented by Land Use Category

The methods used to compute the fraction of total study area (f_i) represented by each land use category are described in the previous subsection (*GIS Analyses to Delineate and Map Roadway Areas*). Table 3 summarizes the specific percentages that were used in the equations for calculating toxic chemical loading estimates for the four land use categories and the highway roadway type.

Study Area Discharge Rate

For the Phase 2 analysis, we used the average surface runoff discharge rates (Q_i) of the Phase 1 analysis for calculating toxic chemical loading estimates. As shown in Table 4, the average surface runoff discharge rate for the Puget Sound Basin was 1,785 cubic meters per second

(m^3/sec). Across the 14 study areas, these values range from 8.0 m^3/sec for Hood Canal (North) to 573 m^3/sec for the Whidbey Basin study area.

Runoff Coefficient for Land Use Category

The project team used the following runoff coefficients $(RC)_i$ in the loading calculations:

$(RC)_{highway}$ = 0.90
$(RC)_{commercial/industrial}$ = 0.85
$(RC)_{residential}$ = 0.70
$(RC)_{agricultural}$ = 0.35
$(RC)_{forest/field/other}$ = 0.20

These values were reasonable estimates within the ranges cited in the available literature (e.g., Chow 1964; Dunne and Leopold 1978).

Best Estimate of Representative Toxic Chemical Concentrations

Table 5 summarizes the number of data sources that were available to characterize the runoff concentrations of each toxic chemical by land use category. This information is broken down to show the number of data sources that were considered local (i.e., from Washington state) versus national. In general, Table 5 shows that a relatively high number of data sources were available for characterizing metals concentrations across all the land use categories. Conversely, few data sources were available to characterize concentrations of total PCBs, total PBDEs, PAHs, triclopyr, and total dioxin TEQs.

In order to characterize toxic chemical concentrations in runoff associated with the commercial/industrial, residential, agricultural, and forest/field/other land use categories, the Phase 2 project team used data compiled by Hart Crower et al (2007) for the Phase 1 analysis. These data included five probability of exceedance (POE) concentrations (95, 75, 50, 25, and 5 percent) for each toxic chemical. The POE concentrations indicate the probability that a reported value for a specific toxic chemical might be exceeded. For example, there is a 95 percent chance that the actual concentration for a toxic chemical will exceed the value reported for the 95 percent POE. Similarly, there is only a 5 percent chance that the actual concentration for a toxic chemical will exceed the value reported for the 5 percent POE. It follows that the value reported for the 50 percent POE is the best estimate of the median concentration for a given toxic chemical.

To develop representative concentrations in runoff from highways, the project team used only data that were obtained through the Phase 2 literature review. Tables B-1 through B-12 in Appendix B summarize the highway runoff data that were available for this purpose. Figure 2 provides a flow chart that summarizes the associated processes. To compute these representative concentrations, we used only data that were obtained through the Phase 2 literature review from studies in North America. If data for a specific toxic chemical were available from at least 10 studies in Washington State, we excluded data from out-of-state studies when computing the concentrations.

To maintain consistency with the Phase 1 analysis, the project team also calculated the following POE estimates for the representative toxic chemical concentrations in highway runoff: 95, 75, 50, 25, and 5 percent. As in the Phase 1 analysis, we assumed that the underlying distributions of the toxic chemical concentration data were lognormal. To generate the POE estimates, we calculated the maximum likelihood estimates for μ, the untransformed mean of the natural logs of the dataset, and σ, the untransformed standard deviation of the natural logs of the dataset (Singh et al. 1997). (The parameters μ and σ are also known as the geometric mean and geometric standard deviation, respectively. The geometric mean is also equivalent to the 50 percent POE concentration.) Table 6 lists these values for each toxic chemical of concern in surface runoff from highways. Note that the values presented for μ and σ in Table 6 are untransformed; therefore, these values represent actual concentrations in units of microgram per liter (μg/L). In calculating these values, we substituted the value of the reported detection limit for non-detect values. This substitution had no impact on the final loading results (except slightly for mercury) due to the relatively small contribution from highways. The values of μ and σ were subsequently used to calculate the POE estimates for each toxic chemical in highway runoff using the inverse lognormal probability function in Microsoft Excel®.

Three of the toxic chemicals of concern were classes of PAHs, including low molecular weight PAHs, carcinogenic PAHs (as defined by the Model Toxics Control Act), and high molecular weight PAHs. To generate POE estimates for these classes of PAHs in highway runoff, we calculated μ and σ as described above for the other toxic chemicals of concern for each individual PAH in the class. We then summed the calculated μ of the individual PAHs in each class to obtain the PAH class μ, and averaged the calculated σ of the individual PAHs in each class to obtain the PAH class σ. This method was required due to the variation of the list of analytes in the PAH classes among the different studies. This method may have underestimated σ for carcinogenic and heavy PAHs in surface runoff from highway areas only. We used the resultant values for μ and σ (Table 6) to calculate the POE estimates for each toxic chemical in highway runoff as described above.

Due to a high frequency of non-detect values, the calculation of highway runoff POE concentrations for low molecular weight PAHs was not possible using the methods described above. Two studies examined low molecular weight PAHs in highway runoff (see Table B-9 in Appendix B for details). In both of those studies, for three of the six low molecular weight PAHs (acenaphthylene, anthracene, and naphthalene), 100 percent of the observations were below their detection limits of 0.1 and 0.05 micrograms per liter (μg/L), respectively. For the remaining three low molecular weight PAHs (acenaphthene, fluorene, and phenanthrene), the two studies combined had 98 percent, 98 percent, and 79 percent non-detect values, respectively. Given the high frequency of non-detect values, it appeared unreasonable to estimate the total low molecular weight PAH concentration simply as the sum of the individual PAH concentrations as this would have been simply a sum of six detection limits (0.6 μg/L). Instead, we assumed 0.1 μg/L to be a reasonable estimate of the geometric mean (or 50 percent POE) concentration and 1.5 μg/L to be a reasonable estimate for σ.

For 5 of the 17 toxic chemicals of concern (total PCBs, total PBDEs, total dioxin TEQ, DDT and metabolites, and triclopyr), no data were available to characterize concentrations in highway runoff. As noted previously (see *Literature Review for Toxic Chemicals in Roadway Runoff* section), the project team did not attempt to generate loading estimates from highways for this subset of chemicals. Therefore, loading estimates for these chemical are presented herein for only the four other land use categories (commercial/industrial, residential, agricultural, and forest/field/other). Since data limitations prevented us from estimating separate loadings from roadways for those toxic chemicals, we assigned zero loading amounts to these chemicals for the highway areas. This assumption had only a minor impact on the final total loading estimates for these chemicals due to the relatively small contribution from highways.

Table 7 summarizes the representative highway runoff concentrations that were derived from the analyses described in Table 6 and in the text above. Concentrations are provided in Table 7 for each of the 17 toxic chemicals of concern and are briefly summarized below.

Arsenic

The commercial/industrial land use category had the highest concentrations of arsenic, with a 50 percent POE concentration of 4.0 µg/L (Table 7). The forest/field/other and agricultural land use categories had the lowest 50 percent POE concentrations at 1.0 and 1.5 µg/L, respectively. Concentrations for the residential land use category and highways were similar (2.0 µg/L).

Cadmium

The commercial/industrial land use category had the highest 50 percent POE concentration (1.5 µg/L) of cadmium, while the highways had the second highest concentration (1.0 µg/L) (Table 7). The residential and agricultural land use categories both had 50 percent POE concentrations of 0.50 µg/L, and the forest/field/other land use category had the lowest 50 percent POE concentration (0.013 µg/L).

Copper

The commercial/industrial land use category had the highest 50 percent POE concentration (25 µg/L) for copper, and highways had the second highest concentration (19 µg/L) (Table 7). The residential and agricultural land use categories had similar 50 percent POE concentrations (4.0 and 5.0 µg/L, respectively), while the forest/field/other land use category had the lowest concentration at 1.0 µg/L.

Lead

With a 50 percent POE concentration of 46 µg/L, lead concentrations were by far the highest in the runoff from highways (Table 7). The next highest 50 percent POE concentration was 20 µg/L for the commercial/industrial land use category. The residential land use category had a 50 percent POE concentration of 10 µg/L, followed by the agricultural and forest/field/other land use categories with concentrations of 5.0 µg/L and 0.50 µg/L, respectively.

Zinc

As was the case with several other metals, the commercial/industrial land use category had the highest zinc concentrations (Table 7), with a 50 percent POE value of 120 µg/L. The second highest concentration was for highways (98 µg/L). The 50 percent POE concentration for the residential land use category (30 µg/L) was greater than the concentration for the agricultural (10 µg/L) and forest/field/other (2.0 µg/L) land use categories.

Mercury

As with most of the heavy metals, the commercial/industrial land use category had the highest 50 percent POE concentration for mercury (0.20 µg/L), and highways had the second highest concentration (0.051 µg/L) (Table 7). The residential, agricultural, and forest/field/other land use categories all had similar 50 percent POE concentrations of 0.01, 0.007, and 0.005 µg/L, respectively.

Total PCBs

As shown in Table 7, the commercial/industrial land use category had the highest 50 percent POE concentration of total PCBs (0.030 µg/L), followed by the residential (0.020 µg/L), agricultural (0.010 µg/L), and forest/field/other (0.0010 µg/L) land use categories. Herrera did not identify any studies that characterized total PCBs in highway runoff.

Total PBDEs

The residential land use category had the highest 50 percent POE concentration for total PBDEs (4.0E-5 µg/L), followed by the agricultural (3.0E-5 µg/L), commercial/industrial (2.0E-5 µg/L), and forest/field/other (8.0E-6 µg/L) land use categories (Table 7). Herrera did not identify any studies that characterized total PBDEs in highway runoff.

Carcinogenic PAHs

As shown in Table 7, the commercial/industrial land use category had the highest 50 percent POE concentration for carcinogenic PAHs (1.0 µg/L). Highways had the second highest concentration (0.82 µg/L). However, since the associated standard deviation was relatively small (Table 6), highways had the highest 95 percent POE concentration (Table 7). The residential and agricultural land use categories had the same 50 percent POE concentration (0.15 µg/L), and the forest/field/other land use category had the lowest concentration (6.0E-3 µg/L).

High Molecular Weight PAHs

The commercial/industrial land use category had the highest 50 percent POE concentration (0.80 µg/L) for high molecular weight PAHs (Table 7). Highways had the second highest concentration (0.42 µg/L). However, since the associated standard deviation was relatively small (Table 6), highways had the highest 95 percent POE concentration (Table 7). The residential and agricultural land use categories had the same 50 percent POE concentration (0.10 µg/L), and the forest/field/other land use category had the lowest concentration (0.0050 µg/L).

Low Molecular Weight PAHs

The commercial/industrial land use category had the highest 50 percent POE concentration (3.0 µg/L) for low molecular weight PAHs, by an order of magnitude (Table 7). The 50 percent POE concentration for the agricultural and residential land use categories was 0.30 µg/L, while the concentration for the forest/field/other land use category was only 0.015 µg/L. The different studies that provided these data had different detection limits for the low molecular weight PAHs. As described above, the project team assumed a 50 percent POE concentration of 0.10 µg/L for highways due to the high number of non-detect values in the associated data set.

bis(2-Ethylhexyl)phthalate

As shown in Table 7, the residential, commercial/industrial, and agricultural land use categories had 50 percent POE concentrations of 10 µg/L. The 50 percent POE concentration for highways was lower (7.6 µg/L), and the concentration for the forest/field/other category was the lowest (0.10 µg/L).

Total Dioxin TEQs

The commercial/industrial land use category had the highest 50 percent POE concentration for total dioxin TEQs (1.0E-5 µg/L), followed by the residential and agricultural (5.0E-6 µg/L) and forest/field/other (1.0E-7 µg/L) land use categories (Table 7). Herrera did not identify any studies that characterized total dioxin TEQs in highway runoff.

DDT and Metabolites

As shown in Table 7, the agricultural land use category had the highest 50 percent POE concentration for DDT and metabolites (6.0E-3 µg/L). Concentrations for the forest/field/other, residential, and commercial/industrial categories were substantially lower (3.0E-3, 1.0E-3, and 2.0E-4 µg/L, respectively). Herrera did not identify any studies that characterized DDT and metabolites in highway runoff.

Triclopyr

The agricultural land use category had the highest 50 percent POE concentrations of triclopyr at 6.0E-2 µg/L, followed by the residential and commercial/industrial land categories at 3.0E-2 µg/L, and the forest/field/other land use category at 4.0E-3 µg/L (Table 7). Herrera did not identify any studies that characterized triclopyr in highway runoff.

Nonylphenol

As shown in Table 7, highways had the highest 50 percent POE concentrations of nonylphenol at 5.9 µg/L. The commercial/industrial land use category also had a relatively high 50 percent POE concentration (4.0 µg/L). The residential, agricultural, and forest/field/other categories all had concentrations that were substantially lower than the concentration for the commercial/industrial category.

Total Petroleum Hydrocarbons

The commercial/industrial land use category had the highest 50 percent POE concentrations for TPH at 6,000 µg/L, followed by the residential (3,000 µg/L), highways (2,252 µg/L), agricultural (1,000 µg/L), and forest/field/other (100 µg/L) land use categories (Table 7).

Results

Calculated toxic chemical loading estimates are presented and summarized in Appendices C through G. The specific contents of these appendices are as follows:

- **Appendix C** – Tabular summaries of absolute toxic chemical loading estimates and loading estimates expressed as a percentage of the total basin or study area loading rate.
- **Appendix D** – Tabular summaries of unit area toxic chemical loading estimates by land use category.
- **Appendix E** – Tabular summary of unit area toxic chemical loading estimates for the Puget Sound Basin and the 14 study areas in Ecology's Puget Sound Box Model.
- **Appendix F** – Graphical summaries comparing absolute toxic chemical loading estimates across the land use categories in the Puget Sound Basin.
- **Appendix G** – Graphical summaries comparing absolute toxic chemical loading estimates across the 14 study areas in Ecology's Puget Sound Box Model.

The toxic chemical loading estimates are also summarized in the subsections below. These loading estimates are compared across the land use categories based on the 50 percent POE values. As noted in the *Introduction*, the loading estimates presented herein provide only a rough guide of the actual quantities of the specific chemicals released from the different land use categories due to the large variability in the available concentration data and the numerous assumptions required to calculate these values. Therefore, the project team has generally emphasized only relative comparisons in the presentation of these results. A discussion of these results is provided in a subsequent section of this document (*Discussion*).

Puget Sound Basin

For the entire Puget Sound Basin, absolute loading estimates were generally highest for residential land use (Table C-1, Appendix C). For example, residential land use was the largest source for 14 of the 17 toxic chemicals of concern. Forest/field/other areas were the largest source for three toxic chemicals of concern (arsenic, mercury, and DDT and metabolites), and the second largest source for four chemicals of concern (copper, lead, total PCBs, and total PBDEs). Agricultural land use was not the primary source for any of toxic chemicals of concern, although it was the second largest source for cadmium, bis(2-ethylhexyl)phthalate, total dioxin TEQs, DDT and metabolites, and triclopyr. Loading estimates for highways were generated for only 12 of the 17 toxic chemicals of concern. For 10 of these 12 chemicals, highways had the lowest loading estimates from all the land use categories: the two exceptions were carcinogenic PAHs and nonylphenol.

Even though absolute loading rates were low for highways, unit area loading rates for this land use category were relatively high (Table D-1, Appendix D). For example, highways had the highest unit area loading rates for six of the toxic chemicals (copper, lead, zinc, carcinogenic PAHs, bis(2-ethylhexyl)phthalate, and nonylphenol), and the second highest for five toxic chemicals (arsenic, cadmium, mercury, high molecular weight PAHs, and TPH). Unit area loading rates for commercial/industrial areas were similarly high. For example, commercial/industrial areas had the highest unit area loading rates for six toxic chemicals (arsenic, cadmium, mercury, high molecular weight PAHs, low molecular weight PAHs, and TPH), and the second highest for six other toxic chemicals (copper, lead, zinc, carcinogenic PAHs, bis(2-ethylhexyl)phthalate, and nonylphenol). Residential areas generally had the third highest unit area loading rates, followed by agricultural areas, and then forest/field/other areas.

Geographically, the largest loadings in absolute terms came from the Whidbey Basin study area (Appendix G), even though this study area had relatively low loading per unit area (Table E-1, Appendix E). The Sinclair/Dyes Inlet study area had the highest unit area loading rates for 10 of the 17 toxic chemicals of concern (Table E-1, Appendix E). The Elliott Bay study area had the highest unit area loading rates for mercury, low molecular weight PAHs, and nonylphenol. The Hood Canal (North) study area generally had the lowest loading rates (Appendix G) and lowest unit area loading rates across all the toxic chemicals of concern (Table E-1, Appendix E).

Computed loading estimates for individual toxic chemicals of concern in the Puget Sound Basin are summarized below.

Arsenic

As shown in Table C-1 in Appendix C, absolute loading rates for arsenic in the Puget Sound Basin ranged from 40 to 140 MT/year (metric tons per year) based on the 75 to 25 percent POE concentrations. Considering only the 50 percent POE concentrations, most of this loading was from forest/field/other areas (52 percent) and residential areas (35 percent). Agricultural areas and commercial/industrial areas were relatively minor sources in comparison, with contributions of 7 and 5 percent, respectively. Loading from highways represented only a small fraction (less than 1 percent) of the total load.

Cadmium

Absolute loading rates for cadmium ranged from 4.6 to 24 MT/year based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). Based on the 50 percent POE concentrations, residential areas were the largest source (64 percent), agricultural areas the second largest (16 percent), commercial/industrial areas the third (13 percent), forest/field/other areas the fourth (5 percent), and highways the smallest (2 percent).

Copper

Copper loading rates ranged from 67 to 270 MT/year based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). Residential areas were the largest source (39 percent) based on the 50 percent POE concentrations. Forest/field/other areas were the second largest source (29 percent). Commercial/industrial and agricultural areas were relatively minor sources in comparison with contributions of 16 and 13 percent, respectively. Loading from highways made up only a small fraction (4 percent) of the total load.

Lead

Absolute loading for lead ranged from 74 to 530 MT/year based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). Based on the 50 percent POE concentrations, residential areas were the largest source (67 percent). Forest/field/other areas, agricultural areas, and commercial/industrial areas were relatively minor sources in comparison with contributions ranging from 9 to 10 percent. Highways contributed only 6 percent of the total load.

Zinc

Absolute loading rates for zinc ranged from 320 to 1,300 MT/year based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). Most (62 percent) of the zinc load was from residential areas. Commercial/industrial areas were the next largest source (16 percent), followed by forest/field/other areas (12 percent), agricultural areas (5 percent), and highways (4 percent).

Mercury

Based on the 75 to 25 percent POE concentrations, absolute loading rates for mercury ranged from 190 to 1,500 kg/year (kilograms per year) (Table C-1, Appendix C). Forest/field/other and commercial/industrial areas were the largest contributors at 36 and 32 percent, respectively. Residential areas were a slightly smaller source (25 percent), while agricultural areas and highways were relatively minor sources with contributions of 4 and 3 percent, respectively.

Total PCBs

Absolute loading rates for total PCBs ranged from 91 to 1,400 kg/year based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). The majority (73 percent) of this load was from residential areas. Forest/field/other, agricultural, and commercial/industrial areas were all relatively minor sources in comparison with contributions ranging from 7 to 11 percent. Due to a lack of data, we did not estimate total PCB loading rates for highways.

Total PBDEs

Total PBDE loading rates ranged from 300 to 3,100 g/year (grams per year) based on the 75 to 25 percent POE concentrations (Table C-1). Residential areas were the largest source (55 percent), followed by forest/field/other area (33 percent), agricultural (11 percent), and commercial/industrial areas (2 percent). Due to a lack of data, we did not estimate total PBDE loading rates for highways.

PAHs

Patterns in loading rates were similar across the three classes of PAHs (carcinogenic PAHs, other high MW PAHs, and low MW PAHs) (Table C-1, Appendix C). In all cases, residential areas were the largest source, contributing approximately half of the loads. Commercial industrial areas were the second largest source, agricultural areas were the third largest source, and forest/field/other areas were the fourth largest source. The highway contribution was different for each PAH class. For low molecular weight PAHs highways contributed less than 1 percent of the total load; for carcinogenic PAHs highways contributed 6 percent of total load; and for high molecular weight PAHs highways contributed 4 percent of total load.

bis(2-Ethylhexyl)phthalate

Based on the 75 to 25 percent POE concentrations, absolute loading rates for bis(2-ethylhexyl)phthalate ranged from 47 to 690 MT/year (Table C-1, Appendix C). The majority of the load (73 percent) was from residential areas. Agriculture was the second largest source (19 percent). Commercial/industrial areas, forest/field/other areas, and highways all contributed less than 5 percent of the total load.

Total Dioxin TEQs

Absolute loading rates for total dioxin TEQ ranged from 24 to 370 g/year (grams per year) based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). Most (69 percent) of the load was from residential sources. Agricultural areas were the second largest source (18 percent). Commercial/industrial and forest/field/other areas contributed 9 and 4 percent of the total load, respectively. Due to a lack of data, we did not estimate total dioxin TEQ loading rates for highways.

DDT and Metabolites

Based on the 75 to 25 percent POE concentrations, absolute loading rates for DDT and metabolites ranged from 39 to 580 kg/year (Table C-1, Appendix C). Forest/field/other areas were by far the largest source (78 percent), while agricultural, residential, and commercial/industrial areas were all relatively minor sources in comparison. Due to a lack of data, we did not estimate DDT and metabolites loading rates for highways.

Triclopyr

Absolute loading rates for triclopyr ranged from 0.20 to 3.0 MT/year based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). Residential areas were the largest source (51 percent), followed by agricultural areas (26 percent), forest/field/other areas (20 percent), and commercial/industrial areas (3 percent). Due to a lack of data, we did not estimate triclopyr loading rates for highways.

Nonylphenol

Based on the 75 to 25 percent POE concentrations, absolute loading rates for nonylphenol ranged from 3.3 to 41 MT/year (Table C-1, Appendix C). Residential and commercial/industrial areas were the largest sources, with contributions of 36 and 31 percent, respectively. Agricultural and forest/field/other areas were relatively minor sources in comparison, with contributions of 9 and 10 percent, respectively. Finally, highways contributed 14 percent of the total load.

TPH

Absolute loading rates for TPH ranged from 23,000 to 120,000 MT/year based on the 75 to 25 percent POE concentrations (Table C-1, Appendix C). Most (75 percent) of the load was from residential areas. Commercial/industrial areas, agricultural areas, forest/field/other areas, and highways were minor sources in comparison, with contributions ranging from 1 to 10 percent.

Ecology's Puget Sound Box Model

Computed loading estimates are summarized below for each of the 14 study areas in Ecology's Puget Sound Box Model.

Main Basin Study Area

In the Main Basin study area, residential areas were the largest source of loadings for 14 of the 17 toxic chemicals of concern (Table C-2, Appendix C). For these 14 chemicals, the contribution from residential areas ranged from 50 to 89 percent of the total study area load. The exceptions to this pattern were as follows: commercial/industrial areas were the largest source (61 percent) for mercury; forest/field/other areas were the largest source (48 percent) for DDT and metabolites; and commercial/industrial areas were the largest source (51 percent) for nonylphenol. In the Main Basin study area, agricultural areas never contributed more than 3 percent of the total study area load. Similarly, loadings from highways were also generally less than 3 percent of the total study area load. Nonylphenol was an exception, with highways contributing 7 percent of the total study area load.

Relative to the other study areas, unit area loading rates in the Main Basin study area were intermediate for most toxic chemicals of concern, generally ranking 4th through 7th out of 14 study areas (Table E-1, Appendix E).

Port Gardner Study Area

In the Port Gardner study area, residential areas were the largest source of loadings for 14 of the 17 toxic chemicals of concern (Table C-3, Appendix C). For this subset of chemicals, loadings from residential areas ranged from 41 to 80 percent of the total study area load. Forest/field/other areas were the largest source of arsenic (52 percent of total loads), mercury (37 percent), and DDT and metabolites (80 percent). Commercial/industrial areas generally contributed less than 20 percent of the total load for all toxic chemicals except mercury, the three classes of PAHs, and nonylphenol. Loadings from agricultural areas ranged from 3 to 19 percent of the total study area load, and were generally smaller than loadings from commercial/industrial areas. With one exception (nonylphenol), loadings from highways represented less than 6 percent of total study area load across all the toxic chemicals.

Relative to the other study areas, the Port Gardner study area had the highest unit area loading rates for arsenic and the second highest loading rate for DDT and metabolites (Table E-1, Appendix E). The unit area loading rates in the study area ranked 3rd to 7th for the 15 other toxic chemicals of concern.

Elliott Bay Study Area

In the Elliott Bay study area, residential areas were the largest contributor for 10 of the 17 toxic chemicals of concern (arsenic, cadmium, lead, zinc, total PCBs, total PBDEs, bis(2-ethylhexyl)phthalate, total dioxin TEQs, triclopyr, and TPH) (Table C-4, Appendix C). For this subset of chemicals, the contribution from residential areas ranged from 50 to 75 percent of total study area load. For six toxic chemicals of concern (copper, mercury, three classes of PAHs, and nonylphenol), commercial/industrial areas were the largest source, with contributions ranging from 49 to 74 percent of the total study area loads. Forest/field/other areas were the largest source (60 percent) of DDT and metabolites. Across all the toxic chemicals, agricultural areas contributed less than 14 percent of total study area load. With the exception of nonylphenol, loadings from highway also represented less than 6 percent of the total study area load.

Relative to the other study areas, the Elliott Bay study area had the greatest unit area loading rates for mercury, low molecular weight PAHs, and nonylphenol (Table E-1, Appendix E). This study area also ranked relatively high (2nd or 3rd among the 14 study areas) in unit area loading rates for cadmium, copper, lead, zinc, total PCBs, carcinogenic PAHs, and total dioxin TEQs.

Commencement Bay Study Area

In the Commencement Bay study area, residential areas were the largest source for 14 of the 17 toxic chemicals of concern (Table C-5, Appendix C). For this subset chemicals, the residential area loading ranged from 46 to 82 percent of total loads. Commercial/industrial areas were the largest source of mercury and nonylphenol, contributing 50 and 46 percent of these loads, respectively. As in other study areas, forest/field/other areas were the largest source (75 percent) of DDT and metabolites. Loadings from agricultural areas ranged from 2 to 13 percent of the total study area load. With the exception of nonylphenol, loadings from highways represented less than 6 percent of the total study area load.

The unit area loading rates for the Commencement Bay study area were mid-range relative to those of the other study areas in Ecology's Puget Sound Box Model (Table E-1, Appendix E). For the 17 toxic chemicals of concern, the unit area loading rates for the Commencement Bay study area ranked between 5th and 10th among the 14 study areas.

South Sound (East) Study Area

In the South Sound (East) study area, residential areas were the largest source for 15 of the 17 toxic chemicals of concern (Table C-6, Appendix C). For this subset of chemicals (all toxic chemicals of concern other than mercury and DDT and metabolites), the residential area loading ranged from 43 to 82 percent of total loads. Commercial/industrial areas were the largest source of mercury (42 percent of total load). Forest/field/other areas were the largest source of DDT and metabolites (66 percent of total load). Loadings from agricultural areas ranged from 3 to 17 percent of the total study area load. Loadings from highways ranged from less than 1 percent to 5 percent of the total study area load, except in the case of nonylphenol, where highways contributed 11 percent.

Relative to the other study areas, the South Sound (East) study area had relatively low unit area loading rates, ranking between 9th and 12th across all of the toxic chemicals of concern (Table E-1, Appendix E).

South Sound (West) Study Area

In the South Sound (West) study area, residential areas were the primary source for 16 of the 17 toxic chemicals of concern (Table C-7, Appendix C). For this subset of chemicals, the residential area loading ranged from 36 to 87 percent of total loads. Forest/field/other areas were the largest source of DDT and metabolites (75 percent), and were the second largest source for five toxic chemicals of concern. Commercial/industrial areas were not the largest source for any toxic chemical of concern, but they were the second largest source for nine chemicals. Loadings from agricultural areas never exceeded 10 percent of the total study load. Loadings from highways were less than 7 percent of total loads, except in the case of nonylphenol, where highways contributed 16 percent of the total study area load.

Relative to the other study areas, the South Sound (West) study area had relatively low unit area loading rates, ranking between 10th and 13th across all of the toxic chemicals of concern (Table E-1, Appendix E).

Hood Canal (South) Study Area

In the Hood Canal (South) study area, residential areas were the largest source for 12 of the 17 chemicals of concern (Table C-8, Appendix C). Forest/field/other areas were the largest source for the other five toxic chemicals of concern (arsenic, copper, mercury, total PBDEs, and DDT and metabolites). The relative loading contributions from agricultural and commercial/industrial areas were less in the Hood Canal (South) study area than in other study areas. Loadings from commercial/industrial areas never exceeded 5 percent of total study area load, and loadings from agricultural areas never exceeded 3 percent. Loadings from highways represented between 1 to 10 percent of the total study area load, except in the case of nonylphenol, where highways contributed 22 percent.

For most toxic chemicals of concern, the Hood Canal (South) study area had the lowest or second-lowest unit area loading rates among the 14 study areas (Table E-1, Appendix E).

Hood Canal (North) Study Area

In the Hood Canal (North) study area, residential areas were the largest source for 16 of the 17 toxic chemicals of concern (all chemicals of concern other than DDT and metabolites) (Table C-

9, Appendix C). Forest/field/other areas were the largest source of DDT and metabolites. The Hood Canal (North) study area was similar to Hood Canal (South) in having the majority of its loadings coming from forest/field/other and residential areas, and relatively small contributions from agricultural and commercial/industrial areas. Loadings from commercial/industrial areas never represented more than 10 percent of the total study area load, and loadings from agricultural areas never represented more than 1 percent.

Relative to the other study areas, the Hood Canal (North) study area had the lowest unit area loading rates (Table E-1, Appendix E) and the lowest loading rates overall (Appendix G).

Sinclair/Dyes Inlet Study Area

In the Sinclair/Dyes Inlet study area, residential areas were the largest source for 15 of the 17 toxic chemicals of concern (Tables C-10, Appendix C), contributing between 43 and 92 percent of total loadings for this subset of toxic chemicals. Commercial/industrial areas were the second largest source (6 to 36 percent of total loads) for 13 toxic chemicals of concern and the largest source for mercury (48 percent of total load). Forest/field/other areas were the primary source for DDT and metabolites (56 percent) and the second largest source of arsenic (16 percent), total PBDEs (8 percent), and triclopyr (5 percent). Loadings from agricultural areas never exceeded 2 percent of the total study area load. Loadings from highways represented less than 1 percent to 8 percent of the total study area load, except for nonylphenol, where highways contributed 19 percent.

Relative to the other study areas, the Sinclair/Dyes Inlet study area had the greatest unit area loading rates for 10 of the 17 toxic chemicals of concern and the second greatest for four toxic chemicals of concern (Table E-1, Appendix E).

Admiralty Inlet Study Area

In the Admiralty Inlet study area, residential areas were the largest source for 16 of the 17 toxic chemicals of concern (Table C-11, Appendix C). For this subset of chemicals, residential loads ranged from 41 to 85 percent of total loads. Forest/field/other areas were the largest source for DDT and metabolites (64 percent) and secondary sources of arsenic, copper, mercury, and total PBDEs. Agricultural areas were not the largest source for any toxic chemical of concern, but they were a secondary source for nine chemicals. Loadings from commercial/industrial areas ranged from less than 1 percent to 22 percent of the total study area load. Loadings from commercial/industrial areas were generally smaller than those from agricultural areas. Loadings from highways represented less than 8 percent of the total study area load, except for nonylphenol, where highways contributed 20 percent.

Unit area loading rates for the Admiralty Inlet study area were intermediate relative to the other study areas, ranking 4th through 8th across all but one of the toxic chemicals of concern (Table E-1, Appendix E).

Strait of Juan de Fuca Study Area

In the Strait of Juan de Fuca study area, residential areas were the largest source for 11 of the 17 toxic chemicals of concern (Table C-12, Appendix C). For four of the six other toxic chemicals of concern, residential areas were a secondary source. Forest/field/other areas were the largest source of five toxic chemicals of concern and secondary sources for three. Loadings from commercial/industrial and agricultural areas were generally of a similar magnitude. Loading from commercial/industrial areas represented from less than 1 percent to 27 percent of the total study area load, and loadings from agricultural areas represented from 4 to 26 percent. Highways were a more important source for toxic chemicals in the Strait of Juan de Fuca in comparison to other study areas. For example, they were the largest source (30 percent) of nonylphenol loads. For the other 16 toxic chemicals of concern, highways contributed from less than 1 percent to 15 percent of the total study area load.

Relative to the other study areas, unit area loading rates for the Strait of Juan de Fuca study area were generally low, ranking 4th to 12th across all of the toxic chemicals of concern (Table E-1, Appendix E).

Strait of Georgia Study Area

Similar to other study areas, in the Strait of Georgia study area, residential areas were the largest source for 12 of the 17 toxic chemicals of concern and a secondary source for three of the five other toxic chemicals of concern (Table C-13, Appendix C). Loadings from agricultural areas were greater in the Strait of Georgia study area relative to other study areas. Agricultural areas were the largest source of triclopyr and copper, and they were secondary sources for 13 toxic chemicals of concern. Forest/field/other areas were the largest source of DDT and metabolites, arsenic, and mercury. Loadings from commercial/industrial areas exceeded those from highways, but were generally smaller than loadings from the other three land use categories. Loadings from commercial/industrial areas ranged from less than 1 percent to 29 percent of the total study area load. Loadings from highways also represented less than 8 percent of the total study area load (except in the case of nonylphenol).

Relative to the other study areas, the Strait of Georgia study area had the greatest unit area loading rate for triclopyr and the third greatest for DDT and metabolites (Table E-1, Appendix E). The unit area loading rates in the study area ranked 4th through 8th for the other toxic chemicals of concern.

Whidbey Basin Study Area

In the Whidbey Basin study area, residential areas were the largest source for 12 of the 17 toxic chemicals of concern, and a secondary source for four toxic chemicals of concern (Table C-14, Appendix C). Forest/field/other areas were the largest source for five toxic chemicals of concern and secondary sources for six others. With the exception of mercury and nonylphenol, loadings from agricultural areas exceeded those from commercial/industrial areas. Loadings from agricultural areas ranged from 6 to 27 percent of the total study area load, and loadings from commercial/industrial areas ranged from less than 1 percent to 14 percent.

The Whidbey Basin study area had the greatest absolute loading rates of all 14 of the study areas (Appendix G). The study area had the greatest unit area loading rate for DDT and metabolites (Table E-1, Appendix E). For other toxic chemicals, the unit area loading rates in this study area were relatively low, ranking 8th to 12th across all of the toxic chemicals of concern.

San Juan Islands Study Area

In the San Juan Islands study area, residential areas were the largest source for 15 of the 17 toxic chemicals of concern (Table C-15, Appendix C). For this subset of chemicals, residential area loadings ranged from 38 to 76 percent of total loads. Commercial/industrial areas were the largest source of mercury (42 percent) and a secondary source for seven other toxic chemicals of concern. Forest/field/other areas were the largest source of DDT and metabolites and a secondary source for arsenic and total PBDEs. Agricultural areas were not the largest source of any toxic chemical of concern, but they were a secondary source of cadmium, copper, lead, total PCBs, bis(2-ethylhexyl)phthalate, total dioxin TEQs, DDT and metabolites, and triclopyr. For all toxic chemicals of concern, loadings from highways represented less than 5 percent of the total study area load.

Compared to the other study areas, the San Juan Islands study area had relatively large unit area loading rates, ranking 2nd through 3rd for many of the toxic chemicals of concern (Table E-1, Appendix E).

Discussion

This section provides a discussion of the loading estimates that were summarized in the previous section. It begins with an overview of the key trends in the pollutant loading estimates. The accuracy, key assumptions, and limitations associated with the following data inputs for generating these loading estimates are then discussed in subsequent subsections:

- Land use area estimates
- Representative toxic chemical concentrations
- Runoff volume estimates

Overview of Key Trends in Loading Estimates

With a few exceptions, the representative toxic chemical concentrations used in this loading analysis for the commercial/industrial land use category and highways were greater than those for the other land use categories (Table 7). Furthermore, the runoff coefficients that were applied to the commercial/industrial category and highways were also large relative to those for the other land use categories. Due to the combination of these two factors, unit area loading rates for the toxic chemicals of concern were generally greatest for commercial/industrial and highway areas within the Puget Sound Basin.

However, since commercial/industrial and highway areas occupy only a small portion of the total area of the Puget Sound Basin (0.76 and 0.15 percent, respectively), these areas were not the largest sources in terms of absolute toxic chemical loading. In general, the largest source of toxic chemical loading to Puget Sound was residential areas due to the following considerations:

- Residential areas occupied a relatively substantial portion (11.6 percent) of the total Puget Sound Basin.
- Representative concentrations of toxic chemicals in runoff from residential areas were greater than those of both agricultural and forest/field/other land use categories.

Due to this combination of factors, residential land use was the largest source (in absolute terms) for 14 of the 17 toxic chemicals of concern and one of the most important determinants for predicting which study areas were the largest contributors of toxic chemical loadings to Puget Sound. For example, the study area with the second greatest proportion of residential land use, Sinclair/Dyes Inlet, had the first or second greatest unit area loading rates for most of the toxic chemicals of concern. Although highways, themselves, have contributed relatively little to the total loading of toxic chemicals to Puget Sound, highways and other roadways often act as conduits for surface runoff that accelerate and ultimately increase the discharge of toxic chemicals from other land uses to Puget Sound.

Two toxic chemicals of concern (i.e., low molecular weight PAHs and mercury) were exceptions to the patterns described above. Specifically, representative concentrations of these two chemicals were an order of magnitude greater for commercial/industrial land use relative to concentrations for residential, agricultural, or forest/field/other land uses. Therefore, the study area with proportionally the largest commercial/industrial area, Elliott Bay, also had the greatest unit area loading rate for low molecular weight PAHs and mercury.

Influence of Land Use Area Estimates on Loading Estimates

As described in the previous section, absolute loading rates were generally the greatest for residential areas because they represented a relatively substantial proportion of the total area of the Puget Sound Basin, and the concentrations of toxic chemicals in the surface runoff from residential areas were relatively large. The project team derived estimates of the areas of each land use category using the procedures described in Appendix A. Key issues that affected the accuracy of these estimates included assumptions required to identify and classify the differing roadway types using differing GIS datasets. In addition, some assumptions were required to generate roadway area estimates based on representative widths for each roadway type.

Although some small inherent inaccuracies existed in the GIS data used to classify and calculate roadway widths, the resulting areas were a reasonably accurate representation of the on-the-ground conditions in the Puget Sound Basin. The project team did not create the roadway centerline data used in this analysis by the project team, but instead obtained them at the county level where they would have been generated using a number of different methodologies such as aerial photography delineation, surveying, and ground truthing. By comparing the roadway centerlines against 2006 aerial photography, we were able to do a coarse-scale quality assurance check to ensure that the GIS roadway features actually appeared in the photography and that the number of roadways not represented was minimal. The classification of roadway centerlines into the three targeted roadway types in this analysis had either been completed by the jurisdiction that had created the dataset or was easily derived by the project team through the use of hard copy maps indicating roadway type.

We also used a systematic approach for assigning roadway widths to each roadway type based on aerial photography of each county over a gridded area to ensure that the resulting roadway width applied to each category was as representative as possible. The relative integrity of the data resulting from this analysis was easily verifiable because the source information had either been generated at the jurisdiction level with much more detail than was possible in this analysis, was available through hard copy maps, or could be easily verified through a comparison of the resultant data to recent aerial photography.

One factor that influenced the relative differences in the loading estimates generated from the Phase 2 analysis from the Phase 1 estimates was the use of land use data from differing time periods. While the Phase 1 analysis used the 1992 national land cover dataset (MRLC 1992), the Phase 2 analysis used the more current 2001 national land cover dataset (MRLC 2001). In general, the percentage of residential area was larger in the 2001 dataset than in the 1992 dataset, while the percentage of commercial/industrial, agricultural, and forest/field/other areas was smaller. For example, the amount of residential area in the Puget Sound Basin increased from 4.17 to 11.6 percent from the 1992 dataset to the 2001 dataset. In contrast, the amount of commercial/industrial area decreased from 1.45 to 0.76 percent from the 1992 dataset to the 2001 dataset. In general, most of these changes likely reflect actual shifts in land use that occurred with increased development in the years between 1992 and 2001. However, it is possible that some of these changes may also be related to differences in the land use designations that the two datasets used and their subsequent grouping for this analysis (Appendix A, Table A-2).

To determine the influence of these changes, if any, on the computed estimates of surface runoff loading, we compared estimated toxic chemical loadings (from the 50 percent POE concentrations) from the Phase 1 and Phase 2 analyses for the Puget Sound Basin. Results from this comparison are summarized in Table 8. These data generally show that loading estimates for most of the toxic chemicals were higher in the Phase 2 analysis than in the Phase 1. DDT and metabolites was the only toxic chemical to exhibit a decrease in loading estimates between the Phase 1 and Phase 2 analyses (Table 8). This shift was generally predictable given that representative DDT and metabolites concentrations were greatest for the agricultural land use category, and agricultural land use was less prevalent in the 2001 land cover dataset than in the 1992 dataset.

The general pattern in the loading estimates likely reflects the shift from agriculture and forest land use to residential land use in the land cover datasets from 1992 and 2001 (Table A-1, Appendix A). Some of the differences between the Phase 1 and Phase 2 loading estimates were also related to differences in the runoff coefficients that we used. Specifically, we used substantially lower runoff coefficients for agricultural and forest/field/other areas in the Phase 2 analysis than in the Phase 1 estimation. We discuss this in more detail below.

Influence of Representative Toxic Chemical Concentrations on Loading Estimates

Unit area loading rates were generally greatest for commercial/industrial areas and highways in large part due to the greater toxic chemical concentrations assigned to these land use categories. However, since these concentrations were compiled from numerous studies that were not specifically related to this analysis, several issues diminished their overall representativeness for estimating the pollutant loadings presented herein. These issues are discussed below.

Sampling Location

For the Phase 1 analysis, representative water quality data were compiled from samples collected from “instream” and from “runoff” in stormwater conveyance systems (Hart Crowser et al. 2007). In general, concentrations obtained from in-stream samples may have reflected a variety of land uses in the surrounding watersheds. Furthermore, these samples may also have reflected other extraneous influences on water quality that may not be related to the surrounding land uses, such as groundwater inputs. Therefore, representative concentrations obtained from instream samples may not have been ideally suited for characterizing concentrations from a specific land use. However, if the in-stream samples were collected from smaller watersheds with fairly homogenous land use patterns, the resultant data may be more representative because they better reflect the quality of water that actually discharges to Puget Sound.

Herrera found relatively few data from controlled studies of toxic chemicals in runoff from residential side streets, arterial/collector roads, and parking lots. Most of the available data for these roadway categories were obtained from stormwater conveyance systems with comingled runoff from other roadways and land use categories. The data compiled for the Phase 1 analysis were also obtained from samples collected from stormwater conveyance systems and/or streams. Therefore, these data also likely reflect comingled runoff from roadways and other land use categories. Based on these considerations, the project team concluded that these data were unsuitable for calculating toxic chemical loading estimates for these specific roadway categories independent of the other land use categories. In general, the lack of available data to independently characterize concentrations of toxic chemicals in the runoff from residential side streets, arterial/collector roads, and parking lots was a substantial data gap.

Sampling Region

Water quality data for the Phase 1 analysis were, in most cases, compiled from both local and national studies. For the Phase 2 analysis, Herrera compiled the data to characterize copper and zinc concentrations in highway runoff generally from local studies. For most of the other toxic chemicals of concern, data from both national and local studies were also necessary for this purpose. For several toxic chemicals of concern, the majority of the data were obtained from national studies. For example, data on arsenic concentrations in highway runoff were obtained from a total of 16 studies, 14 of which were conducted in California. Similarly, data on cadmium concentrations in highway runoff were obtained from a total of 18 studies, 15 of which were conducted outside of Washington. Since water quality data from local studies are more representative of local conditions, loading estimates based on data primarily from national studies may be somewhat less accurate for estimating loadings to the Puget Sound Basin.

Sample Size

Herrera found relatively few data characterizing the key toxic organic chemicals in runoff from the targeted roadway categories. Where these data were available for any particular roadway category, the majority of the reported values were below detection limits. For the remaining toxic chemicals of concern, the number of studies available for characterizing their associated concentrations in roadway runoff varied greatly. For example, data were available from more than 12 studies for characterizing toxic metals (i.e., arsenic, cadmium, copper, lead, and zinc) and TPH in highway runoff. However, for mercury, nonylphenol, PAHs, and bis(2-ethylhexyl)phthalate, the number of studies ranged from two to four. In many cases, the data obtained from the relatively few studies available for a particular roadway category varied significantly for any given toxic chemical of concern.

Sample Bias

Concentrations used to predict the loading estimates presented herein were compiled from numerous studies with varying objectives not directly related to this analysis. In many cases, these objectives or the associated experimental design may have introduced a bias that affected the accuracy of the loading estimates. For example, some of the studies that were used to characterize metals and organic chemicals in runoff from industrial areas were implemented in connection with remedial investigations in waterways that were known to be heavily contaminated. In these cases, the compiled water quality data may have overestimated concentrations that were likely to be observed in more typical waterways. Similarly, much of the data used to characterize toxic chemical concentrations in highway runoff were compiled from studies of best management practice performance. In general, these studies are typically performed on urban highways with relatively high traffic volumes. Due to this consideration, the compiled water quality data may again have overestimated concentrations that were likely to be observed in runoff from rural highways with much lower traffic volumes.

The analysis presented herein was predicated on the assumption that the toxic chemicals experienced no treatment as they travel in runoff from the land use and roadway areas, across other land surfaces, and ultimately to streams and rivers that discharge to Puget Sound. This assumption was generally valid in highly urban areas where toxic chemicals were likely efficiently conveyed to Puget Sound via developed stormwater conveyance systems. However, in rural areas that lack these systems, this runoff may infiltrate or otherwise take a slower route to the receiving water, thereby providing the opportunity for decomposition, settling, sorption, precipitation, and other mechanisms of attenuation. Due to these considerations, the toxic chemical concentrations used to determine loading estimates may have been biased high, especially in rural areas where fewer built conduits for stormwater runoff exist.

Influence of Non-Detect Values

The majority of the available data for some toxic chemicals of concern were at or below analytical method detection limits. For example, data obtained from Caltrans (2003) for characterizing concentrations of carcinogenic PAHs in highway runoff had 98 to 100 percent non-detect values (<0.05 µg/L) for the six individual PAHs in this category. Similarly, data obtained from Caltrans (2003) for high molecular weight PAHs had 75 to 81 percent non-detect values.

To evaluate the potential effects of these data on the computed loading estimates, the project team performed a simple sensitivity analysis by computing the 50 percent POE concentrations for toxic chemicals of concern in highway runoff using three different values assigned to non-detect value data: non-detect values assigned a value of zero; non-detect values assigned a value of one-half the detection limit; and non-detect values assigned the value of the detection limit. We performed these calculations using the data obtained through the Phase 2 analysis for 12 toxic chemicals of concern in highway runoff.

As shown in Table 9, eight of these chemicals had 50 percent POE concentrations that were unaffected or not strongly affected by non-detect values. For these chemicals (i.e., arsenic, cadmium, copper, lead, zinc, bis(2-ethylhexyl)phthalate, nonylphenol, and TPH), assigning one-half the detection limit to non-detect values changed the highway runoff 50 percent POE concentration by less than 4 percent. However, for mercury, carcinogenic PAHs, and other high molecular weight PAHs, the 50 percent POE concentrations decreased by 20 to 30 percent when the non-detect values were assigned a value of one-half the detection limit. Obviously, the uncertainty in the results will increase as the number of non-detect values increases for a particular toxic chemical. In this analysis, 49 percent of the data for mercury were non-detect values.

Finally, the influence of non-detect values on the loading estimates was likely greater than that for which we have accounted because many of the datasets that characterized pollutant concentrations in highway runoff provided only summary statistics (e.g., mean values) rather than the raw data with detailed information on the number of non-detect values. In all cases, we calculated the POE values based on the mean value from each individual study. However, the lack of specific information on the number of non-detect values for every study prevented a more accurate assessment of the overall influence of non-detect values on the loading estimates.

Influence of Runoff Volume Estimates on Loading Estimates

As described in the *Methods* section, we used representative runoff coefficients for each land use category to compute the associated toxic chemical loading estimates. In general, the high unit area loading rates for commercial/industrial areas and highways were related in part to their relatively high runoff coefficients. However, the considerable uncertainty in the runoff coefficients may affect the overall accuracy of the estimated loading rates.

To investigate this uncertainty, we performed a sensitivity analysis by adjusting the runoff coefficient for a specific land use category and examining the resultant variation in the associated loading estimates. This variation was then compared to the variation imparted in the loading estimates through the different POE concentrations. Specifically, Herrera calculated separate loading estimates for lead in forest/field/other areas within the Port Gardner study area based on the 50 percent POE concentration, using a runoff coefficient of 0.2 (the value used in results discussed thus far) and a runoff coefficient twice this value (0.4). Results from this analysis showed that the loading estimate for forest/field/other areas increased by 19 percent (3.37 MT/year to 4.01 MT/year) when the runoff coefficient was changed in this manner. Conversely, if the POE concentration for lead were increased from 50 percent to 95 percent (Table 7) and the runoff coefficient remained at 0.2 for forest/field/other, there was a 96 percent decrease in the loading estimate for lead (Table C-1). Based on these results, we concluded that the runoff coefficients used in these Phase 2 estimates were a much smaller source of uncertainty than the assigned toxic chemical concentrations.

Loading estimates computed using the 50 percent POE concentrations were greater for almost all chemicals of concern in the Phase 2 analysis relative to the Phase 1 (Table 8). This difference in loadings may reflect the shift from agricultural and forest land use to residential land use that appears in the land cover datasets from 1992 and 2001. However, this difference was also likely related to differences in the runoff coefficients that were used in the respective analyses.

Specifically, the runoff coefficient used for agricultural areas was decreased from a value of 0.60 in the Phase 1 analysis to 0.35 in Phase 2. Similarly, the runoff coefficient used for forest/field/other areas was decreased from a value of 0.50 in the Phase 1 analysis to 0.20 in Phase 2. These changes caused the proportion of runoff volume from agricultural and forest/field/other areas to decrease in the Phase 2 analysis, while the proportion of runoff arising from commercial/industrial and residential areas increased. Since the latter land use categories had larger toxic chemical concentrations, these changes resulted in the larger loading estimates of the Phase 2 analysis.

Conclusions

The results of this Phase 2 analysis of toxic chemical loading from roadways in the Puget Sound Basin were generally consistent with the estimates previously obtained in the Phase 1 study. The results will help to distinguish and prioritize toxic threats to Puget Sound among some of the sources of "surface runoff" as defined in the Phase 1 study. The primary benefit from this Phase 2 study was a better understanding of the relative total and relative unit area loading rates from the various land use and highway areas.

1. The contribution of toxic chemical loadings from highways was a small fraction (less than 1 percent to 14 percent, depending on the chemical) of the total loading from surface runoff into Puget Sound.

2. Although sufficient data existed to characterize some of the contaminants in runoff from the highway roadway type, adequate data were lacking to do the same for side streets, arterial and collector roads, and parking lots. Therefore, the loading contributions of the other roadway types and parking lots were not separated from (were left included within) the loadings from the four other land use areas (commercial/industrial, residential, agricultural, and forest/field/other).

3. The continuing shift in the region between 1992 and 2001 from agricultural and forest land use to residential land use likely caused, in part, the generally greater estimates of loading from surface runoff derived in this Phase 2 analysis. Differences in the runoff coefficients that the respective analyses used likely also contributed to the higher loading estimates in Phase 2 versus Phase 1.

4. The unit area loading rates were generally the greatest for the commercial/industrial land use and highway areas. However, since these areas occupied only a relatively small portion of the Puget Sound Basin, these areas were relatively minor pollutant sources in terms of the total loading mass. In general for all toxic chemicals considered, except arsenic, mercury, and DDT and metabolites, residential land use areas were the largest source of loadings to Puget Sound because: (1) they occupied a relatively substantial portion of the Puget Sound Basin, and (2) the concentrations of toxic chemicals in the associated runoff were relatively large.

5. Distinguishing the loading contributions of the various land use areas from the roadway areas was difficult because most of the data that existed for the non-highway roadway types reflected commingled runoff (a mixture of runoff from the road and parking lot surfaces and from the general non-road land surfaces). The main assumptions required for calculating loading estimates and their consequences for the results were:

   a) Loading calculations assumed that toxic chemicals experienced no biological, chemical, or physical degradation, transformation, or attenuation as they flowed from the land use and roadway areas, across the land surface, sometimes into freshwater streams and rivers, and then finally into Puget Sound. A substantial portion of the total mass of the chemicals that discharge at the edge of the pavement or from other sources likely degrades or adsorbs onto various substrates or simply settles out prior to reaching Puget Sound. Therefore, the loading estimates may have been biased somewhat high, especially in rural areas where fewer built conduits for stormwater runoff exist.

b) The choice of runoff coefficients (RCs) employed to estimate total loadings for different land use categories can significantly alter the results. Although a sensitivity analysis showed the differences in total loading caused by varying RCs by a factor of two still fell within the variation caused by the uncertainty of the concentration values, using different or more geographically refined RCs might direct policy makers to different priorities

Recommendations

1. Ecology should consider how conversion of forested and agricultural lands to more developed and impervious urban or residential uses affects the water quality of surface runoff. Methods that Ecology should support to limit increases of toxic chemical loadings to Puget Sound include reducing the sources of contaminants and reducing direct discharges to surface waters by dispersing and infiltrating potentially contaminated surface runoff.

2. Based on the wide ranges of available concentration data and the assumptions required for making any loading estimates, the numerical loading values presented in this study provide only a rough guide of the actual quantities of the specific chemicals released from different land use and roadway areas. The types of additional information needed to prioritize the toxic threats from surface runoff into Puget Sound include:

   a) Concentration data for toxic chemicals in surface runoff from multiple locations in the Puget Sound Basin at various times throughout the year.

   b) Concentration data for toxic chemicals in surface runoff from multiple well-defined areas that represent specific land uses.

   c) Concentration data for toxic chemicals in surface runoff that illustrate the attenuation effects of the various natural landscape and constructed features located between the original sources of surface runoff and the point of its final discharge to Puget Sound.

3. The need exists to balance improved accuracy of the loading contributions from different land use categories with the level of effort necessary to determine improved input variables or data. Therefore, attempting to distinguish the relative contributions from further sub-divisions of the source areas may not be a worthwhile exercise at this time. Ecology must decide which of the data gaps it should fill and then prioritize the various components of that effort. In doing so, Ecology must obtain credible information that will help direct resources to the most critical needs to improve Puget Sound and sequence the work in coordination with other evaluation efforts and decision points. Ecology should also develop more definitive information for targeting specific land uses for pollution source control efforts to maximize the overall benefit to Puget Sound. Some of the work to accomplish these goals may include the following, depending on available resources and priorities:

   a) Create a comprehensive conceptual model of the Puget Sound Basin, into which Ecology's Toxics Box Model will fit and against which other scientists can compare their assumptions, input data, and analytical methods.

   b) Improve estimates of the relative contribution of toxic chemicals from land use and roadway areas with additional data collected through the implementation of controlled studies for specific land use categories (i.e., commercial/industrial, residential, agricultural, undeveloped forest/field/other, and highways). A good way to conduct these studies is to focus on relatively small catchments.

c) Differentiate the loading contribution from potential pollutant sources within each land use category (e.g., roofs, roads, and lawns).

d) Increase the priority of monitoring organic toxic chemicals in surface runoff, particularly for compounds that are a growing concern in urban stormwater runoff such as PAHs, PBDEs, phthalates, and TPH.

e) Require laboratory reporting limits that are as low as analytically feasible for all monitoring of stormwater runoff to facilitate the detection of trace amounts of toxic chemicals.

f) Consolidate efforts to further assess toxic chemicals with the assessment of other contaminants, such as nutrients.

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Tables

Table 1. Key Toxic Chemicals for the Phase 1 and Phase 2 Analyses.

- Arsenic
- Cadmium
- Copper
- Lead
- Zinc
- Mercury
- Total PCBs (a)
- Total PBDEs (a)
- Carcinogenic PAHs (b)
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Benzo(k)fluoranthene
    - Chrysene
    - Dibenzo(a,h)anthracene
    - Indeno(1,2,3-cd)pyrene
- High molecular weight PAHs (b)
    - Benzo(g,h,i)perylene
    - Fluoranthene
    - Pyrene
- Low molecular weight PAHs (b)
    - Acenaphthene
    - Acenaphthylene
    - Anthracene
    - Fluorene
    - Naphthalene
    - Phenanthrene
- bis(2-Ethylhexyl)phthalate
- Triclopyr (a)
- Nonylphenol
- Total Dioxin TEQs (a)
- DDT and Metabolites (a)
- Oil and TPH

(a) Loading estimates were not generated for this toxic chemical in highway runoff due to a lack of data.

(b) Loading estimates were not generated for any of the individual constituents under this toxic chemical category due to a lack of data.

DDT = dichlorodiphenyltrichloroethane.
PAHs = polyaromatic hydrocarbons.
PBDEs = polybrominated diphenyl ethers.
PCBs = polychlorinated biphenyls.
TEQs = toxicity equivalents.
TPH = total petroleum hydrocarbon.

Table 2. Areas of the 14 Study Areas within the Land Use Categories and Subcategories.

Land Use Category (a)	Land Use Subcategory	Study Areas in Ecology's Puget Sound Box Model														
		Main Basin	**Port Gardner**	**Elliott Bay**	**Commencement Bay**	**South Sound (East)**	**South Sound (West)**	**Hood Canal (South)**	**Hood Canal (North)**	**Sinclair/ Dyes Inlet**	**Admiralty Inlet**	**Strait of Juan de Fuca**	**Strait of Georgia**	**Whidbey Basin**	**San Juan Islands**	**Puget Sound Basin**
Commercial/Industrial	Non-Road	23.97	6.204	19.65	11.09	9.384	3.333	0.2180	0.1648	2.588	0.3872	2.222	5.731	3.395	2.195	90.54
Commercial/Industrial	Side Street	1.047	0.9382	0.5892	0.2869	0.3119	0.1023	0.002924	0.008803	0.1018	0.02132	0.08654	0.1856	0.1939	0.06155	3.938
Commercial/Industrial	Arterial/Collector	2.147	0.2411	1.372	0.8927	0.6667	0.3038	0.005659	0.0003707	0.09533	0.007922	0.1972	0.1632	0.1140	0.02057	6.228
Commercial/Industrial	Highway	0.8880	0.2331	0.5096	0.2940	0.3790	0.1348	0.008404	0.0002183	0.09432	0.01097	0.2036	0.06244	0.09163	0.01927	2.929
Residential	Non-Road	304.6	149.2	109.2	139.2	180.4	89.76	33.01	16.69	49.94	16.86	45.66	101.2	144.1	33.68	1414
Residential	Side Street	29.72	18.09	8.165	8.379	10.04	5.156	1.534	1.159	2.990	1.243	2.388	6.259	8.976	2.377	106.5
Residential	Arterial/Collector	11.13	5.557	4.199	6.322	8.172	3.530	0.9526	0.6779	1.921	0.6759	2.443	2.689	3.416	1.454	53.14
Residential	Highway	1.516	1.946	1.049	1.300	1.535	1.138	0.5436	0.1880	0.7692	0.2572	1.704	2.286	2.115	0.1738	16.52
Agriculture	Non-Road	8.268	53.39	21.17	28.55	50.24	13.57	2.094	0.3270	0.9797	7.789	32.86	209.9	125.2	26.98	581.3
Agriculture	Side Street	0.07373	1.471	0.1767	0.4722	0.3742	0.08633	0.01978	0.002518	0.005312	0.05887	0.4712	1.140	1.324	0.2009	5.877
Agriculture	Arterial/Collector	0.01410	0.2892	0.1077	0.1467	0.2278	0.03993	0.004937	0.001506	0.003164	0.03032	0.2480	0.2348	0.1541	0.1170	1.619
Agriculture	Highway	0.001026	0.01534	0.02454	0.02567	0.004824	0.0005905	0.001861	0	0.006520	0.006084	0.02698	0.05527	0.05827	0.002084	0.2291
Forest/Field/Other	Non-Road	406.3	1588	337.2	839.0	788.0	485.3	890.3	112.5	84.83	85.17	1122	1069	3390	187.9	11386
Forest/Field/Other	Side Street	4.750	9.138	1.898	2.130	3.708	3.981	4.336	1.408	0.7461	1.110	2.311	2.145	6.274	1.964	45.90
Forest/Field/Other	Arterial/Collector	1.064	1.679	0.3085	0.7241	1.633	1.174	1.174	0.1996	0.4849	0.1294	1.0124	0.5232	0.9874	0.4284	11.52
Forest/Field/Other	Highway	0.03042	0.09002	0.01940	0.1488	0.09166	0.08339	0.1888	0.02251	0.09024	0.03291	0.4470	0.1461	0.1427	0.01050	1.544
Subtotals																
Commercial/Industrial		28.056	7.616	22.12	12.56	10.74	3.874	0.2350	0.1742	2.879	0.4274	2.710	6.142	3.795	2.296	103.6
Residential		346.9	174.8	122.6	155.2	200.1	99.58	36.04	18.72	55.63	19.03	52.20	112.5	158.6	37.68	1590
Agriculture		8.357	55.17	21.48	29.19	50.84	13.70	2.120	0.3311	0.9947	7.885	33.61	211.3	126.7	27.30	589.0
Forest		412.1	1598	339.4	842.0	793.5	490.6	896.0	114.2	86.15	86.44	1126	1072	3397	190.3	11440
	Non-Road	743.1	1796	487.3	1018	1028	592.0	925.6	129.7	138.3	110.2	1203	1386	3662	250.7	13470
	Side Street	35.59	29.64	10.83	11.27	14.44	9.326	5.893	2.579	3.843	2.434	5.256	9.730	16.77	4.604	162.2
	Arterial/Collector	14.36	7.766	5.987	8.085	10.70	5.048	2.137	0.8794	2.505	0.8436	3.900	3.610	4.671	2.021	72.51
	Highway	2.435	2.284	1.602	1.769	2.011	1.357	0.7427	0.2107	0.9602	0.3072	2.382	2.550	2.408	0.2056	21.22
	Total Area (square miles)	**795.5**	**1836**	**505.7**	**1039**	**1055**	**607.7**	**934.4**	**133.4**	**145.6**	**113.8**	**1214**	**1402**	**3686**	**257.6**	**13726**

(a) Land use categories were based on the land use designations in the national land cover dataset (MRLC 2001), and do not include the marine water areas of Puget Sound..

All values are in units of square miles. Total areas may not add up due to rounding. The precision of the data in the table is only two significant figures.

Table 3. Percentages of the 14 Study Areas within the Land Use Categories and Subcategories.

Land Use Category (a)	Land Use Subcategory	Study Areas in Ecology's Puget Sound Box Model														
		Main	**Port Gardner**	**Elliott Bay**	**Commencement Bay**	**South Sound (East)**	**South Sound (West)**	**Hood Canal (South)**	**Hood Canal (North)**	**Sinclair/ Dyes Inlet**	**Admiralty Inlet**	**Strait of Juan de Fuca**	**Strait of Georgia**	**Whidbey**	**San Juan Islands**	**Puget Sound Basin**
Commercial/Industrial	Non-Road	3.01%	0.34%	3.89%	1.07%	0.89%	0.55%	0.02%	0.12%	1.78%	0.34%	0.18%	0.41%	0.09%	0.85%	0.66%
Commercial/Industrial	Side Street	0.13%	0.05%	0.12%	0.03%	0.03%	0.02%	0.00%	0.01%	0.07%	0.02%	0.01%	0.01%	0.01%	0.02%	0.03%
Commercial/Industrial	Arterial/Collector	0.27%	0.01%	0.27%	0.09%	0.06%	0.05%	0.00%	0.00%	0.07%	0.01%	0.02%	0.01%	0.00%	0.01%	0.05%
Commercial/Industrial	Highway	0.11%	0.01%	0.10%	0.03%	0.04%	0.02%	0.00%	0.00%	0.06%	0.01%	0.02%	0.00%	0.00%	0.01%	0.02%
Residential	Non-Road	38.29%	8.13%	21.60%	13.39%	17.10%	14.77%	3.53%	12.51%	34.29%	14.81%	3.76%	7.22%	3.91%	13.08%	10.30%
Residential	Side Street	3.74%	0.99%	1.61%	0.81%	0.95%	0.85%	0.16%	0.87%	2.05%	1.09%	0.20%	0.45%	0.24%	0.92%	0.78%
Residential	Arterial/Collector	1.40%	0.30%	0.83%	0.61%	0.77%	0.58%	0.10%	0.51%	1.32%	0.59%	0.20%	0.19%	0.09%	0.56%	0.39%
Residential	Highway	0.19%	0.11%	0.21%	0.13%	0.15%	0.19%	0.06%	0.14%	0.53%	0.23%	0.14%	0.16%	0.06%	0.07%	0.12%
Agriculture	Non-Road	1.04%	2.91%	4.19%	2.75%	4.76%	2.23%	0.22%	0.25%	0.67%	6.85%	2.71%	14.98%	3.40%	10.48%	4.24%
Agriculture	Side Street	0.01%	0.08%	0.03%	0.05%	0.04%	0.01%	0.00%	0.00%	0.00%	0.05%	0.04%	0.08%	0.04%	0.08%	0.04%
Agriculture	Arterial/Collector	0.00%	0.02%	0.02%	0.01%	0.02%	0.01%	0.00%	0.00%	0.00%	0.03%	0.02%	0.02%	0.00%	0.05%	0.01%
Agriculture	Highway	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
Forest/Field/Other	Non-Road	51.08%	86.47%	66.68%	80.76%	74.68%	79.86%	95.28%	84.37%	58.24%	74.85%	92.40%	76.26%	91.95%	72.94%	82.94%
Forest/Field/Other	Side Street	0.60%	0.50%	0.38%	0.20%	0.35%	0.66%	0.46%	1.06%	0.51%	0.98%	0.19%	0.15%	0.17%	0.76%	0.33%
Forest/Field/Other	Arterial/Collector	0.13%	0.09%	0.06%	0.07%	0.15%	0.19%	0.13%	0.15%	0.33%	0.11%	0.08%	0.04%	0.03%	0.17%	0.08%
Forest/Field/Other	Highway	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%	0.02%	0.06%	0.03%	0.04%	0.01%	0.00%	0.00%	0.01%
Subtotals																
Commercial/Industrial		3.53%	0.41%	4.38%	1.21%	1.02%	0.64%	0.03%	0.13%	1.98%	0.38%	0.22%	0.44%	0.10%	0.89%	0.76%
Residential		43.61%	9.52%	24.25%	14.93%	18.97%	16.39%	3.86%	14.03%	38.19%	16.73%	4.30%	8.03%	4.30%	14.63%	11.58%
Agriculture		1.05%	3.00%	4.25%	2.81%	4.82%	2.25%	0.23%	0.25%	0.68%	6.93%	2.77%	15.08%	3.44%	10.60%	4.29%
Forest/Field/Other		51.81%	87.06%	67.12%	81.05%	75.20%	80.72%	95.89%	85.59%	59.15%	75.97%	92.71%	76.46%	92.16%	73.88%	83.37%
	Non-Road	93.42%	97.84%	96.36%	97.97%	97.43%	97.41%	99.06%	97.25%	94.98%	96.85%	99.05%	98.87%	99.35%	97.35%	98.14%
	Side Street	4.47%	1.61%	2.14%	1.08%	1.37%	1.53%	0.63%	1.93%	2.64%	2.14%	0.43%	0.69%	0.45%	1.79%	1.18%
	Arterial/Collector	1.80%	0.42%	1.18%	0.78%	1.01%	0.83%	0.23%	0.66%	1.72%	0.74%	0.32%	0.26%	0.13%	0.78%	0.53%
	Highway	0.31%	0.12%	0.32%	0.17%	0.19%	0.22%	0.08%	0.16%	0.66%	0.27%	0.20%	0.18%	0.07%	0.08%	0.15%
	Total Area (square miles)	**795.5**	**1836**	**505.7**	**1039**	**1055**	**607.7**	**934.4**	**133.4**	**145.6**	**113.8**	**1214**	**1402**	**3686**	**257.6**	**13726**

(a) Land use categories were based on the land use designations in the national land cover dataset (MRLC 2001), and do not include the marine water areas of Puget Sound.

Total percentages may not add up due to rounding. The precision of the data in the table is only two significant figures.

Table 4. Average Surface Runoff Discharge Rates for Each Land Use Category.

Study Area	Land Use Category										Total Study Area Runoff
	Commercial/ Industrial		Residential		Agriculture		Forest/Field/Other		Highway		
	(m^3/sec)	(percent)	(m^3/sec)	(percent)	(m^3/sec)	(percent)	(m^3/sec)	(percent)	(m^3/sec)	(percent)	(m^3/sec)
Main Basin	3.76	6.55%	39.38	68.61%	0.48	0.83%	13.42	23.39%	0.36	0.62%	57.4
Port Gardner	4.19	1.34%	80.86	25.83%	12.9	4.12%	213.67	68.26%	1.37	0.44%	313
Elliott Bay	4.69	10.19%	21.71	47.2%	1.92	4.16%	17.32	37.65%	0.37	0.80%	46
Commencement Bay	3.48	3.5%	35.92	36.1%	3.41	3.42%	56.16	56.44%	0.53	0.53%	99.5
South Sound (East)	2.29	2.7%	36.07	42.63%	4.62	5.46%	41.16	48.66%	0.47	0.55%	84.6
South Sound (West)	0.81	1.8%	17.48	39.11%	1.22	2.72%	24.89	55.67%	0.31	0.69%	44.7
Hood Canal (South)	0.12	0.09%	15.95	12.08%	0.48	0.36%	115.02	87.14%	0.43	0.33%	132
Hood Canal (North)	0.03	0.41%	2.86	35.77%	0.03	0.32%	5.04	62.98%	0.04	0.52%	8.0
Sinclair/ Dyes Inlet	0.70	4.0%	11.35	64.88%	0.10	0.58%	5.09	29.08%	0.26	1.46%	17.5
Admiralty Inlet	0.15	1.05%	5.68	38.87%	1.19	8.16%	7.46	51.11%	0.12	0.82%	14.6
Strait of Juan de Fuca	1.27	0.77%	21.10	12.79%	7.02	4.25%	134.34	81.42%	1.28	0.78%	165
Strait of Georgia	2.69	1.39%	40.14	20.69%	38.48	19.83%	111.51	57.48%	1.19	0.62%	194
Whidbey Basin	2.15	0.38%	74.87	13.07%	30.29	5.29%	464.21	81.01%	1.48	0.26%	573
San Juan Islands	0.91	2.55%	12.34	34.55%	4.49	12.57%	17.88	50.08%	0.09	0.24%	35.7
Puget Sound Total	27.24	1.53%	415.70	23.29%	106.60	5.97%	1,227.16	68.75%	8.30	0.46%	1785

The precision of the data in the table is only two significant figures.

m^3/sec = cubic meters per second.

Table 5. Number of Studies Characterizing Chemical Concentrations in Runoff.

Chemical of Concern	Forest/Field/Other (a)	Agricultural (a)	Residential (a)	Commercial/ Industrial (a)	Highways
Arsenic	3 / 2	0 / 0	1 / 0	6 / 4	16 / 2
Cadmium	12 / 9	1 / 0	3 / 0	8 / 4	18 / 3
Copper	23 / 20	3 / 2	7 / 4	14 / 10	29 / 14
Lead	15 / 12	1 / 0	5 / 2	9 / 5	18 / 3
Zinc	21 / 18	3 / 2	7 / 4	14 / 8	27 / 12
Mercury	11 / 7	3 / 2	6 / 4	10 / 6	3 / 2
Total PCBs	1 / 1	3 / 2	2 / 0	5 / 0	0 / 0
Total PBDEs	6 / 6	2 / 2	0 / 0	6 / 1	0 / 0
Carcinogenic PAHs	1 / 0	0 / 0	3 / 2	11 / 3	3 / 2
High MW PAHs	1 / 0	0 / 0	3 / 2	11 / 3	2-4 / 1-3 (b)
Low MW PAHs	1 / 0	0 / 0	3 / 2	11 / 3	2 / 1
bis(2-Ethylhexyl)phthalate	18 / 2	0 / 0	1 / 0	15 / 6	3 / 3
Triclopyr	3 / 2	3 / 3	0/ 0	7 / 7	0 / 0
Nonylphenol	7 / 5	0 / 0	0 / 0	12 / 2	2 / 2
Total Dioxin TEQs	0 / 0	0 / 0	0 / 0	11 / 11	0 / 0
DDT and Metabolites	21 / 18	12 / 10	2 / 0	3 / 0	0 / 0
TPH	1 / 0	1 / 0	1 / 0	13 / 0	11 / 10

Table is formatted to show “total number of studies / number of studies in Washington.”

(a) Based on Hart Crowser et al. (2007). In several cases, it was unclear how a study was assigned to a specific land use category (e.g. several data sources were described as "urban" rather than residential or commercial/industrial).

(b) Ranges are given because the number of available studies differed for each PAH. See Table B8 in Appendix B for more information.

DDT = dichlorodiphenyltrichloroethane.
MW = molecular weight.
PAHs = polyaromatic hydrocarbons.
PBDEs = polybrominated diphenyl ethers.
PCBs = polychlorinated biphenyls.
TEQ = toxicity equivalent.
TPH = total petroleum hydrocarbons.

Table 6. Comparison of Geometric Mean and Geometric Standard Deviation Values.

Chemical of Concern	Highways (ug/L)	
	μ	σ
Arsenic	2.0	1.7
Cadmium	1.0	1.9
Copper	18.7	1.7
Lead	45.7	3.2
Zinc	97.5	1.9
Mercury	0.05	3.4
Total PCBs	NA	NA
Total PDBEs	NA	NA
Carcinogenic PAHs	0.82	2.3
High MW PAHs	0.42	2.7
Low MW PAHs	0.10	1.5
bis(2-Ethylhexyl)phthalate	7.58	1.7
Total Dioxin TEQs	NA	NA
DDT and Metabolites	NA	NA
Triclopyr	NA	NA
Nonylphenol	5.9	2.1
TPH	2,252	2.1

Geometric mean concentrations are equivalent to 50 percent POE concentrations.

DDT = dichlorodiphenyltrichloroethane.
MW = molecular weight.
NA = no highway runoff studies available.
PAHs = polyaromatic hydrocarbons.
PBDEs = polybrominated diphenyl ethers.
PCBs = polychlorinated biphenyls.
TEQ = toxicity equivalent.
TPH = total petroleum hydrocarbons.
μ = geometric mean.
σ = geometric standard deviation.

Table 7. Probability of Exceedance Concentrations for Each Land Use Category.

Chemical of Concern	Residential (a)					Commercial/Industrial (a)					Forest/Field/Other (a)					Agriculture (a)					Highways (b)				
	5%	25%	50%	75%	95%	5%	25%	50%	75%	95%	5%	25%	50%	75%	95%	5%	25%	50%	75%	95%	5%	25%	50%	75%	95%
Arsenic	8.1	3.5	2.0	1.1	0.49	14.9	6.9	4.0	2.3	1.1	5.2	2.0	1.0	0.50	0.20	5.6	2.6	1.5	0.87	0.40	4.6	2.8	2.0	1.4	0.88
Cadmium	3.6	1.1	0.50	0.22	0.07	9.2	3.2	1.5	0.71	0.25	0.9	7.5E-02	1.3E-02	2.3E-03	1.8E-04	3.1	1.1	0.50	0.24	0.08	2.7	1.5	1.0	0.62	0.34
Copper	21	7.9	4.0	2.0	0.77	110	46	25	13.6	5.7	7.2	2.2	1.0	0.45	0.14	36	11	5.0	2.2	0.69	46	27	19	13	7.6
Lead	118	28	10	3.6	0.85	133	43	20	9.2	3.0	11	1.8	0.5	0.14	0.022	33	11	5.0	2.3	0.75	309	100	46	21	6.8
Zinc	155	59	30	15	5.8	527	220	120	65	27	14	4.5	2.0	0.89	0.28	72	22	10	4.5	1.4	286	152	98	63	33
Mercury	0.12	2.8E-02	1.0E-02	3.6E-03	8.5E-04	2.36	0.55	0.20	7.3E-02	1.7E-02	5.9E-02	1.4E-02	5.0E-03	1.8E-03	4.2E-04	0.19	2.7E-02	7.0E-03	1.8E-03	2.6E-04	0.39	0.12	5.1E-02	2.2E-02	6.8E-03
Total PCBs	5.4E-01	7.7E-02	2.0E-02	5.2E-03	7.5E-04	8.1E-01	1.2E-01	3.0E-02	7.8E-03	1.1E-03	6.1E-02	5.4E-03	1.0E-03	1.9E-04	1.6E-05	2.7E-01	3.9E-02	1.0E-02	2.6E-03	3.7E-04	No highway runoff studies available				
Total PBDEs	4.7E-04	1.1E-04	4.0E-05	1.5E-05	3.4E-06	5.4E-04	7.7E-05	2.0E-05	5.2E-06	7.5E-07	2.1E-04	3.1E-05	8.0E-06	2.1E-06	3.0E-07	8.1E-04	1.2E-04	3.0E-05	7.8E-06	1.1E-06	No highway runoff studies available				
Carcinogenic PAHs	1.8	0.41	0.15	5.5E-02	1.3E-02	11.8	2.8	1.0	0.36	8.5E-02	1.6E-01	2.3E-02	6.0E-03	1.6E-03	2.2E-04	1.8	0.4	0.15	5.5E-02	1.3E-02	3.3	1.5	0.82	0.47	0.20
High MW PAHs	1.2	0.28	0.10	3.6E-02	8.5E-03	9.4	2.2	0.80	0.29	6.8E-02	1.3E-01	1.9E-02	5.0E-03	1.3E-03	1.9E-04	1.2	0.28	0.10	3.6E-02	8.5E-03	2.2	0.82	0.42	0.21	0.08
Low MW PAHs	3.5	0.83	0.30	0.11	2.5E-02	35.4	8.3	3.0	1.1	0.3	0.40	5.8E-02	1.5E-02	3.9E-03	5.6E-04	3.5	0.83	0.30	0.11	2.5E-02	0.19	0.13	0.10	7.6E-02	5.1E-02
bis(2-Ethylhexyl)phthalate	268	39	10	2.6	0.37	268.4	38.5	10.	2.6	0.37	6.1	0.54	0.10	1.9E-02	1.6E-03	268	39	10	2.6	0.37	18.9	11.0	7.6	5.2	3.0
Total Dioxin TEQs	1.3E-04	1.9E-05	5.0E-06	1.3E-06	1.9E-07	2.7E-04	3.9E-05	1.0E-05	2.6E-06	3.7E-07	6.1E-06	5.4E-07	1.0E-07	1.9E-08	1.6E-09	1.3E-04	1.9E-05	5.0E-06	1.3E-06	1.9E-07	No highway runoff studies available				
DDT and Metabolites	2.7E-02	3.9E-03	1.0E-03	2.6E-04	3.7E-05	5.4E-03	7.7E-04	2.0E-04	5.2E-05	7.5E-06	8.1E-02	1.2E-02	3.0E-03	7.8E-04	1.1E-04	1.6E-01	2.3E-02	6.0E-03	1.6E-03	2.2E-04	No highway runoff studies available				
Triclopyr	0.81	0.12	3.0E-02	7.8E-03	1.1E-03	1.83	0.16	3.0E-02	5.6E-03	4.9E-04	1.1E-01	1.5E-02	4.0E-03	1.0E-03	1.5E-04	1.6	0.23	6.0E-02	1.6E-02	0.00	No highway runoff studies available				
Nonylphenol	8.1	1.2	0.30	7.8E-02	1.1E-02	107.3	15.4	4.0	1.0	0.15	1.8	0.16	3.0E-02	5.6E-03	4.9E-04	8.1	1.2	0.30	7.8E-02	1.1E-02	19	9.6	5.9	3.6	1.8
TPH	21,594	6,740	3,000	1,335	417	26,367	11,010	6,000	3,270	1,365	2,684	385	100	26	3.7	11,790	2,750	1,000	364	85	7,375	3,663	2,252	1,384	687

Values are presented as micrograms per liter of surface runoff.

(a) From Table 5 of Hart Crowser et al. (2007).

(b) Calculated with the method described in the text and Figure 2.

DDT = dichlorodiphenyltrichloroethane.
MW = molecular weight.
PAHs = polyaromatic hydrocarbons.
PBDEs = polybrominated diphenyl ethers.
PCBs = polychlorinated biphenyls.
TEQ = toxicity equivalent.
TPH = total petroleum hydrocarbons.

Table 8. Comparison Between the Phase 1 and Phase 2 Analyses of the Estimates of Toxic Chemical Loadings from Surface Runoff.

Chemical of Concern	Phase 1 (a)	Phase 2	Percentage Change from Phase 1 to Phase 2 (b)
Arsenic (MT/year)	63	74	17%
Cadmium (MT/year)	4.9	10	110%
Copper (MT/year)	100	134	34%
Lead (MT/year)	84	197	134%
Zinc (MT/year)	320	633	98%
Mercury (kg/year)	490	534	8.9%
Total PCBs (kg/year)	160	361	125%
Total PBDEs (g/year)	610	953	56%
Carcinogenic PAHs (MT/year)	2.1	3.8	80%
High MW PAHs (MT/year)	1.6	2.6	65%
Low MW PAHs (MT/year)	5.4	8.1	51%
bis(2-Ethylhexyl)phthalate (MT/year)	70	179	156%
Total Dioxin TEQs (g/year)	42	95	126%
DDT and Metabolites (kg/year)	170	150	-12%
Triclopyr (MT/year)	0.49	0.8	59%
Nonylphenol (MT/year)	7.1	11	56%
TPH (MT/year)	21,000	52,340	149%

(a) Based on loading estimates derived from the 50 percent POE concentrations in Table B-2 of Hart Crowser et al. (2007).

(b) Calculated as [(Phase 2-Phase 1)/Phase 1]*100%.

DDT = dichlorodiphenyltrichloroethane.
MT = metric ton.
MW = molecular weight.
PAHs = polyaromatic hydrocarbons.
PBDEs = polybrominated diphenyl ethers.
PCBs = polychlorinated biphenyls.
TEQ = toxicity equivalent.
TPH = total petroleum hydrocarbon.

Table 9. Sensitivity Analysis to Examine the Influence of Non-Detect Values.

Chemical of Concern	50 Percent POE Concentration for Highway Runoff (a) (µg/L)		
	Non-Detect Values Assigned Detection Limit	Non-Detect Values Assigned 50% DL (b) (percentage)	Non-Detect Values Assigned Zeros (b) (percentage)
Arsenic	2.0	1.9 (3.41%)	1.9 (3.63%)
Cadmium	1.0	0.9 (0.87%)	0.9 (1.46%)
Copper	18.7	18.7 (0.08%)	18.7 (0.15%)
Lead	45.7	45.7 (0%)	45.7 (0.01%)
Zinc	97.5	No non-detect values in highway runoff database	
Mercury	0.1	0.04 (22.38%)	0.01 (79.43%)
Total PCBs		No studies measuring total PCBs in highway runoff	
Total PDBEs		No studies measuring total PDBEs in highway runoff	
Carcinogenic PAHs	0.8	0.6 (29.13%) (c)	0.1 (86.91%) (c)
High MW PAHs	0.4	0.3 (19.68%) (c)	0.2 (51.66%)
Low MW PAHs	0.1	Large uncertainty due to below DL measurements (d)	
bis(2-Ethylhexyl)phthalate	7.6	No non-detect values in highway runoff database	
Total Dioxin TEQs		No studies measuring total dioxin TEQ in highway runoff	
DDT and Metabolites		No studies measuring DDT in highway runoff	
Triclopyr		No studies measuring triclopyr in highway runoff	
Nonylphenol	5.9	No non-detect values in highway runoff database	
TPH	2,251.7	2,164.3 (3.88%)	2,001.6 (11.11%)

(a) For each chemical of concern at each sampling location, Appendix B provides the number of samples that were analyzed and the number of reported "non-detect" analytical results.

(b) Values in parentheses are the percentage decreases from the 50 percent POE concentration calculated with non-detects assigned the detection limit.

(c) One study reported number of non-detect values but not the detection limit. The detection limit from a second study was assumed to apply to both studies.

(d) Two studies (Yonge et al. 2002 and Caltrans 2003) measured six low molecular weight PAHs (n=10 and n=32) in highway runoff. For four of the six PAHs, both studies reported no detections. For the other two PAHs, the two studies combined had 79 and 98% non-detect values. In the loading analysis, Herrera used the higher of the two studies' detection limits as the 50% probability of exceedance concentration for PAHs.

POE = probability of exceedance.
DDT = dichlorodiphenyltrichloroethane.
DL = detection limit.
MW = molecular weight.
PAHs = polycyclic aromatic hydrocarbons.
PBDEs = polybrominated diphenyl ethers.
PCBs = polychlorinated biphenyls.
TEQ = toxicity equivalent.
TPH = total petroleum hydrocarbon.
µg/L = micrograms per liter.

Figures

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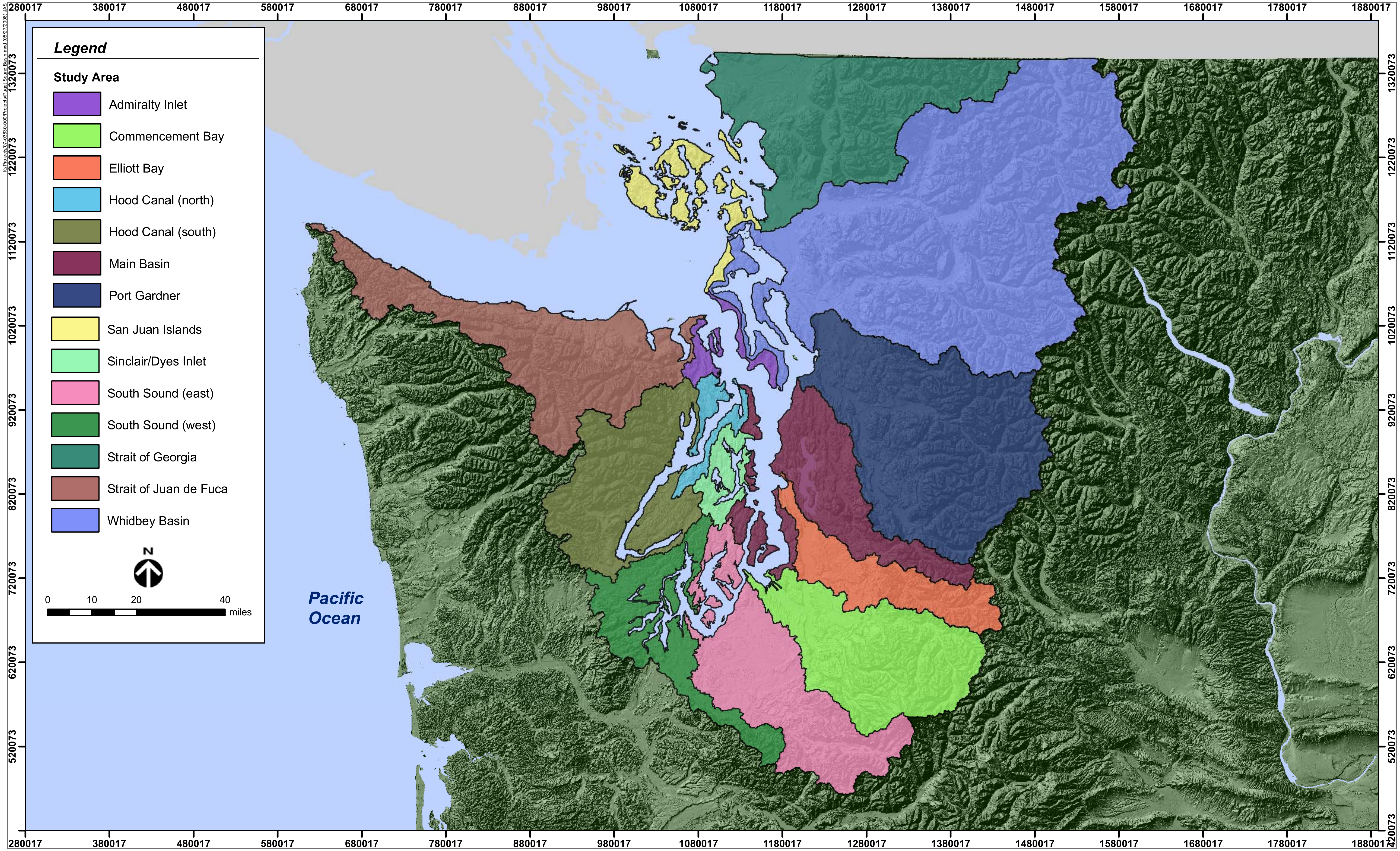


Figure 1. Study Areas in the Puget Sound Basin.

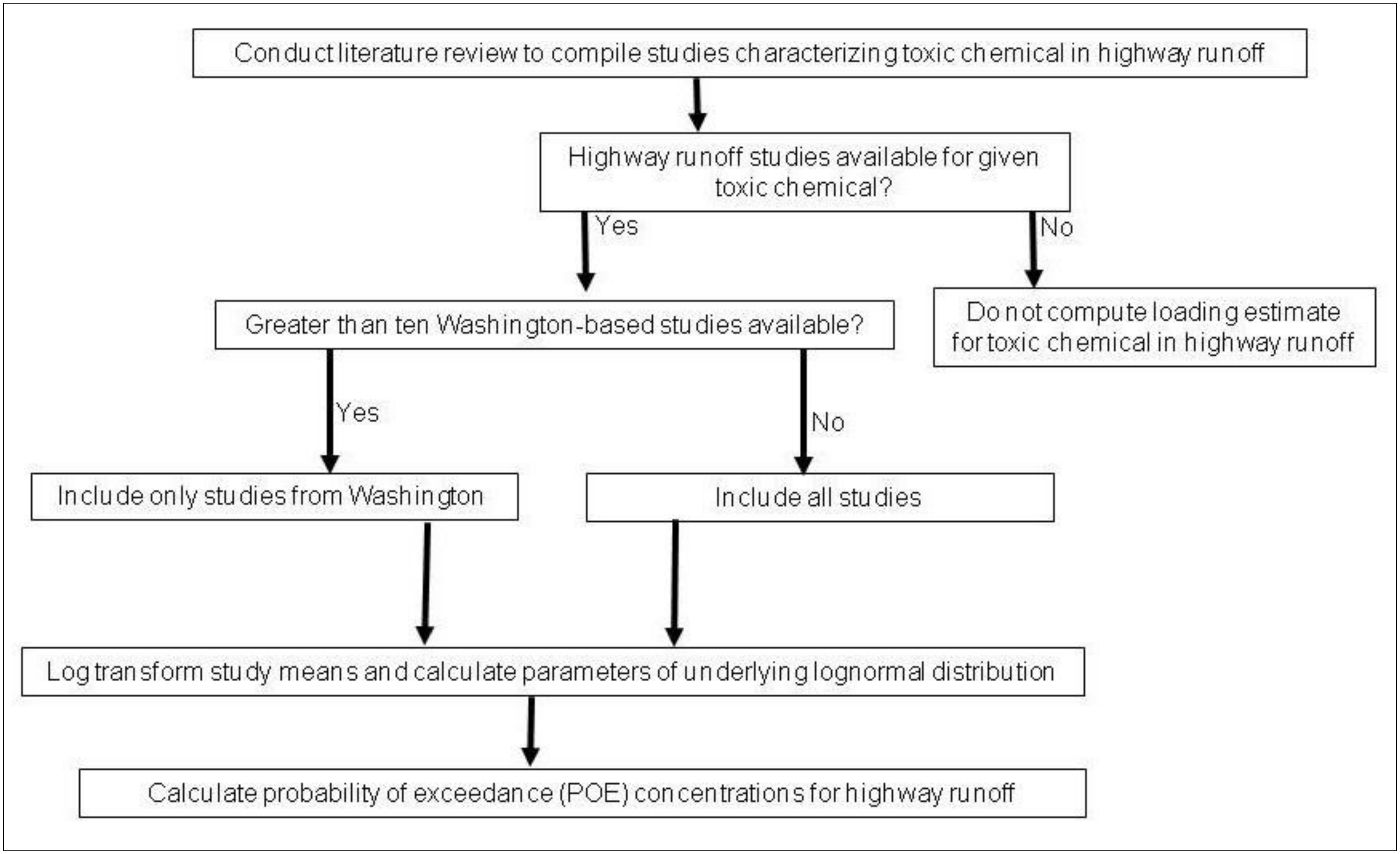


Figure 2. **Flow Chart of the Process to Determine Highway Runoff Concentrations.**

Appendices

Appendix A

GIS Roadway Area and Land Use Analyses

GIS Roadway Area and Land Use Analyses

As part of the Phase 2 study, the project team (EnviroVision, Herrera, and Ecology) performed a GIS analysis intended to refine the land use classification completed for the Phase 1 analysis (Hart Crowser et al. 2007) to include information about roadway areas. The roadway areas were calculated for the Puget Sound Basin and 14 study areas associated with Ecology's Puget Sound Box Model and were classified into the following roadway land use subcategories:

- Residential side streets
- Arterial/collector roads
- Highways

The original goal was to separate these roadway land use subcategories from the four major land use categories defined in Phase 1 (commercial/industrial, residential, agricultural, and forest/field/other), and use the resultant data to recompute the toxic chemical loading estimates. However, lack of sufficient toxic chemical concentration data later precluded separate estimates of loading for all the roadway subcategories except highways. The GIS layers and other calculations were completed and are available for possible use in another project sometime in the future. The following sections describe the data sources used in the roadway area and land use analyses and their known limitations, the analytical steps that were performed, and the quality control and quality assurance measures taken to ensure that the data being generated were both correct and complete.

Data Sources and Limitations

All GIS datasets used in the roadway area and land use analyses were converted to the Washington State Plane South HARN 83 projection with both the vertical and horizontal datum being in feet. Documentation on all datasets used in the analyses including the data source and native coordinate system can be found in Table A-1.

Roadway Data

The GIS roadway data were gathered and analyzed first at the county scale, 13 counties located at least partially within the Puget Sound Basin. Most counties in the study area had GIS roadway data available. Where data were not available from the jurisdiction directly, they were obtained through one of several statewide agencies, including the Washington State Departments of Natural Resources and Transportation.

Since data from different sources have different levels of resolution, roadway datasets delineated from statewide layers typically were less accurate than roadway datasets delineated at the county level.

Aerial Photography

Color aerial photography used for measuring approximate roadway width was obtained at the county level for all 13 counties in the Puget Sound Basin through the United States Department of Agriculture National Agriculture Imagery Program (USDA NAIP). The aerial photography was flown in 2006 and had a pixel resolution of 1 meter.

Land Use Data

Land use/land cover data for the entire Puget Sound Basin were obtained from the Multi-Resolution Land Characteristics Consortium (MRLC 2001), a cooperative project between nine federal agencies with the objective of making available Landsat 5 imagery of the conterminous United States. The National Land Cover Dataset 2001 (NLCD 2001) is a second-generation raster dataset showing 21 classes of land-cover data at a resolution of 30-meter pixels. Each pixel represents a normalized land use value obtained through the combination of datasets from three time periods. Figure A-1 shows the grouped NLCD 2001 land cover of the Puget Sound Basin.

The Phase 1 land use analysis of the Puget Sound Basin was based on the National Land Cover Dataset 1992 (NLCD 1992), the first generation dataset created by the Multi-Resolution Land Characteristics Consortium (MRLC 1992). Since the classification scheme between NLCD 1992 and NLCD 2001 was not identical, some variance existed between the land use groupings used in the Phase 1 report and those used in Phase 2. Table A-2 lists the 21 classes for both NLCD 1992 and NLCD 2001, the groupings that were used, and what the total area of each class was for the Puget Sound Basin. MRLC 2001 has documented a process undertaken to show the limitations of a direct comparison between the two datasets (available online at http://www.mrlc.gov/changeproduct.php).

Methods

This section describes the GIS methods that the project team employed to classify roadway data into the three land use subcategories, to generate areas for each subcategory, and to generate updated land use numbers for the four major land use categories. An example process-flow diagram showing the analytical steps for the Port Gardner study area is shown in Figure A-2.

Roadway Type Classification

To facilitate calculating roadway land use subcategory areas, it was necessary to classify all GIS roadways as residential side streets, arterial/collector roads, or highways. Of the 13 counties in the Puget Sound Basin, five had data available that had already been partially or completely classified. The roadway classifications designated by these counties were grouped into the three land use subcategories, as shown in Table A-3.

For counties with roadway GIS data that had been partially classified or had no classification information at all, a number of resources were used to determine what subcategory they should be classified as. Countywide zoning and land use data as well as aerial photography were used to identify residential areas, and all roads in those areas that were not clearly arterial/collector roads were designated as residential side streets. As there were no GIS datasets available to help easily identify arterial/collector roads, paper road atlases for the state of Washington with an established road hierarchy were used to help determine whether a road was an arterial/collector or a residential side street. Roads that were categorized as major or minor arterials were classified as arterial/collector roadways, and those categorized as being other paved roads were classified as residential side streets.

The Washington State Department of Transportation statewide highway layer was used to assist in classifying highways for all counties that had not specifically designated roadways as being of that land use subcategory. If data were available at the county level that included additional roadways categorized as highway that were not represented in the statewide highway layer, those roadways were also included in the highway land use subcategory.

Since a large percentage of the information used to classify the roadways was not available in a GIS format, the process of selecting roads and classifying them was done manually on a roadway-by-roadway basis.

Roadway Width Calculation

After all GIS roadway line data had been classified as residential side streets, arterial/collector roads, or highways, the next analytical step was to generate roadway areas for each land use subcategory. This was approached at the county level for all 13 counties in the Puget Sound Basin. Since the classified roadway data depicted only the road centerline, it was necessary to determine the width of each roadway and then convert each roadway to a polygon so that area could be calculated.

Since the Puget Sound Basin contains a huge number of roadways, it was not possible to measure and assign a width to each one individually. To make this task manageable, it was necessary to obtain one representative width for each land use subcategory for each county and to apply that width to all roadways in that designation. This was accomplished by breaking each county into 12 sections, and using aerial photography within each section to measure roadway widths at five locations for each land use subcategory. The average width for each roadway type was calculated for each section, and then an average was taken of all 12 sections to determine the most representative roadway width to apply to all features in that category. A summary of the widths assigned to each roadway type (land use subcategory) by county is presented in Table A-4.

Where more refined roadway category information at the county level was available, the roadway width calculation analysis was performed on the more detailed information before it was grouped into the three roadway subcategories. For example, if a county had data available that categorized roadways into major and minor arterials, widths would be calculated for each type of arterial separately before combining the resulting polygons into one arterial/collector roadway subcategory.

Land Use Analysis

To produce results that were comparable to those presented in the Phase 1 report, the calculated roadway areas were incorporated with the NLCD 2001 land cover dataset to generate new areas for each of the four major land use categories and subcategories. Total areas were calculated as well as areas for the various combinations of the major land use categories and roadway and non-roadway subcategories. This made it possible to determine what type and percentage of the NLCD 2001 land cover data were replaced by a roadway land use subcategory. Table 2 in the main report shows the land use category and subcategory percentages that were generated from the GIS analysis.

Table A-1. Detailed Information about GIS Datasets Used in the Phase 2 Roadway and Land Use Analyses.

Data Type	Geographic Extent	Source	Coordinate System	Online Metadata (if available)
Roadway	Jefferson County	Department of Natural Resources	WA State Plane S NAD 83 HARN (feet)	http://fortress.wa.gov/dnr/app1/dataweb/metadata/trans.htm
Roadway	Island County	Department of Natural Resources	WA State Plane S NAD 83 HARN (feet)	http://fortress.wa.gov/dnr/app1/dataweb/metadata/trans.htm
Roadway	King County	King County GIS Center	WA State Plane N NAD 83 (feet)	http://www.metrokc.gov/gis/sdc/index.htm
Roadway	Pierce County	Pierce County GIS Team	WA State Plane S NAD 83 HARN (feet)	http://yakima.co.pierce.wa.us/geodataexpress/main.html
Roadway	Kitsap County	Kitsap County GIS	WA State Plane N NAD 83 (feet)	http://www.kitsapgov.com/gis/metadata/
Roadway	Clallam County	DNR modified by Clallam County	WA State Plane N NAD 83 (feet)	Not available online
Roadway	Snohomish County	Snohomish County Assessor	WA State Plane N NAD 83 (feet)	ftp://ftp.snoco.org/assessor/shapefiles/
Roadway	San Juan County	San Juan County Public Works	WA State Plane N NAD 83 (feet)	http://www.sanjuanco.com/gis/gislibrary/road_centerlines_metadata.htm
Roadway	Thurston County	Thurston County GeoData Center	WA State Plane S NAD 83 (feet)	http://www.geodata.org/metadata.htm
Roadway	Lewis County	Department of Natural Resources	WA State Plane S NAD 83 HARN (feet)	http://fortress.wa.gov/dnr/app1/dataweb/metadata/trans.htm
Roadway	Whatcom County	Whatcom County Planning	WA State Plane N NAD 83 (feet)	Not available online
Roadway	Skagit County	Skagit County GIS	WA State Plane S NAD 83 HARN (feet)	http://www.skagitcounty.net/Common/Asp/Default.asp?d=GIS&c=General&p=Digital/main.htm
Roadway	Mason County	Department of Natural Resources	WA State Plane N NAD 83 (feet)	http://fortress.wa.gov/dnr/app1/dataweb/metadata/trans.htm
Land Use	Puget Sound Basin	Multi-Resolution Land Characteristics Consortium	USA Contiguous Albers Equal Area Conic NAD 83 (geographic)	http://www.mrlc.gov/nlcd.php
Aerial Photos	All 13 Counties in the Puget Sound Basin	United States Department of Agriculture National Agriculture Imagery Program	UTM Zone 10 NAD 83 (meters)	http://rocky2.ess.washington.edu/data/raster/naip2006/index.html

Table A-2. Comparison of Areas Generated from the MRLC 2001 and MRLC 1992 Land Use Data.

MRLC 2001				MRLC 1992			
Land Use Number	**Land Use Designation**	**Grouping**	**Total Area (sq miles)**	**Land Use Number**	**Land Use Designation**	**Grouping**	**Total Area (sq miles)**
11	Open Water	Forest/Field/Other	189	11	Open Water	Forest/Field/Other	239
12	Perennial Ice/Snow	Forest/Field/Other	153	12	Perennial Ice/Snow	Forest/Field/Other	158
21	Developed, Open Space	Residential	657	21	Low Intensity Residential	Residential	585
22	Developed, Low Intensity	Residential	669	22	High Intensity Residential	Residential	1
23	Developed, Medium Intensity	Residential	262	23	Commercial/Industrial Transportation	Commercial/Industrial Transportation	194
24	Developed, High Intensity	Commercial/Industrial/Transportation	103				
31	Barren Land (Rock/Sand Clay)	Forest/Field/Other	427	31	Bare Rock/Sand/Clay	Forest/Field/Other	409
32	Unconsolidated Shore (a)	N/A	0	32	Quarries/Strip Mines/Gravel Pits	Forest/Field/Other	7
				33	Transitional	Forest/Field/Other	647
41	Deciduous Forest	Forest/Field/Other	415	41	Deciduous Forest	Forest/Field/Other	1,364
42	Evergreen Forest	Forest/Field/Other	7,072	42	Evergreen Forest	Forest/Field/Other	7,334
43	Mixed Forest	Forest/Field/Other	1,057	43	Mixed Forest	Forest/Field/Other	1,229
51	Dwarf Scrub (b)	N/A	0	51	Shrubland	Forest/Field/Other	414
52	Shrub/Scrub	Forest/Field/Other	1,239				
				61	Orchards/Vineyards/Other	Agricultural	31
71	Grassland/Herbaceous	Forest/Field/Other	498	71	Grasslands/Herbaceous	Forest/Field/Other	379
81	Pasture/Hay	Agricultural	477	81	Pasture/Hay	Agricultural	567
82	Cultivated Crops	Agricultural	112	82	Row Crops	Agricultural	48
				83	Small Grains	Agricultural	37
				84	Fallow	Agricultural	1
				85	Urban/Recreational Grasses	Forest/Field/Other	35
90	Woody Wetlands	Forest/Field/Other	271				
				91	Woody Wetlands	Forest/Field/Other	45
				92	Emergent Herbaceous Wetlands	Forest/Field/Other	4
95	Emergent Herbaceous Wetlands	Forest/Field/Other	127				
		Total	13,726			**Total**	13,726

(a) Coastal areas only.

(b) Alaska only.

Table A-3. Reclassification of Original Roadway Data into Three Land Use Subcategories.

Geographic Extent	Original Roadway Classification	Land Use Subcategory
King County	Collector	Arterial/Collector Road
King County	Freeway	Highway
King County	Local	Residential Side Street
King County	Minor	Arterial/Collector Road
King County	Primary	Arterial/Collector Road
King County	Ramp	Highway
King County	Bridge	Highway
Pierce County	MapClass 1: Interstate	Highway
Pierce County	MapClass 2: Ramps	Highway
Pierce County	MapClass 3: Limited Access Highway	Highway
Pierce County	MapClass 4: Other State Highway	Highway
Pierce County	MapClass 5: County or City Arterial	Arterial/Collector Road
Pierce County	MapClass 6: Lower Class Arterial	Arterial/Collector Road
Pierce County	MapClass 8: Local Roads and City Streets	Residential Side Street
Pierce County	MapClass 9: Non-Addressed Streets	Residential Side Street
Clallam County	Highway	Highway
Clallam County	Main	Arterial/Collector Road
Clallam County	Private	Residential Side Street
Whatcom County	Collector Road	Arterial/Collector Road
Whatcom County	I-5	Highway
Whatcom County	Primary Route	Arterial/Collector Road
Whatcom County	Primary Truck Route	Arterial/Collector Road
Whatcom County	Private	Residential Side Street
Whatcom County	Residential/Other	Residential Side Street
Whatcom County	Secondary Route	Arterial/Collector Road
Whatcom County	Secondary Truck Route	Arterial/Collector Road
Thurston County	A: Arterial	Arterial/Collector Road
Thurston County	C: Collector	Arterial/Collector Road
Thurston County	L: Local	Arterial/Collector Road
Thurston County	Subdivision	Residential Side Street

This table shows only those roadway classifications that were reclassified in their entirety.

Table A-4. Assigned Roadway Widths for Each Land Use Subcategory.

Geographic Extent	Land Use Subcategory	Average Assigned Width
Clallam County	Arterial/Collector Road	60 feet
	Residential Side Street	30 feet
	Highway	80 feet
Island County	Arterial/Collector Road	60 feet
	Residential Side Street	30 feet
Jefferson County	Arterial/Collector Road	60 feet
	Residential Side Street	30 feet
King County	Collector Street	40 feet
	Minor Street	50 feet
	Primary Street	80 feet
	Residential Side Street	30 feet
	Ramps	30 feet
	Highway	80 feet
	Bridge	30 feet
Kitsap County	Arterial/Collector Road	60 feet
	Residential Side Street	30 feet
Lewis County	Arterial/Collector Road	50 feet
	Residential Side Street	25 feet
Mason County	Arterial/Collector Road	60 feet
	Residential Side Street	20 feet
Pierce County	Arterial/Collector Road	80 feet
	Residential Side Street	30 feet
	Highway	60 feet
San Juan County	Arterial/Collector Road	50 feet
	Residential Side Street	30 feet
Skagit County	Arterial/Collector Road	60 feet
	Residential Side Street	35 feet
Snohomish County	Arterial/Collector Road	70 feet
	Residential Side Street	30 feet
	Highway	80 feet
Thurston County	Arterial/Collector Road	60 feet
	Residential Side Street	35 feet
Whatcom County	Arterial/Collector Road	40 feet
	Residential Side Street	30 feet
Washington State (a)	Undivided Highway	40 feet
	Divided Highway	60 feet
	Ramps	30 feet

(a) Washington State highway data were used to classify highways in all counties with roadway GIS data that did not include a specific "highway" road type designation.

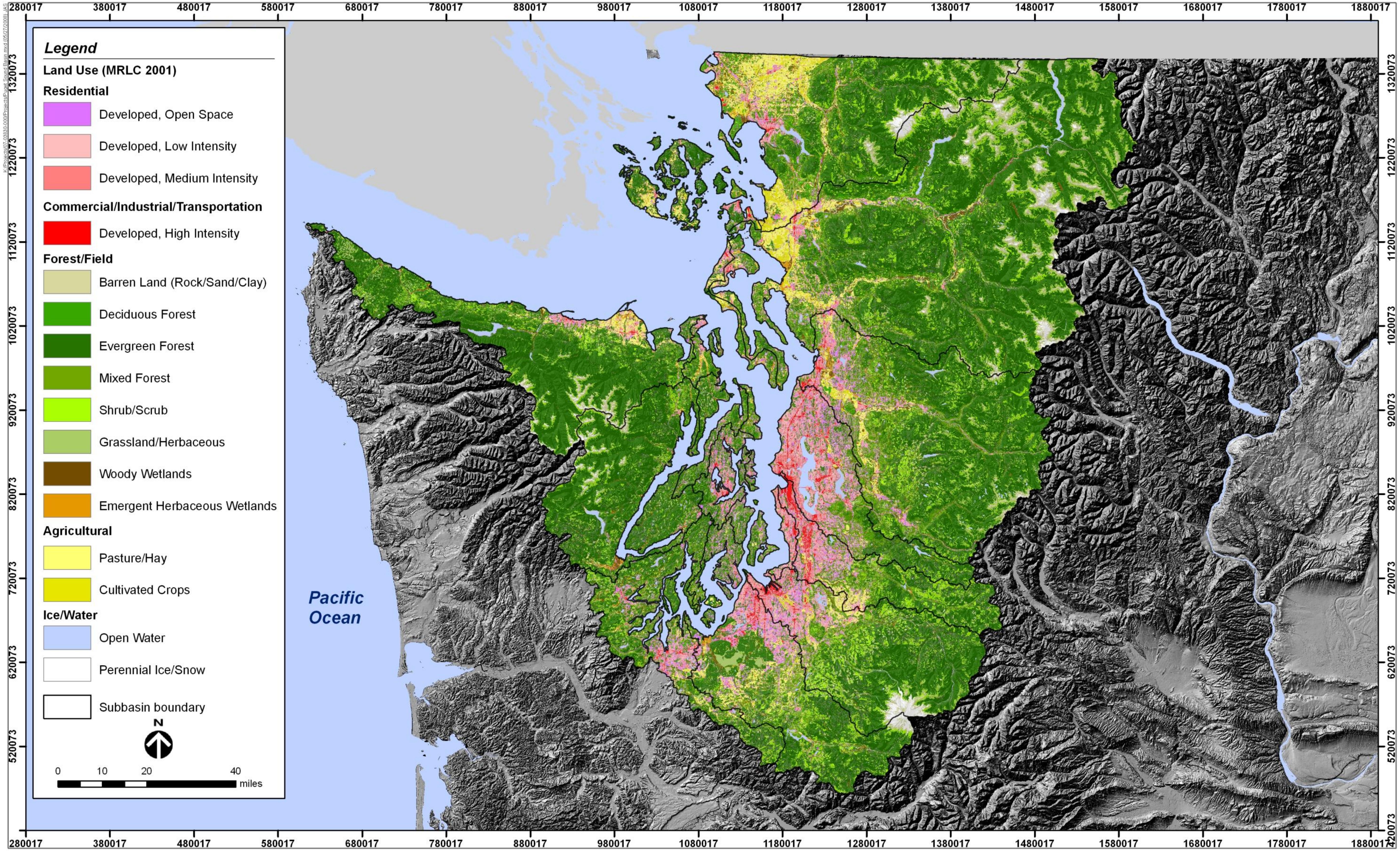
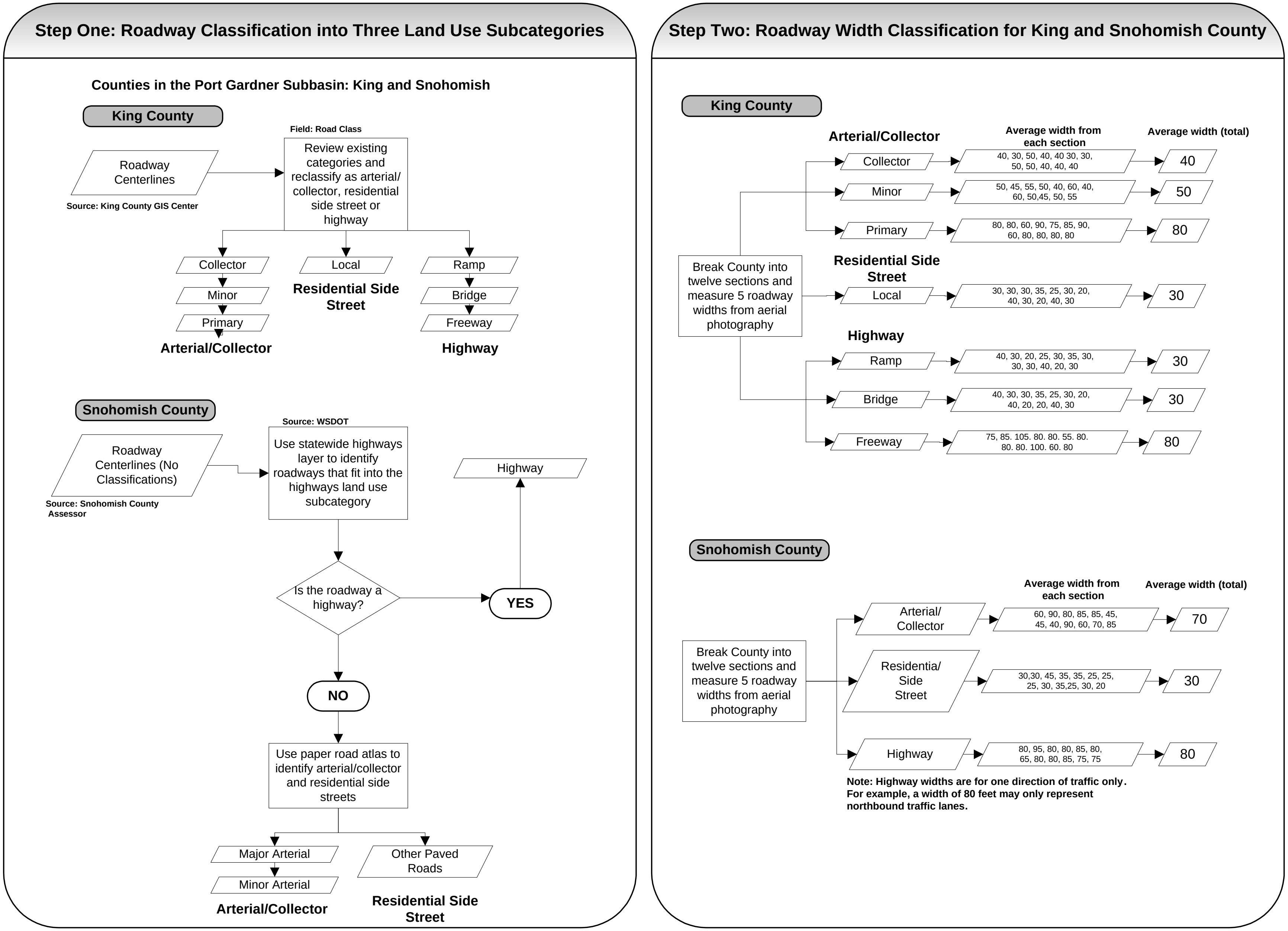


Figure A-1. Land Use Shown by the National Land Cover Dataset (MRLC 2001) in the Puget Sound Basin

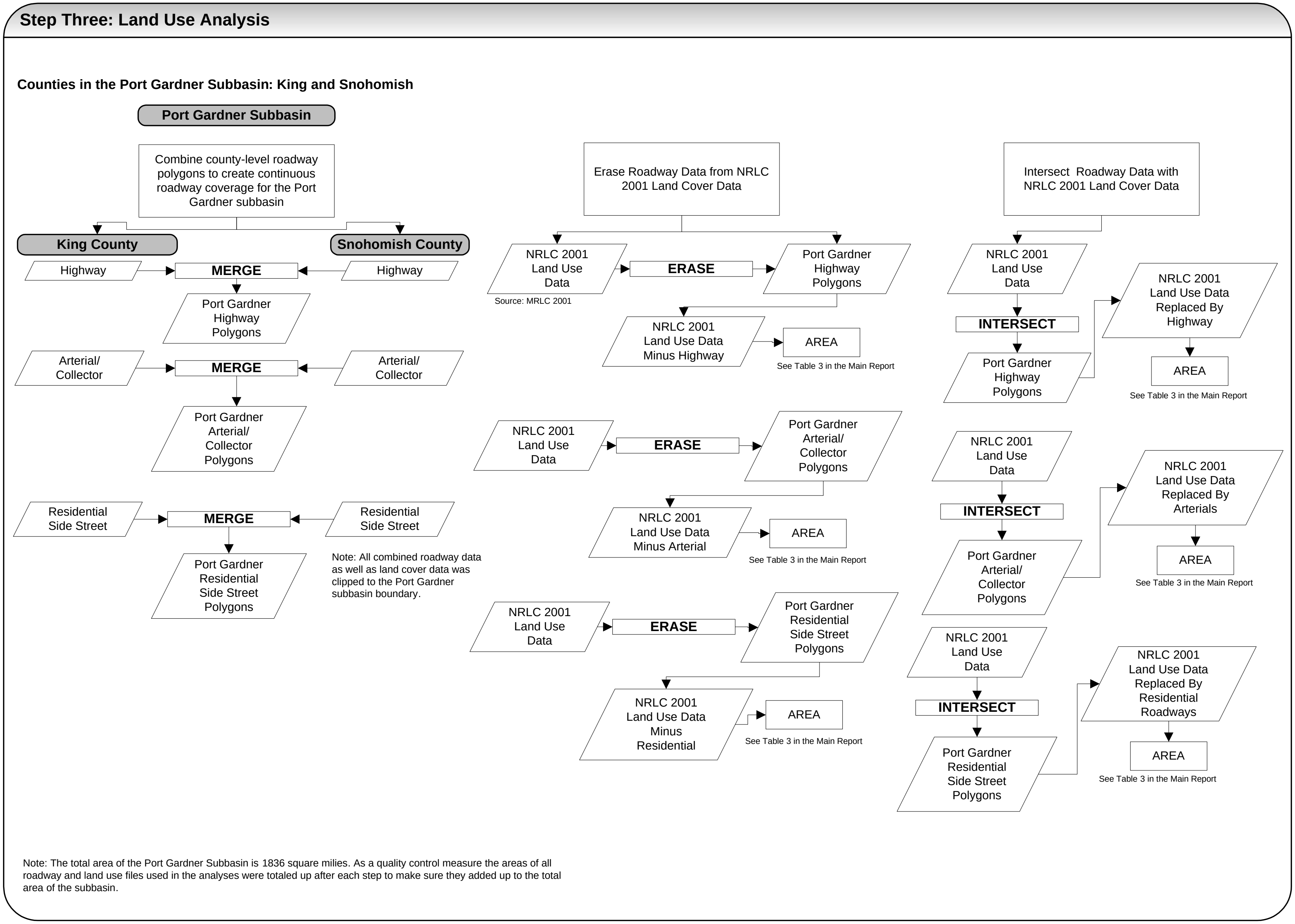


Step One: Roadway Classification into Three Land Use Subcategories

Step Two: Roadway Width Classification for King and Snohomish County

Note: Highway widths are for one direction of traffic only. For example, a width of 80 feet may only represent northbound traffic lanes.

Figure A-2. Example Process Flow Diagram for the Roadway and Land Use Analyses (Sheet 1 of 2)



Note: All combined roadway data as well as land cover data was clipped to the Port Gardner subbasin boundary.

Note: The total area of the Port Gardner Subbasin is 1836 square milies. As a quality control measure the areas of all roadway and land use files used in the analyses were totaled up after each step to make sure they added up to the total area of the subbasin.

Figure A-2. Example Process Flow Diagram for the Roadway and Land Use Analyses (Sheet 2 of 2)

Appendix B

Summary of Highway Runoff Concentration Data Used in Roadway Runoff Loading Estimates

References for Appendix B

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WSDOT. 2007. 2007 Stormwater Report. Washington State Department of Transportation. Olympia, Washington.

Yonge, D., A. Hossain, M. Barber, S. Chen, and D. Griffin. 2002. Wet Detention Pond Design for Highway Runoff Pollutant Control. National Cooperative Highway Research Program.

Zawlocki, K.R. 1981. A Survey of Trace Organics in Highway Runoff in Seattle, Washington. University of Washington, Seattle, WA.

Table B-1. Summary of Data Compiled to Characterize Total Arsenic Concentrations in Highway Runoff.

								Range					
Chemical of Concern (ug/L)	**Location**	**Reference**	**Roadway Type**	**Sample Type**	**Sample Location**	**N (a)**	**ND (b)**	**Min**	**Max**	**Median**	**Mean (c)**	**Standard Deviation (d)**	**Sampling Period**
Total Arsenic	California	Kayhanian et al. (2007)	highway	composite	edge of pavement	635	241	0.5	70	1.1	2.7	7.9	2000-2003
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	10		1.5	5.3	2.8	2.5	1.1	1999-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	17		0.5	3.3	1.2	1.0	0.8	2000-2002
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		0.5	4.1	1.3	1.0	1.0	2001-2002
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	7		1	3.4	2.1	1.9	0.9	1999-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		1	3.8	2.1	1.8	1.0	2000-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	6		1	8.4	2.8	1.8	2.8	2000-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	4		1.5	1.7	1.6	1.6	0.1	2000-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	10		1.6	4.2	2.8	2.8	0.8	2000-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	6		2	9.2	3.8	2.7	2.7	2000-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	7		1.7	3.9	2.4	1.8	1.0	1999-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	5		0.9	4.9	1.8	1.0	1.7	2000-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	6		4.8	16.6	8.4	7.2	4.6	2000-2001
Total Arsenic	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		0.6	3.4	1.3	1.2	0.9	2000-2001
Total Arsenic	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		1.4	2.8	2.4	2.2		2003-2004
Total Arsenic	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11					2.6		1995-1996

Summary Statistics	
Total N	760
Total ND	≥241
ND Values per Total N Samples	≥32%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Table B-2. Summary of Data Compiled to Characterize Total Cadmium Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
Total Cadmium	varied	Gobel et al. (2007)	highway	unknown	conveyance system						3.7		unknown
Total Cadmium	California	Kayhanian et al. (2007)	highway	composite	edge of pavement	635	406	0.2	30	0.4	0.7	1.6	2000-2003
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	10		0.6	2.9	1.60	1.30	0.90	1999-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	17		0.3	2.2	0.7	0.5	0.5	2000-2002
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		0.3	1.4	0.7	0.5	0.3	2001-2002
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	7		0.2	1.3	0.6	0.4	0.5	1999-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		0.6	1.9	1.20	1.10	0.50	2000-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	6		0.5	1.2	0.80	0.80	0.20	2000-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	5		0.4	2.6	1.4	1.3	0.8	2000-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	10		0.6	3	1.70	1.60	0.80	2000-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	6		0.4	8.3	2.4	1.4	2.9	2000-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	7		0.5	2.1	0.9	0.6	0.6	1999-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	5		0.4	3	1.0	0.4	1.1	2000-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	6		0.3	2.5	1.0	0.9	0.8	2000-2001
Total Cadmium	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		0.6	1.3	0.80	0.70	0.20	2000-2001
Total Cadmium	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.5	2.2	1	1.2		2003-2004
Total Cadmium	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11		<0.05			0.9		1995-1996
Total Cadmium	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	0				2.8		1997-1999
Total Cadmium	France	Legret and Pagotto (1999)	highway	composite	edge of pavement	49		0.2	4.2	0.7	1	0.9	1995-1996

Summary Statistics	
Total N	771
Total ND	≥406
ND Values per Total N Samples	≥53%

(a) Number of samples.

(b) Number of non-detect values.

(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.

(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Shaded studies were not used in summary statistics or in calculating probability of exceedance concentrations.

Table B-3. Summary of Data Compiled to Characterize Total Copper Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
Total Copper	SR205 MP34.29, WA	WSDOT (2007)	highway	composite	edge of pavement	11	0	7.3	19.6	13.1	12.6	3.5	2005-2007
Total Copper	SR5 MP15.52, WA	WSDOT (2007)	highway	composite	conveyance system	18	2	1.0	18.5	3.8	5.2	4.4	2005-2007
Total Copper	SR14 MP10.39, WA	WSDOT (2007)	highway	composite	conveyance system	11	0	9.8	22.8	16.2	16.9	4.1	2005-2007
Total Copper	SR18 MP13.13, WA	WSDOT (2007)	highway	composite	conveyance system	13	0	1.1	28.0	15.5	14.3	9.0	2005-2007
Total Copper	SR18 MP18.51, WA	WSDOT (2007)	highway	composite	edge of pavement	12	0	3.3	30.8	12.1	12.9	8.4	2005-2007
Total Copper	SR18 MP 8.04, WA	WSDOT (2007)	highway	composite	conveyance system	14	0	7.3	38.7	18.4	18.8	9.4	2005-2007
Total Copper	SR500 MP5.38, WA	WSDOT (2007)	highway	composite	conveyance system	12	0	8.6	26.5	14.6	15.3	4.9	2005-2007
Total Copper	SR522 MP16.30, WA	WSDOT (2007)	highway	composite	conveyance system	13	0	4.1	71.5	27.9	30.3	16.2	2005-2007
Total Copper	SR525 MP1.58, WA	WSDOT (2007)	highway	composite	conveyance system	12	0	4.3	78.2	15.1	19.4	19.8	2005-2007
Total Copper	SR525 MP2.52, WA	WSDOT (2007)	highway	composite	conveyance system	16	0	5.6	44.3	15.8	17.7	10.9	2005-2007
Total Copper	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		36	76.5	53.1	56		2003-2004
Total Copper	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11					23.1		1995-1996
Total Copper	SR 520, WA	Zawlocki 1981	highway	composite	edge of pavement	5	3				26.6		1979-1981
Total Copper	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	0				30.2		1997-1999
Total Copper	France	Legret and Pagotto (1999)	highway	composite	edge of pavement	49		11	146	33	45	27	1995-1996
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	19		26	120	57	51	27	1999-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	17		<0.05	83	25.5	19.0	18.2	2000-2002
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		13	52	24	20	12	2001-2002
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		6.3	54	25	21	15	1999-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		35	9500	874	77	2600	2000-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	10		8.3	64	37	39	19	2000-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	9		4.6	89	37	27	29	2000-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	14		27	230	87	84	48	2000-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		13	232	65	40	71	2000-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		15	73	38	36	18	1999-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		13	107	32	21	31	2000-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	9		10	101	40	33	28	2000-2001
Total Copper	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		22	110	43	34	26	2000-2001
Total Copper	varied	Gobel et al. (2007)	highway	unknown	conveyance system						65		unknown
Total Copper	California	Kayhanian et al. (2007)	highway	composite	edge of pavement	635	0	1.2	270	21.1	35.5	31.6	2000-2003

Summary Statistics	
Total N	167
Total ND	≥5
ND Values per Total N Samples	≥3%

(a) Number of samples.

(b) Number of non-detect values.

(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.

(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Shaded studies were not used in summary statistics or in calculating probability of exceedance concentrations.

Table B-4. Summary of Data Compiled to Characterize Total Lead Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
Total Lead	varied	Gobel et al. (2007)	highway	unknown	conveyance system						224		unknown
Total Lead	California	Kayhanian et al. (2007)	highway	composite	edge of pavement	635	38	1	2600	13	48	151	2000-2003
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	19		25	270	75	47	62	1999-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	17		3.7	42	10.6	6.5	9.4	2000-2002
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		3.8	38	8.8	5.1	10.0	2001-2002
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		5.1	269	61.8	34.2	69.2	1999-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		100	2300	445	290	576	2000-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	10		7.6	97	46.9	48.5	28.0	2000-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	9		8.1	148	70.2	74.2	51.7	2000-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	14		35	440	133	87	120	2000-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		41	2086	444	196	676	2000-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		43	250	122	120	61	1999-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		11.5	220	62.8	35.0	68.8	2000-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	9		7.5	103	46.3	40.1	32.7	2000-2001
Total Lead	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		5.6	18	10.0	9.6	3.5	2000-2001
Total Lead	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		10.9	46.5	15.7	24		2003-2004
Total Lead	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11		<0.05			60.8		1995-1996
Total Lead	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	0				27.3		1997-1999
Total Lead	France	Legret and Pagotto (1999)	highway	composite	edge of pavement	49		14	188	43	58	44	1995-1996

Summary Statistics	
Total N	>820
Total ND	≥38
ND Values per Total N Samples	~5%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.
Shaded studies were not used in summary statistics or in calculating probability of exceedance concentrations.

Table B-5. Summary of Data Compiled to Characterize Total Zinc Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
Total Zinc	SR205 MP34.29, WA	WSDOT (2007)	highway	composite	edge of pavement	11	0	45.6	81.7	66.7	63.1	13.4	2005-2007
Total Zinc	SR5 MP15.52, WA	WSDOT (2007)	highway	composite	conveyance system	18	0	7.9	46.3	18.1	21.4	10.4	2005-2007
Total Zinc	SR14 MP10.39, WA	WSDOT (2007)	highway	composite	conveyance system	11	0	37.6	91.3	64.0	66.9	16.1	2005-2007
Total Zinc	SR18 MP13.13, WA	WSDOT (2007)	highway	composite	conveyance system	13	0	23.0	188.0	100.0	102.2	56.2	2005-2007
Total Zinc	SR18 MP18.51, WA	WSDOT (2007)	highway	composite	edge of pavement	12	0	27.0	184.0	70.0	79.0	48.0	2005-2007
Total Zinc	SR18 MP 8.04, WA	WSDOT (2007)	highway	composite	conveyance system	14	0	35.0	348.0	86.5	103.8	79.0	2005-2007
Total Zinc	SR500 MP5.38, WA	WSDOT (2007)	highway	composite	conveyance system	12	0	58.1	131.0	89.5	95.8	22.7	2005-2007
Total Zinc	SR522 MP16.30, WA	WSDOT (2007)	highway	composite	conveyance system	13	0	112.0	583.0	229.0	269.5	154.6	2005-2007
Total Zinc	SR525 MP1.58, WA	WSDOT (2007)	highway	composite	conveyance system	12	0	31.0	343.0	72.5	121.4	112.7	2005-2007
Total Zinc	SR525 MP2.52, WA	WSDOT (2007)	highway	composite	conveyance system	16	0	9.0	251.0	81.5	88.8	61.5	2005-2007
Total Zinc	Redmond, WA	St. John and Horner (1997)	highway	composite	conveyance system	11					227.5		1995-1996
Total Zinc	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	0				155.2		1997-1998
Total Zinc	France	Legret and Pagotto (1999)	highway	composite	edge of pavement	49		104	1544	254	356	288	1995-1996
Total Zinc	varied	Gobel et al. (2007)	highway	unknown	conveyance system						345		unknown
Total Zinc	California	Kayhanian et al. (2007)	highway	composite	conveyance system	635	0	5.5	1680	111.2	187.1	199.8	2000-2003
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	19		150	1100	467	350	284	1999-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	17		<0.05	1500	281	178	340	2000-2002
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		52	500	207	170	141	2001-2002
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		4.6	489	169.7	119.0	141.3	1999-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		190	2000	534	360	480	2000-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	10		26	430	204	190	122	2000-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	9		50.9	547	265.1	288.0	164.0	2000-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	14		220	1600	612	545	385	2000-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		66	1542	369	201	487	2000-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	13		161	636	334	288	155	1999-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	8		64	687	182	101	210	2000-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	9		100	1093	361	322	302	2000-2001
Total Zinc	California	ISBMP Database (2008)	highway	unknown	conveyance system	11		210	800	403	330	207	2000-2001

Summary Statistics	
Total N	153
Total ND	≥0
ND Values per Total N Samples	≥0%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.
Shaded studies were not used in summary statistics or in calculating probability of exceedance concentrations.

Table B-6. Summary of Data Compiled to Characterize Total Mercury Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range Min	Range Max	Median	Mean (c)	Standard Deviation (d)	Sampling Period
Total Mercury	I-5	Herrera (2003)	highway	unknown	conveyance system	3	3	0.2	0.2	0.2	0.2	0	1997
Total Mercury	California	Caltrans (2003)	highway	composite	edge of pavement	23	14	0.008	0.160	0.026	0.037	0.038	2000-2003
Total Mercury	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.01	0.04	0.02	0.02		2003-2004

Summary Statistics	
Total N	35
Total ND	≥17
ND Values per Total N Samples	≥49%

(a) Number of samples.

(b) Number of non-detect values.

(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.

(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Table B-7. Summary of Data Compiled to Characterize Carcinogentic Polyaromatic Hydrocarbon Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
Benzo(a)anthracene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	4				0.16		1997-1999
Benzo(a)anthracene	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11					0.45		1995-1996
Benzo(a)anthracene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Benzo(a)pyrene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Benzo(a)pyrene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Benzo(a)pyrene	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.048	0.247	0.19	0.156		2003-2004
Benzo(b)fluoranthene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	9				0.11		1997-1999
Benzo(b)fluoranthene	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.048	0.223	0.048	0.126		2003-2004
Benzo(b)fluoranthene	California	Caltrans (2003)	highway	composite	edge of pavement	32	31	<0.05	0.05	<0.05	<0.05		2000-2003
Benzo(k)fluoranthene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Benzo(k)fluoranthene	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.048	0.233	0.048	0.0776		2003-2004
Benzo(k)fluoranthene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Chrysene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	2	<0.05			0.21		1997-1999
Chrysene	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11					0.682		1995-1996
Chrysene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Dibenzo(a,h)anthracene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Dibenzo(a,h)anthracene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Indeno(1,2,3-cd)pyrene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Indeno(1,2,3-cd)pyrene	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11					0.76		1995-1996
Indeno(1,2,3-cd)pyrene	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.048	0.267	0.195	0.151		2003-2004
Indeno(1,2,3-cd)pyrene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003

Summary Statistics

	Total N	Total ND	ND Values per Total N Samples
Benzo(a)anthracene	53	≥36	≥68%
Benzo(a)pyrene	51	≥42	≥82%
Benzo(b)fluoranthene	51	≥40	≥79%
Benzo(k)fluoranthene	51	≥42	≥82%
Chrysene	53	≥34	≥64%
Dibenzo(a,h)anthracene	42	42	100%
Indeno(1,2,3-cd)pyrene	62	≥42	≥68%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Table B-8. Summary of Data Compiled to Characterize Other High Molecular Weight Polyaromatic Hydrocarbon Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
Benzo(g,h,i)perylene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Benzo(g,h,i)perylene	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.048	0.391	0.082	0.164		2003-2004
Benzo(g,h,i)perylene	California	Caltrans (2003)	highway	composite	edge of pavement	32	26	<0.05	0.17	<0.05	<0.05		2000-2003
Fluoranthene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	0				0.3		1997-1999
Fluoranthene	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11					0.33		1995-1996
Fluoranthene	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.048	0.657	0.166	0.271		2003-2004
Fluoranthene	California	Caltrans (2003)	highway	composite	edge of pavement	32	26	<0.05	0.1	<0.05	<0.05		2000-2003
Pyrene	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.019	0.855	0.245	0.349		2003-2004
Pyrene	California	Caltrans (2003)	highway	composite	edge of pavement	32	24	<0.05	0.13	<0.05	<0.05	0.03	2000-2003

Summary Statistics

	Total N	Total ND	ND Values per Total N Samples
Benzo(g,h,i)perylene	51	≥36	≥71%
Fluoranthene	62	≥26	≥42%
Pyrene	41	≥24	≥59%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Table B-9. Summary of Data Compiled to Characterize Low Molecular Weight Polyaromatic Hydrocarbon Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range Min	Range Max	Median	Mean (c)	Standard Deviation (d)	Sampling Period
Acenapthene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Acenapthene	California	Caltrans (2003)	highway	composite	edge of pavement	32	31	<0.05	0.25	<0.05	<0.05		2000-2003
Acenapthylene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Acenapthylene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Anthracene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Anthracene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Fluorene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Fluorene	California	Caltrans (2003)	highway	composite	edge of pavement	32	31	<0.05	0.06	<0.05	<0.05		2000-2003
Naphthalene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	10				0.1		1997-1999
Naphthalene	California	Caltrans (2003)	highway	composite	edge of pavement	32	32	<0.05	<0.05	<0.05	<0.05		2000-2003
Phenanthrene	Vancouver, WA	Yonge et al. (2002)	highway	composite	conveyance system	10	4				0.17		1997-1999
Phenanthrene	California	Caltrans (2003)	highway	composite	edge of pavement	32	29	<0.05	0.14	<0.05	<0.05		2000-2003

Summary Statistics

	Total N	Total ND	ND Values per Total N Samples
Acenapthene	42	41	98%
Acenapthylene	42	42	100%
Anthracene	42	42	100%
Fluorene	42	41	98%
Naphthalene	42	42	100%
Phenanthrene	42	33	79%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Table B-10. Summary of Data Compiled to Characterize bis(2-Ethylhexyl)phthalate Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
bis(2-Ethylhexyl)phthalate	Seattle WA	King County (2007)	highway	grab	edge of pavement	7			20.3		13.91		unknown
bis(2-Ethylhexyl)phthalate	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11					4.68		1995-1996
bis(2-Ethylhexyl)phthalate	I-5	Herrera (2003)	highway	unknown	conveyance system	4	0	0.884	11.4	7.24	6.69	5.41	1997

Summary Statistics

Total N	22
Total ND	≥0
ND Values per Total N Samples	≥0%

(a) Number of samples.

(b) Number of non-detect values.

(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.

(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Table B-11. Summary of Data Compiled to Characterize Nonylphenol Concentrations in Highway Runoff.

Chemical of Concern (ug/L)	Location	Reference	Roadway Type	Sample Type	Sample Location	N (a)	ND (b)	Range		Median	Mean (c)	Standard Deviation (d)	Sampling Period
								Min	Max				
Nonylphenol	Seattle, WA	King County (2005)	highway	composite	edge of pavement	9		0.48	9.09	2.57	3.52		2003-2004
Nonylphenol	Seattle, WA	King County (2007)	highway	grab	edge of pavement	11			44.2		9.81		unknown

Summary Statistics	
Total N	20
Total ND	≥0
ND Values per Total N Samples	≥0%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Table B-12. Summary of Data Compiled to Characterize Total Petroleum Hydrocarbon Concentrations in Highway Runoff.

								Range					
Chemical of Concern (mg/L)	**Location**	**Reference**	**Roadway Type**	**Sample Type**	**Sample Location**	**N (a)**	**ND (b)**	**Min**	**Max**	**Median**	**Mean (c)**	**Standard Deviation (d)**	**Sampling Period**
TPH	California	Kayhanian et al. (2007)	highway	composite	edge of pavement	22		0.12	13.00	1.40	2.20	3.40	2000-2003
TPH - Oil	SR205 MP34.29, WA	WSDOT (2007)	highway	composite	edge of pavement	7	0	1.55	5.98	4.27	3.91	1.68	2005-2007
TPH - Oil	SR5 MP15.52, WA	WSDOT (2007)	highway	composite	conveyance system	7	6	0.50	0.97	0.50	0.57	0.18	2005-2007
TPH - Oil	SR14 MP10.39, WA	WSDOT (2007)	highway	composite	conveyance system	2	0	5.00	5.07	5.04	5.04	0.05	2005-2007
TPH - Oil	SR18 MP13.13, WA	WSDOT (2007)	highway	composite	conveyance system	7	0	0.58	10.50	1.32	2.91	3.46	2005-2007
TPH - Oil	SR18 MP18.51, WA	WSDOT (2007)	highway	composite	edge of pavement	6	0	0.47	1.50	0.70	0.79	0.38	2005-2007
TPH - Oil	SR18 MP 8.04, WA	WSDOT (2007)	highway	composite	conveyance system	7	0	0.52	3.56	1.93	1.87	1.00	2005-2007
TPH - Oil	SR500 MP5.38, WA	WSDOT (2007)	highway	composite	conveyance system	2	0	2.48	13.40	7.94	7.94	7.72	2005-2007
TPH - Oil	SR522 MP16.30, WA	WSDOT (2007)	highway	composite	conveyance system	5	0	0.67	3.95	1.67	1.99	1.41	2005-2007
TPH - Oil	SR525 MP1.58, WA	WSDOT (2007)	highway	composite	conveyance system	5	0	0.95	3.95	1.60	1.96	1.23	2005-2007
TPH - Oil	SR525 MP2.52, WA	WSDOT (2007)	highway	composite	conveyance system	5	0	0.98	2.21	2.17	1.93	0.53	2005-2007
TPH - Oil	Redmond, WA	St. John and Horner (1997)	highway	composite	edge of pavement	11	0				2.68		1995-1996

Summary Statistics	
Total N	86
Total ND	≥6
ND Values per Total N Samples	≥7%

(a) Number of samples.
(b) Number of non-detect values.
(c) Mean = Untransform of the mean of the natural logarithms of the study mean concentrations.
(d) Standard Deviation = Untransform of the standard deviation of the natural logarithms of the study mean concentrations.

Appendix C

Tabular Summaries of Absolute Toxic Chemical Loading Estimates and Loading Estimates Expressed as a Percentage of the Total Basin or Study Area Loading Rate

Table C-1. Loading Rates for the Entire Puget Sound Basin by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.28E+01	4%	1.06E+02	31%	1.88E+01	6%	2.01E+02	59%	1.21E+00	<1%	3.40E+02
25	5.90E+00	4%	4.65E+01	34%	8.66E+00	6%	7.60E+01	55%	7.42E-01	1%	1.38E+02
50	3.44E+00	5%	2.62E+01	35%	5.05E+00	7%	3.87E+01	52%	5.28E-01	1%	7.40E+01
75	1.98E+00	5%	1.48E+01	37%	2.94E+00	7%	1.97E+01	50%	3.75E-01	1%	3.98E+01
95	9.43E-01	6%	6.48E+00	39%	1.35E+00	8%	7.48E+00	45%	2.30E-01	1%	1.65E+01
Cadmium (MT/year)											
5	7.87E+00	8%	4.72E+01	46%	1.03E+01	10%	3.62E+01	35%	7.12E-01	1%	1.02E+02
25	2.71E+00	11%	1.47E+01	61%	3.53E+00	15%	2.91E+00	12%	3.85E-01	2%	2.43E+01
50	1.29E+00	13%	6.56E+00	64%	1.68E+00	16%	5.03E-01	5%	2.51E-01	2%	1.03E+01
75	6.14E-01	13%	2.92E+00	64%	8.01E-01	17%	8.72E-02	2%	1.63E-01	4%	4.59E+00
95	2.11E-01	14%	9.11E-01	61%	2.75E-01	18%	6.99E-03	<1%	8.83E-02	6%	1.49E+00
Copper (MT/year)											
5	9.44E+01	12%	2.72E+02	35%	1.21E+02	16%	2.79E+02	36%	1.20E+01	2%	7.78E+02
25	3.94E+01	14%	1.03E+02	38%	3.78E+01	14%	8.70E+01	32%	7.08E+00	3%	2.74E+02
50	2.15E+01	16%	5.25E+01	39%	1.68E+01	13%	3.87E+01	29%	4.89E+00	4%	1.34E+02
75	1.17E+01	18%	2.67E+01	40%	7.49E+00	11%	1.72E+01	26%	3.38E+00	5%	6.66E+01
95	4.89E+00	20%	1.01E+01	41%	2.34E+00	9%	5.38E+00	22%	1.99E+00	8%	2.47E+01
Lead (MT/year)											
5	1.14E+02	5%	1.55E+03	67%	1.12E+02	5%	4.41E+02	19%	8.09E+01	4%	2.29E+03
25	3.73E+01	7%	3.61E+02	68%	3.65E+01	7%	6.97E+01	13%	2.62E+01	5%	5.31E+02
50	1.72E+01	9%	1.31E+02	67%	1.68E+01	9%	1.94E+01	10%	1.20E+01	6%	1.97E+02
75	7.92E+00	11%	4.77E+01	64%	7.74E+00	10%	5.38E+00	7%	5.46E+00	7%	7.42E+01
95	2.59E+00	14%	1.11E+01	59%	2.54E+00	13%	8.51E-01	5%	1.77E+00	9%	1.89E+01
Zinc (MT/year)											
5	4.53E+02	13%	2.04E+03	61%	2.42E+02	7%	5.58E+02	17%	7.49E+01	2%	3.37E+03
25	1.89E+02	15%	7.73E+02	62%	7.56E+01	6%	1.74E+02	14%	3.97E+01	3%	1.25E+03
50	1.03E+02	16%	3.94E+02	62%	3.36E+01	5%	7.75E+01	12%	2.55E+01	4%	6.33E+02
75	5.62E+01	17%	2.00E+02	62%	1.50E+01	5%	3.45E+01	11%	1.64E+01	5%	3.23E+02
95	2.35E+01	19%	7.60E+01	61%	4.67E+00	4%	1.08E+01	9%	8.70E+00	7%	1.24E+02
Mercury (kg/year)											
5	2.03E+03	31%	1.55E+03	23%	6.32E+02	10%	2.28E+03	35%	1.01E+02	2%	6.59E+03
25	4.73E+02	32%	3.61E+02	24%	9.07E+01	6%	5.33E+02	36%	3.08E+01	2%	1.49E+03
50	1.72E+02	32%	1.31E+02	25%	2.35E+01	4%	1.94E+02	36%	1.35E+01	3%	5.34E+02
75	6.25E+01	32%	4.77E+01	25%	6.11E+00	3%	7.04E+01	37%	5.89E+00	3%	1.93E+02
95	1.46E+01	33%	1.11E+01	25%	8.78E-01	2%	1.64E+01	37%	1.79E+00	4%	4.48E+01
Total PCBs (kg/year)											
5	6.92E+02	6%	7.04E+03	64%	9.03E+02	8%	2.37E+03	22%	No studies were available to characterize total PCBs in highway runoff		1.10E+04
25	9.94E+01	7%	1.01E+03	70%	1.30E+02	9%	2.09E+02	14%			1.45E+03
50	2.58E+01	7%	2.62E+02	73%	3.36E+01	9%	3.87E+01	11%			3.61E+02
75	6.69E+00	7%	6.81E+01	75%	8.73E+00	10%	7.17E+00	8%			9.07E+01
95	9.61E-01	8%	9.78E+00	77%	1.25E+00	10%	6.34E-01	5%			1.26E+01
Total PBDEs (g/year)											
5	4.61E+02	3%	6.19E+03	35%	2.71E+03	15%	8.31E+03	47%	No studies were available to characterize total PBDEs in highway runoff		1.77E+04
25	6.63E+01	2%	1.44E+03	47%	3.89E+02	13%	1.19E+03	39%			3.09E+03
50	1.72E+01	2%	5.25E+02	55%	1.01E+02	11%	3.10E+02	33%			9.53E+02
75	4.46E+00	1%	1.91E+02	63%	2.62E+01	9%	8.04E+01	27%			3.02E+02
95	6.41E-01	1%	4.45E+01	74%	3.76E+00	6%	1.15E+01	19%			6.05E+01
Carcinogenic PAHs (MT/year)											
5	1.01E+01	22%	2.32E+01	50%	5.95E+00	13%	6.24E+00	13%	8.72E-01	2%	4.64E+01
25	2.36E+00	23%	5.41E+00	52%	1.39E+00	13%	8.95E-01	9%	3.83E-01	4%	1.04E+01
50	8.60E-01	23%	1.97E+00	52%	5.05E-01	13%	2.32E-01	6%	2.16E-01	6%	3.78E+00
75	3.13E-01	22%	7.15E-01	51%	1.83E-01	13%	6.03E-02	4%	1.22E-01	9%	1.39E+00
95	7.29E-02	21%	1.67E-01	48%	4.28E-02	12%	8.66E-03	3%	5.35E-02	16%	3.45E-01

Table C-1 (continued). Loading Rates for the Entire Puget Sound Basin by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	8.11E+00	24%	1.55E+01	46%	3.97E+00	12%	5.20E+00	16%	5.73E-01	2%	3.33E+01
25	1.89E+00	26%	3.61E+00	49%	9.25E-01	13%	7.46E-01	10%	2.16E-01	3%	7.39E+00
50	6.88E-01	26%	1.31E+00	50%	3.36E-01	13%	1.94E-01	7%	1.09E-01	4%	2.64E+00
75	2.50E-01	26%	4.77E-01	50%	1.22E-01	13%	5.02E-02	5%	5.53E-02	6%	9.55E-01
95	5.83E-02	26%	1.11E-01	49%	2.85E-02	13%	7.22E-03	3%	2.08E-02	9%	2.26E-01
Low MW PAHs (MT/year)											
5	3.04E+01	29%	4.64E+01	44%	1.19E+01	11%	1.56E+01	15%	5.10E-02	<1%	1.04E+02
25	7.09E+00	31%	1.08E+01	47%	2.78E+00	12%	2.24E+00	10%	3.44E-02	<1%	2.30E+01
50	2.58E+00	32%	3.94E+00	48%	1.01E+00	12%	5.81E-01	7%	2.62E-02	<1%	8.13E+00
75	9.38E-01	32%	1.43E+00	49%	3.67E-01	13%	1.51E-01	5%	1.99E-02	1%	2.91E+00
95	2.19E-01	32%	3.34E-01	50%	8.56E-02	13%	2.16E-02	3%	1.34E-02	2%	6.73E-01
bis(2-Ethylhexyl)phthalate (MT/year)											
5	2.31E+02	5%	3.52E+03	72%	9.03E+02	18%	2.37E+02	5%	4.95E+00	<1%	4.90E+03
25	3.31E+01	5%	5.06E+02	73%	1.30E+02	19%	2.09E+01	3%	2.89E+00	<1%	6.92E+02
50	8.60E+00	5%	1.31E+02	73%	3.36E+01	19%	3.87E+00	2%	1.98E+00	1%	1.79E+02
75	2.23E+00	5%	3.40E+01	72%	8.73E+00	19%	7.17E-01	2%	1.36E+00	3%	4.71E+01
95	3.20E-01	4%	4.89E+00	67%	1.25E+00	17%	6.34E-02	1%	7.96E-01	11%	7.32E+00
Total Dioxin TEQs (g/year)											
5	2.31E+02	9%	1.76E+03	66%	4.51E+02	17%	2.37E+02	9%	No studies were available to characterize total dioxin TEQs in highway runoff		2.68E+03
25	3.31E+01	9%	2.53E+02	68%	6.48E+01	17%	2.09E+01	6%			3.72E+02
50	8.60E+00	9%	6.56E+01	69%	1.68E+01	18%	3.87E+00	4%			9.49E+01
75	2.23E+00	9%	1.70E+01	70%	4.36E+00	18%	7.17E-01	3%			2.43E+01
95	3.20E-01	9%	2.44E+00	71%	6.27E-01	18%	6.34E-02	2%			3.45E+00
DDT and Metabolites (kg/year)											
5	4.61E+00	<1%	3.52E+02	9%	5.42E+02	13%	3.12E+03	78%	No studies were available to characterize DDT and metabolites in highway runoff		4.02E+03
25	6.63E-01	<1%	5.06E+01	9%	7.78E+01	13%	4.48E+02	78%			5.77E+02
50	1.72E-01	<1%	1.31E+01	9%	2.02E+01	13%	1.16E+02	78%			1.50E+02
75	4.46E-02	<1%	3.40E+00	9%	5.24E+00	13%	3.01E+01	78%			3.88E+01
95	6.41E-03	<1%	4.89E-01	9%	7.52E-01	13%	4.33E+00	78%			5.58E+00
Triclopyr (MT/year)											
5	1.58E+00	7%	1.06E+01	49%	5.42E+00	25%	4.16E+00	19%	No studies were available to characterize triclopyr in highway runoff		2.17E+01
25	1.39E-01	5%	1.52E+00	50%	7.78E-01	26%	5.97E-01	20%			3.03E+00
50	2.58E-02	3%	3.94E-01	51%	2.02E-01	26%	1.55E-01	20%			7.76E-01
75	4.78E-03	2%	1.02E-01	51%	5.24E-02	26%	4.02E-02	20%			1.99E-01
95	4.22E-04	1%	1.47E-02	52%	7.52E-03	27%	5.77E-03	20%			2.84E-02
Nonylphenol (MT/year)											
5	9.23E+01	31%	1.06E+02	35%	2.71E+01	9%	7.10E+01	24%	5.07E+00	2%	3.01E+02
25	1.33E+01	32%	1.52E+01	37%	3.89E+00	9%	6.27E+00	15%	2.51E+00	6%	4.11E+01
50	3.44E+00	31%	3.94E+00	36%	1.01E+00	9%	1.16E+00	10%	1.54E+00	14%	1.11E+01
75	8.92E-01	27%	1.02E+00	31%	2.62E-01	8%	2.15E-01	6%	9.44E-01	28%	3.33E+00
95	1.28E-01	16%	1.47E-01	18%	3.76E-02	5%	1.90E-02	2%	4.67E-01	58%	7.98E-01
TPH (MT/year)											
5	2.27E+04	5%	2.83E+05	63%	3.97E+04	9%	1.04E+05	23%	1.93E+03	<1%	4.51E+05
25	9.46E+03	8%	8.84E+04	72%	9.25E+03	8%	1.49E+04	12%	9.59E+02	1%	1.23E+05
50	5.16E+03	10%	3.94E+04	75%	3.36E+03	6%	3.87E+03	7%	5.90E+02	1%	5.23E+04
75	2.81E+03	12%	1.75E+04	76%	1.22E+03	5%	1.00E+03	4%	3.62E+02	2%	2.29E+04
95	1.17E+03	16%	5.47E+03	75%	2.85E+02	4%	1.44E+02	2%	1.80E+02	2%	7.25E+03

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-2. Loading Rates for the Main Basin Study Area by Land Use Category

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.77E+00	12%	1.01E+01	71%	8.41E-02	1%	2.19E+00	15%	5.22E-02	<1%	1.42E+01
25	8.14E-01	13%	4.41E+00	72%	3.87E-02	1%	8.32E-01	14%	3.19E-02	1%	6.13E+00
50	4.75E-01	14%	2.49E+00	72%	2.25E-02	1%	4.24E-01	12%	2.27E-02	1%	3.43E+00
75	2.73E-01	14%	1.40E+00	73%	1.31E-02	1%	2.16E-01	11%	1.61E-02	1%	1.92E+00
95	1.30E-01	15%	6.14E-01	73%	6.05E-03	1%	8.18E-02	10%	9.88E-03	1%	8.42E-01
Cadmium (MT/year)											
5	1.09E+00	18%	4.47E+00	74%	4.59E-02	1%	3.97E-01	7%	3.07E-02	1%	6.03E+00
25	3.74E-01	20%	1.40E+00	76%	1.58E-02	1%	3.18E-02	2%	1.66E-02	1%	1.83E+00
50	1.78E-01	22%	6.21E-01	75%	7.52E-03	1%	5.51E-03	1%	1.08E-02	1%	8.23E-01
75	8.48E-02	23%	2.77E-01	74%	3.58E-03	1%	9.54E-04	<1%	7.03E-03	2%	3.73E-01
95	2.92E-02	24%	8.63E-02	72%	1.23E-03	1%	7.65E-05	<1%	3.80E-03	3%	1.21E-01
Copper (MT/year)											
5	1.30E+01	30%	2.58E+01	60%	5.41E-01	1%	3.05E+00	7%	5.18E-01	1%	4.29E+01
25	5.45E+00	33%	9.76E+00	59%	1.69E-01	1%	9.52E-01	6%	3.05E-01	2%	1.66E+01
50	2.97E+00	34%	4.97E+00	57%	7.52E-02	1%	4.24E-01	5%	2.10E-01	2%	8.65E+00
75	1.62E+00	36%	2.53E+00	56%	3.35E-02	1%	1.89E-01	4%	1.46E-01	3%	4.52E+00
95	6.75E-01	38%	9.60E-01	54%	1.04E-02	1%	5.89E-02	3%	8.55E-02	5%	1.79E+00
Lead (MT/year)											
5	1.57E+01	9%	1.47E+02	86%	4.98E-01	<1%	4.82E+00	3%	3.48E+00	2%	1.71E+02
25	5.16E+00	12%	3.42E+01	83%	1.63E-01	<1%	7.63E-01	2%	1.13E+00	3%	4.14E+01
50	2.37E+00	15%	1.24E+01	80%	7.52E-02	<1%	2.12E-01	1%	5.14E-01	3%	1.56E+01
75	1.09E+00	18%	4.52E+00	76%	3.46E-02	1%	5.88E-02	1%	2.35E-01	4%	5.94E+00
95	3.58E-01	24%	1.05E+00	70%	1.13E-02	1%	9.30E-03	1%	7.60E-02	5%	1.51E+00
Zinc (MT/year)											
5	6.26E+01	24%	1.93E+02	73%	1.08E+00	<1%	6.10E+00	2%	3.23E+00	1%	2.66E+02
25	2.61E+01	25%	7.32E+01	71%	3.38E-01	<1%	1.90E+00	2%	1.71E+00	2%	1.03E+02
50	1.42E+01	27%	3.73E+01	70%	1.50E-01	<1%	8.47E-01	2%	1.10E+00	2%	5.36E+01
75	7.76E+00	28%	1.90E+01	68%	6.69E-02	<1%	3.77E-01	1%	7.07E-01	3%	2.79E+01
95	3.24E+00	30%	7.20E+00	66%	2.09E-02	<1%	1.18E-01	1%	3.74E-01	3%	1.10E+01
Mercury (kg/year)											
5	2.80E+02	61%	1.47E+02	32%	2.82E+00	1%	2.50E+01	5%	4.35E+00	1%	4.59E+02
25	6.53E+01	61%	3.42E+01	32%	4.06E-01	<1%	5.83E+00	5%	1.32E+00	1%	1.07E+02
50	2.37E+01	61%	1.24E+01	32%	1.05E-01	<1%	2.12E+00	5%	5.79E-01	1%	3.90E+01
75	8.63E+00	61%	4.52E+00	32%	2.73E-02	<1%	7.70E-01	5%	2.53E-01	2%	1.42E+01
95	2.01E+00	60%	1.05E+00	32%	3.92E-03	<1%	1.80E-01	5%	7.71E-02	2%	3.33E+00
Total PCBs (kg/year)											
5	9.56E+01	12%	6.67E+02	84%	4.03E+00	1%	2.59E+01	3%	No studies were available to characterize total PCBs in highway runoff		7.92E+02
25	1.37E+01	12%	9.58E+01	85%	5.79E-01	1%	2.29E+00	2%			1.12E+02
50	3.56E+00	12%	2.49E+01	86%	1.50E-01	1%	4.24E-01	1%			2.90E+01
75	9.24E-01	12%	6.45E+00	86%	3.90E-02	1%	7.85E-02	1%			7.49E+00
95	1.33E-01	12%	9.26E-01	86%	5.60E-03	1%	6.94E-03	1%			1.07E+00
Total PBDEs (g/year)											
5	6.37E+01	8%	5.86E+02	78%	1.21E+01	2%	9.09E+01	12%	No studies were available to characterize total PBDEs in highway runoff		7.53E+02
25	9.15E+00	6%	1.37E+02	85%	1.74E+00	1%	1.31E+01	8%			1.61E+02
50	2.37E+00	4%	4.97E+01	89%	4.51E-01	1%	3.39E+00	6%			5.59E+01
75	6.16E-01	3%	1.81E+01	92%	1.17E-01	1%	8.79E-01	4%			1.97E+01
95	8.85E-02	2%	4.22E+00	95%	1.68E-02	<1%	1.26E-01	3%			4.45E+00
Carcinogenic PAHs (MT/year)											
5	1.40E+00	38%	2.20E+00	59%	2.66E-02	1%	6.82E-02	2%	3.75E-02	1%	3.73E+00
25	3.26E-01	37%	5.13E-01	59%	6.20E-03	1%	9.79E-03	1%	1.65E-02	2%	8.72E-01
50	1.19E-01	37%	1.86E-01	58%	2.25E-03	1%	2.54E-03	1%	9.29E-03	3%	3.19E-01
75	4.32E-02	37%	6.78E-02	58%	8.20E-04	1%	6.60E-04	1%	5.24E-03	4%	1.18E-01
95	1.01E-02	35%	1.58E-02	56%	1.91E-04	1%	9.47E-05	<1%	2.30E-03	8%	2.85E-02

Table C-2 (continued). Loading Rates for the Main Basin Study Area by Land Use Category

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	1.12E+00	42%	1.47E+00	55%	1.77E-02	1%	5.68E-02	2%	2.47E-02	1%	2.68E+00
25	2.61E-01	42%	3.42E-01	55%	4.13E-03	1%	8.16E-03	1%	9.28E-03	1%	6.25E-01
50	9.50E-02	42%	1.24E-01	55%	1.50E-03	1%	2.12E-03	1%	4.70E-03	2%	2.28E-01
75	3.45E-02	42%	4.52E-02	54%	5.47E-04	1%	5.50E-04	1%	2.38E-03	3%	8.32E-02
95	8.05E-03	41%	1.05E-02	54%	1.28E-04	1%	7.89E-05	<1%	8.95E-04	5%	1.97E-02
Low MW PAHs (MT/year)											
5	4.20E+00	48%	4.40E+00	50%	5.32E-02	1%	1.71E-01	2%	2.19E-03	<1%	8.82E+00
25	9.79E-01	48%	1.03E+00	50%	1.24E-02	1%	2.45E-02	1%	1.48E-03	<1%	2.04E+00
50	3.56E-01	48%	3.73E-01	50%	4.51E-03	1%	6.35E-03	1%	1.13E-03	<1%	7.41E-01
75	1.29E-01	48%	1.36E-01	50%	1.64E-03	1%	1.65E-03	1%	8.57E-04	<1%	2.69E-01
95	3.02E-02	48%	3.16E-02	50%	3.83E-04	1%	2.37E-04	<1%	5.78E-04	1%	6.30E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	3.19E+01	9%	3.33E+02	90%	4.03E+00	1%	2.59E+00	1%	2.13E-01	<1%	3.72E+02
25	4.57E+00	9%	4.79E+01	90%	5.79E-01	1%	2.29E-01	<1%	1.24E-01	<1%	5.34E+01
50	1.19E+00	9%	1.24E+01	89%	1.50E-01	1%	4.24E-02	<1%	8.54E-02	1%	1.39E+01
75	3.08E-01	8%	3.23E+00	89%	3.90E-02	1%	7.85E-03	<1%	5.87E-02	2%	3.64E+00
95	4.42E-02	8%	4.63E-01	85%	5.60E-03	1%	6.94E-04	<1%	3.43E-02	6%	5.48E-01
Total Dioxin TEQs (g/year)											
5	3.19E+01	16%	1.67E+02	82%	2.02E+00	1%	2.59E+00	1%	No studies were available to characterize total dioxin TEQs in highway runoff		2.03E+02
25	4.57E+00	16%	2.39E+01	82%	2.90E-01	1%	2.29E-01	1%			2.90E+01
50	1.19E+00	16%	6.21E+00	83%	7.52E-02	1%	4.24E-02	1%			7.52E+00
75	3.08E-01	16%	1.61E+00	83%	1.95E-02	1%	7.85E-03	<1%			1.95E+00
95	4.42E-02	16%	2.32E-01	83%	2.80E-03	1%	6.94E-04	<1%			2.79E-01
DDT and Metabolites (kg/year)											
5	6.37E-01	1%	3.33E+01	47%	2.42E+00	3%	3.41E+01	48%	No studies were available to characterize DDT and metabolites in highway runoff		7.05E+01
25	9.15E-02	1%	4.79E+00	47%	3.48E-01	3%	4.90E+00	48%			1.01E+01
50	2.37E-02	1%	1.24E+00	47%	9.02E-02	3%	1.27E+00	48%			2.63E+00
75	6.16E-03	1%	3.23E-01	47%	2.34E-02	3%	3.30E-01	48%			6.82E-01
95	8.85E-04	1%	4.63E-02	47%	3.36E-03	3%	4.74E-02	48%			9.79E-02
Triclopyr (MT/year)											
5	2.17E-01	17%	1.00E+00	78%	2.42E-02	2%	4.55E-02	4%	No studies were available to characterize triclopyr in highway runoff		1.29E+00
25	1.92E-02	11%	1.44E-01	83%	3.48E-03	2%	6.53E-03	4%			1.73E-01
50	3.56E-03	8%	3.73E-02	86%	9.02E-04	2%	1.69E-03	4%			4.34E-02
75	6.60E-04	6%	9.68E-03	88%	2.34E-04	2%	4.40E-04	4%			1.10E-02
95	5.83E-05	4%	1.39E-03	90%	3.36E-05	2%	6.31E-05	4%			1.54E-03
Nonylphenol (MT/year)											
5	1.27E+01	53%	1.00E+01	42%	1.21E-01	1%	7.76E-01	3%	2.18E-01	1%	2.39E+01
25	1.83E+00	53%	1.44E+00	42%	1.74E-02	1%	6.86E-02	2%	1.08E-01	3%	3.46E+00
50	4.75E-01	51%	3.73E-01	40%	4.51E-03	<1%	1.27E-02	1%	6.62E-02	7%	9.31E-01
75	1.23E-01	47%	9.68E-02	37%	1.17E-03	<1%	2.35E-03	1%	4.06E-02	15%	2.64E-01
95	1.77E-02	34%	1.39E-02	27%	1.68E-04	<1%	2.08E-04	<1%	2.01E-02	39%	5.21E-02
TPH (MT/year)											
5	3.13E+03	10%	2.68E+04	86%	1.77E+02	1%	1.14E+03	4%	8.31E+01	<1%	3.14E+04
25	1.31E+03	13%	8.38E+03	84%	4.13E+01	<1%	1.63E+02	2%	4.13E+01	<1%	9.93E+03
50	7.12E+02	16%	3.73E+03	82%	1.50E+01	<1%	4.24E+01	1%	2.54E+01	1%	4.52E+03
75	3.88E+02	19%	1.66E+03	80%	5.47E+00	<1%	1.10E+01	1%	1.56E+01	1%	2.08E+03
95	1.62E+02	23%	5.18E+02	75%	1.28E+00	<1%	1.58E+00	<1%	7.75E+00	1%	6.91E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-3. Loading Rates for the Port Gardner Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.97E+00	3%	2.07E+01	34%	2.28E+00	4%	3.49E+01	58%	2.01E-01	<1%	6.00E+01
25	9.08E-01	4%	9.05E+00	37%	1.05E+00	4%	1.32E+01	54%	1.23E-01	1%	2.44E+01
50	5.29E-01	4%	5.10E+00	39%	6.11E-01	5%	6.74E+00	52%	8.74E-02	1%	1.31E+01
75	3.05E-01	4%	2.88E+00	41%	3.56E-01	5%	3.43E+00	49%	6.21E-02	1%	7.03E+00
95	1.45E-01	5%	1.26E+00	43%	1.64E-01	6%	1.30E+00	45%	3.80E-02	1%	2.91E+00
Cadmium (MT/year)											
5	1.21E+00	7%	9.18E+00	51%	1.24E+00	7%	6.31E+00	35%	1.18E-01	1%	1.81E+01
25	4.17E-01	10%	2.87E+00	67%	4.27E-01	10%	5.06E-01	12%	6.37E-02	1%	4.28E+00
50	1.99E-01	11%	1.28E+00	71%	2.04E-01	11%	8.77E-02	5%	4.15E-02	2%	1.81E+00
75	9.45E-02	12%	5.68E-01	71%	9.69E-02	12%	1.52E-02	2%	2.71E-02	3%	8.02E-01
95	3.25E-02	13%	1.77E-01	68%	3.33E-02	13%	1.22E-03	<1%	1.46E-02	6%	2.59E-01
Copper (MT/year)											
5	1.45E+01	11%	5.29E+01	40%	1.47E+01	11%	4.85E+01	37%	1.99E+00	2%	1.33E+02
25	6.07E+00	13%	2.00E+01	43%	4.57E+00	10%	1.51E+01	32%	1.17E+00	2%	4.70E+01
50	3.31E+00	14%	1.02E+01	44%	2.04E+00	9%	6.74E+00	29%	8.10E-01	4%	2.31E+01
75	1.80E+00	16%	5.20E+00	45%	9.06E-01	8%	3.00E+00	26%	5.60E-01	5%	1.15E+01
95	7.53E-01	18%	1.97E+00	46%	2.83E-01	7%	9.37E-01	22%	3.29E-01	8%	4.27E+00
Lead (MT/year)											
5	1.76E+01	4%	3.01E+02	71%	1.35E+01	3%	7.68E+01	18%	1.34E+01	3%	4.22E+02
25	5.75E+00	6%	7.02E+01	72%	4.42E+00	5%	1.21E+01	13%	4.34E+00	4%	9.68E+01
50	2.65E+00	7%	2.55E+01	72%	2.04E+00	6%	3.37E+00	9%	1.98E+00	6%	3.56E+01
75	1.22E+00	9%	9.28E+00	70%	9.37E-01	7%	9.36E-01	7%	9.04E-01	7%	1.33E+01
95	3.99E-01	12%	2.16E+00	65%	3.07E-01	9%	1.48E-01	4%	2.93E-01	9%	3.31E+00
Zinc (MT/year)											
5	6.98E+01	12%	3.97E+02	66%	2.93E+01	5%	9.71E+01	16%	1.24E+01	2%	6.05E+02
25	2.91E+01	13%	1.50E+02	67%	9.15E+00	4%	3.03E+01	13%	6.58E+00	3%	2.25E+02
50	1.59E+01	14%	7.66E+01	67%	4.07E+00	4%	1.35E+01	12%	4.23E+00	4%	1.14E+02
75	8.66E+00	15%	3.90E+01	67%	1.81E+00	3%	6.00E+00	10%	2.72E+00	5%	5.82E+01
95	3.61E+00	16%	1.48E+01	66%	5.66E-01	3%	1.87E+00	8%	1.44E+00	6%	2.23E+01
Mercury (kg/year)											
5	3.12E+02	28%	3.01E+02	27%	7.65E+01	7%	3.98E+02	36%	1.67E+01	2%	1.10E+03
25	7.28E+01	29%	7.02E+01	28%	1.10E+01	4%	9.27E+01	37%	5.09E+00	2%	2.52E+02
50	2.65E+01	29%	2.55E+01	28%	2.85E+00	3%	3.37E+01	37%	2.23E+00	2%	9.08E+01
75	9.62E+00	29%	9.28E+00	28%	7.40E-01	2%	1.23E+01	37%	9.75E-01	3%	3.29E+01
95	2.25E+00	29%	2.16E+00	28%	1.06E-01	1%	2.86E+00	37%	2.97E-01	4%	7.67E+00
Total PCBs (kg/year)											
5	1.07E+02	5%	1.37E+03	69%	1.09E+02	5%	4.12E+02	21%	No studies were available to characterize total PCBs in highway runoff		2.00E+03
25	1.53E+01	6%	1.97E+02	74%	1.57E+01	6%	3.64E+01	14%			2.64E+02
50	3.97E+00	6%	5.10E+01	78%	4.07E+00	6%	6.74E+00	10%			6.58E+01
75	1.03E+00	6%	1.32E+01	80%	1.06E+00	6%	1.25E+00	8%			1.66E+01
95	1.48E-01	6%	1.90E+00	82%	1.52E-01	7%	1.10E-01	5%			2.31E+00
Total PBDEs (g/year)											
5	7.10E+01	2%	1.20E+03	39%	3.28E+02	11%	1.45E+03	47%	No studies were available to characterize total PBDEs in highway runoff		3.05E+03
25	1.02E+01	2%	2.81E+02	51%	4.71E+01	9%	2.08E+02	38%			5.46E+02
50	2.65E+00	2%	1.02E+02	60%	1.22E+01	7%	5.39E+01	32%			1.71E+02
75	6.87E-01	1%	3.71E+01	68%	3.17E+00	6%	1.40E+01	25%			5.50E+01
95	9.86E-02	1%	8.66E+00	77%	4.55E-01	4%	2.01E+00	18%			1.12E+01
Carcinogenic PAHs (MT/year)											
5	1.56E+00	19%	4.51E+00	56%	7.20E-01	9%	1.09E+00	14%	1.44E-01	2%	8.02E+00
25	3.64E-01	20%	1.05E+00	58%	1.68E-01	9%	1.56E-01	9%	6.34E-02	4%	1.80E+00
50	1.32E-01	20%	3.83E-01	59%	6.11E-02	9%	4.05E-02	6%	3.58E-02	5%	6.52E-01
75	4.81E-02	20%	1.39E-01	58%	2.22E-02	9%	1.05E-02	4%	2.02E-02	8%	2.40E-01
95	1.12E-02	19%	3.25E-02	55%	5.18E-03	9%	1.51E-03	3%	8.86E-03	15%	5.92E-02

Table C-3 (continued). Loading Rates for the Port Gardner Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	1.25E+00	22%	3.01E+00	52%	4.80E-01	8%	9.05E-01	16%	9.50E-02	2%	5.74E+00
25	2.91E-01	23%	7.02E-01	55%	1.12E-01	9%	1.30E-01	10%	3.57E-02	3%	1.27E+00
50	1.06E-01	23%	2.55E-01	56%	4.07E-02	9%	3.37E-02	7%	1.81E-02	4%	4.54E-01
75	3.85E-02	23%	9.28E-02	57%	1.48E-02	9%	8.75E-03	5%	9.16E-03	6%	1.64E-01
95	8.98E-03	23%	2.16E-02	56%	3.45E-03	9%	1.26E-03	3%	3.44E-03	9%	3.88E-02
Low MW PAHs (MT/year)											
5	4.68E+00	26%	9.03E+00	51%	1.44E+00	8%	2.71E+00	15%	8.45E-03	<1%	1.79E+01
25	1.09E+00	28%	2.11E+00	54%	3.36E-01	9%	3.90E-01	10%	5.70E-03	<1%	3.93E+00
50	3.97E-01	29%	7.66E-01	55%	1.22E-01	9%	1.01E-01	7%	4.34E-03	<1%	1.39E+00
75	1.44E-01	29%	2.78E-01	56%	4.44E-02	9%	2.62E-02	5%	3.30E-03	1%	4.97E-01
95	3.37E-02	29%	6.49E-02	56%	1.04E-02	9%	3.77E-03	3%	2.23E-03	2%	1.15E-01
bis(2-Ethylhexyl)phthalate (MT/year)											
5	3.55E+01	4%	6.85E+02	79%	1.09E+02	13%	4.12E+01	5%	8.19E-01	<1%	8.72E+02
25	5.10E+00	4%	9.83E+01	80%	1.57E+01	13%	3.64E+00	3%	4.78E-01	<1%	1.23E+02
50	1.32E+00	4%	2.55E+01	80%	4.07E+00	13%	6.74E-01	2%	3.29E-01	1%	3.19E+01
75	3.43E-01	4%	6.62E+00	79%	1.06E+00	13%	1.25E-01	1%	2.26E-01	3%	8.37E+00
95	4.93E-02	4%	9.51E-01	73%	1.52E-01	12%	1.10E-02	1%	1.32E-01	10%	1.29E+00
Total Dioxin TEQs (g/year)											
5	3.55E+01	7%	3.42E+02	72%	5.46E+01	12%	4.12E+01	9%	No studies were available to characterize total dioxin TEQs in highway runoff		4.74E+02
25	5.10E+00	8%	4.92E+01	75%	7.84E+00	12%	3.64E+00	6%			6.58E+01
50	1.32E+00	8%	1.28E+01	76%	2.04E+00	12%	6.74E-01	4%			1.68E+01
75	3.43E-01	8%	3.31E+00	77%	5.28E-01	12%	1.25E-01	3%			4.31E+00
95	4.93E-02	8%	4.75E-01	78%	7.59E-02	12%	1.10E-02	2%			6.12E-01
DDT and Metabolites (kg/year)											
5	7.10E-01	<1%	6.85E+01	10%	6.56E+01	10%	5.43E+02	80%	No studies were available to characterize DDT and metabolites in highway runoff		6.78E+02
25	1.02E-01	<1%	9.83E+00	10%	9.41E+00	10%	7.80E+01	80%			9.73E+01
50	2.65E-02	<1%	2.55E+00	10%	2.44E+00	10%	2.02E+01	80%			2.52E+01
75	6.87E-03	<1%	6.62E-01	10%	6.34E-01	10%	5.25E+00	80%			6.55E+00
95	9.86E-04	<1%	9.51E-02	10%	9.10E-02	10%	7.54E-01	80%			9.41E-01
Triclopyr (MT/year)											
5	2.43E-01	7%	2.05E+00	56%	6.56E-01	18%	7.24E-01	20%	No studies were available to characterize triclopyr in highway runoff		3.68E+00
25	2.14E-02	4%	2.95E-01	57%	9.41E-02	18%	1.04E-01	20%			5.15E-01
50	3.97E-03	3%	7.66E-02	58%	2.44E-02	19%	2.70E-02	20%			1.32E-01
75	7.35E-04	2%	1.99E-02	59%	6.34E-03	19%	7.00E-03	21%			3.39E-02
95	6.50E-05	1%	2.85E-03	59%	9.10E-04	19%	1.01E-03	21%			4.83E-03
Nonylphenol (MT/year)											
5	1.42E+01	28%	2.05E+01	40%	3.28E+00	6%	1.24E+01	24%	8.39E-01	2%	5.12E+01
25	2.04E+00	29%	2.95E+00	42%	4.71E-01	7%	1.09E+00	16%	4.15E-01	6%	6.97E+00
50	5.29E-01	28%	7.66E-01	41%	1.22E-01	7%	2.02E-01	11%	2.55E-01	14%	1.87E+00
75	1.37E-01	24%	1.99E-01	35%	3.17E-02	6%	3.75E-02	7%	1.56E-01	28%	5.62E-01
95	1.97E-02	15%	2.85E-02	21%	4.55E-03	3%	3.31E-03	2%	7.74E-02	58%	1.33E-01
TPH (MT/year)											
5	3.49E+03	4%	5.51E+04	67%	4.80E+03	6%	1.81E+04	22%	3.20E+02	<1%	8.18E+04
25	1.46E+03	6%	1.72E+04	76%	1.12E+03	5%	2.60E+03	12%	1.59E+02	1%	2.25E+04
50	7.94E+02	8%	7.66E+03	80%	4.07E+02	4%	6.74E+02	7%	9.76E+01	1%	9.63E+03
75	4.33E+02	10%	3.41E+03	81%	1.48E+02	4%	1.75E+02	4%	6.00E+01	1%	4.22E+03
95	1.81E+02	14%	1.06E+03	80%	3.45E+01	3%	2.51E+01	2%	2.98E+01	2%	1.33E+03

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-4. Loading Rates for the Elliott Bay Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	2.21E+00	20%	5.55E+00	51%	3.38E-01	3%	2.83E+00	26%	5.38E-02	<1%	1.10E+01
25	1.01E+00	22%	2.43E+00	52%	1.56E-01	3%	1.07E+00	23%	3.29E-02	1%	4.71E+00
50	5.92E-01	23%	1.37E+00	52%	9.07E-02	3%	5.46E-01	21%	2.34E-02	1%	2.62E+00
75	3.41E-01	23%	7.72E-01	53%	5.29E-02	4%	2.78E-01	19%	1.66E-02	1%	1.46E+00
95	1.62E-01	25%	3.39E-01	53%	2.43E-02	4%	1.05E-01	16%	1.02E-02	2%	6.41E-01
Cadmium (MT/year)											
5	1.35E+00	30%	2.47E+00	54%	1.85E-01	4%	5.11E-01	11%	3.16E-02	1%	4.55E+00
25	4.66E-01	34%	7.70E-01	57%	6.35E-02	5%	4.10E-02	3%	1.71E-02	1%	1.36E+00
50	2.22E-01	36%	3.43E-01	56%	3.02E-02	5%	7.10E-03	1%	1.11E-02	2%	6.13E-01
75	1.06E-01	38%	1.53E-01	54%	1.44E-02	5%	1.23E-03	<1%	7.25E-03	3%	2.81E-01
95	3.63E-02	39%	4.76E-02	51%	4.95E-03	5%	9.87E-05	<1%	3.92E-03	4%	9.29E-02
Copper (MT/year)											
5	1.62E+01	44%	1.42E+01	38%	2.18E+00	6%	3.93E+00	11%	5.34E-01	1%	3.71E+01
25	6.79E+00	47%	5.38E+00	37%	6.79E-01	5%	1.23E+00	9%	3.14E-01	2%	1.44E+01
50	3.70E+00	49%	2.74E+00	37%	3.02E-01	4%	5.46E-01	7%	2.17E-01	3%	7.50E+00
75	2.02E+00	51%	1.40E+00	35%	1.35E-01	3%	2.43E-01	6%	1.50E-01	4%	3.94E+00
95	8.41E-01	53%	5.29E-01	34%	4.20E-02	3%	7.59E-02	5%	8.82E-02	6%	1.58E+00
Lead (MT/year)											
5	1.96E+01	17%	8.08E+01	72%	2.00E+00	2%	6.22E+00	6%	3.59E+00	3%	1.12E+02
25	6.43E+00	23%	1.88E+01	67%	6.56E-01	2%	9.84E-01	4%	1.16E+00	4%	2.81E+01
50	2.96E+00	27%	6.85E+00	63%	3.02E-01	3%	2.73E-01	3%	5.30E-01	5%	1.09E+01
75	1.36E+00	32%	2.49E+00	58%	1.39E-01	3%	7.59E-02	2%	2.42E-01	6%	4.31E+00
95	4.46E-01	38%	5.81E-01	50%	4.56E-02	4%	1.20E-02	1%	7.84E-02	7%	1.16E+00
Zinc (MT/year)											
5	7.80E+01	39%	1.06E+02	53%	4.35E+00	2%	7.87E+00	4%	3.32E+00	2%	2.00E+02
25	3.26E+01	41%	4.04E+01	51%	1.36E+00	2%	2.46E+00	3%	1.76E+00	2%	7.85E+01
50	1.77E+01	43%	2.06E+01	50%	6.04E-01	1%	1.09E+00	3%	1.13E+00	3%	4.11E+01
75	9.67E+00	45%	1.05E+01	48%	2.69E-01	1%	4.87E-01	2%	7.28E-01	3%	2.16E+01
95	4.04E+00	47%	3.97E+00	46%	8.40E-02	1%	1.52E-01	2%	3.86E-01	4%	8.63E+00
Mercury (kg/year)											
5	3.49E+02	73%	8.08E+01	17%	1.14E+01	2%	3.22E+01	7%	4.48E+00	1%	4.78E+02
25	8.14E+01	73%	1.88E+01	17%	1.63E+00	1%	7.52E+00	7%	1.36E+00	1%	1.11E+02
50	2.96E+01	74%	6.85E+00	17%	4.23E-01	1%	2.73E+00	7%	5.97E-01	1%	4.02E+01
75	1.08E+01	74%	2.49E+00	17%	1.10E-01	1%	9.93E-01	7%	2.61E-01	2%	1.46E+01
95	2.51E+00	73%	5.81E-01	17%	1.58E-02	<1%	2.32E-01	7%	7.95E-02	2%	3.42E+00
Total PCBs (kg/year)											
5	1.19E+02	22%	3.68E+02	69%	1.62E+01	3%	3.34E+01	6%	No studies were available to characterize total PCBs in highway runoff		5.36E+02
25	1.71E+01	23%	5.28E+01	70%	2.33E+00	3%	2.95E+00	4%			7.52E+01
50	4.44E+00	23%	1.37E+01	71%	6.04E-01	3%	5.46E-01	3%			1.93E+01
75	1.15E+00	23%	3.56E+00	72%	1.57E-01	3%	1.01E-01	2%			4.97E+00
95	1.65E-01	23%	5.11E-01	72%	2.25E-02	3%	8.95E-03	1%			7.08E-01
Total PBDEs (g/year)											
5	7.94E+01	14%	3.23E+02	57%	4.87E+01	9%	1.17E+02	21%	No studies were available to characterize total PBDEs in highway runoff		5.69E+02
25	1.14E+01	10%	7.54E+01	68%	6.99E+00	6%	1.68E+01	15%			1.11E+02
50	2.96E+00	8%	2.74E+01	75%	1.81E+00	5%	4.37E+00	12%			3.66E+01
75	7.68E-01	6%	9.97E+00	81%	4.71E-01	4%	1.13E+00	9%			1.23E+01
95	1.10E-01	4%	2.32E+00	87%	6.76E-02	3%	1.63E-01	6%			2.67E+00
Carcinogenic PAHs (MT/year)											
5	1.74E+00	55%	1.21E+00	38%	1.07E-01	3%	8.80E-02	3%	3.87E-02	1%	3.19E+00
25	4.07E-01	55%	2.83E-01	38%	2.49E-02	3%	1.26E-02	2%	1.70E-02	2%	7.44E-01
50	1.48E-01	54%	1.03E-01	38%	9.07E-03	3%	3.28E-03	1%	9.58E-03	4%	2.73E-01
75	5.38E-02	53%	3.74E-02	37%	3.30E-03	3%	8.51E-04	1%	5.40E-03	5%	1.01E-01
95	1.25E-02	51%	8.72E-03	36%	7.69E-04	3%	1.22E-04	<1%	2.37E-03	10%	2.45E-02

Table C-4 (continued). Loading Rates for the Elliott Bay Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	1.40E+00	59%	8.08E-01	34%	7.13E-02	3%	7.33E-02	3%	2.54E-02	1%	2.37E+00
25	3.25E-01	59%	1.88E-01	34%	1.66E-02	3%	1.05E-02	2%	9.56E-03	2%	5.51E-01
50	1.18E-01	59%	6.85E-02	34%	6.04E-03	3%	2.73E-03	1%	4.84E-03	2%	2.00E-01
75	4.30E-02	59%	2.49E-02	34%	2.20E-03	3%	7.09E-04	1%	2.45E-03	3%	7.33E-02
95	1.00E-02	58%	5.81E-03	33%	5.13E-04	3%	1.02E-04	1%	9.22E-04	5%	1.74E-02
Low MW PAHs (MT/year)											
5	5.23E+00	65%	2.42E+00	30%	2.14E-01	3%	2.20E-01	3%	2.26E-03	<1%	8.09E+00
25	1.22E+00	65%	5.65E-01	30%	4.99E-02	3%	3.16E-02	2%	1.53E-03	<1%	1.87E+00
50	4.44E-01	66%	2.06E-01	30%	1.81E-02	3%	8.20E-03	1%	1.16E-03	<1%	6.77E-01
75	1.61E-01	66%	7.47E-02	30%	6.59E-03	3%	2.13E-03	1%	8.83E-04	<1%	2.46E-01
95	3.76E-02	65%	1.74E-02	30%	1.54E-03	3%	3.05E-04	1%	5.96E-04	1%	5.75E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	3.97E+01	16%	1.84E+02	76%	1.62E+01	7%	3.34E+00	1%	2.19E-01	<1%	2.43E+02
25	5.70E+00	16%	2.64E+01	76%	2.33E+00	7%	2.95E-01	1%	1.28E-01	<1%	3.49E+01
50	1.48E+00	16%	6.85E+00	75%	6.04E-01	7%	5.46E-02	1%	8.80E-02	1%	9.08E+00
75	3.84E-01	16%	1.78E+00	74%	1.57E-01	7%	1.01E-02	<1%	6.05E-02	3%	2.39E+00
95	5.51E-02	15%	2.55E-01	69%	2.25E-02	6%	8.95E-04	<1%	3.53E-02	10%	3.69E-01
Total Dioxin TEQs (g/year)											
5	3.97E+01	28%	9.19E+01	64%	8.11E+00	6%	3.34E+00	2%	No studies were available to characterize total dioxin TEQs in highway runoff		1.43E+02
25	5.70E+00	28%	1.32E+01	65%	1.16E+00	6%	2.95E-01	1%			2.04E+01
50	1.48E+00	28%	3.43E+00	65%	3.02E-01	6%	5.46E-02	1%			5.26E+00
75	3.84E-01	28%	8.89E-01	65%	7.84E-02	6%	1.01E-02	1%			1.36E+00
95	5.51E-02	28%	1.28E-01	65%	1.13E-02	6%	8.95E-04	<1%			1.95E-01
DDT and Metabolites (kg/year)											
5	7.94E-01	1%	1.84E+01	25%	9.73E+00	13%	4.40E+01	60%	No studies were available to characterize DDT and metabolites in highway runoff		7.29E+01
25	1.14E-01	1%	2.64E+00	25%	1.40E+00	13%	6.32E+00	60%			1.05E+01
50	2.96E-02	1%	6.85E-01	25%	3.63E-01	13%	1.64E+00	60%			2.72E+00
75	7.68E-03	1%	1.78E-01	25%	9.41E-02	13%	4.25E-01	60%			7.05E-01
95	1.10E-03	1%	2.55E-02	25%	1.35E-02	13%	6.11E-02	60%			1.01E-01
Triclopyr (MT/year)											
5	2.71E-01	28%	5.52E-01	56%	9.73E-02	10%	5.87E-02	6%	No studies were available to characterize triclopyr in highway runoff		9.79E-01
25	2.40E-02	19%	7.92E-02	63%	1.40E-02	11%	8.42E-03	7%			1.26E-01
50	4.44E-03	14%	2.06E-02	67%	3.63E-03	12%	2.19E-03	7%			3.08E-02
75	8.22E-04	11%	5.33E-03	70%	9.41E-04	12%	5.67E-04	7%			7.66E-03
95	7.26E-05	7%	7.66E-04	73%	1.35E-04	13%	8.15E-05	8%			1.06E-03
Nonylphenol (MT/year)											
5	1.59E+01	69%	5.52E+00	24%	4.87E-01	2%	1.00E+00	4%	2.25E-01	1%	2.31E+01
25	2.28E+00	68%	7.92E-01	24%	6.99E-02	2%	8.85E-02	3%	1.11E-01	3%	3.34E+00
50	5.92E-01	66%	2.06E-01	23%	1.81E-02	2%	1.64E-02	2%	6.82E-02	8%	9.00E-01
75	1.54E-01	60%	5.33E-02	21%	4.71E-03	2%	3.04E-03	1%	4.18E-02	16%	2.56E-01
95	2.20E-02	43%	7.66E-03	15%	6.76E-04	1%	2.68E-04	1%	2.07E-02	40%	5.14E-02
TPH (MT/year)											
5	3.90E+03	19%	1.48E+04	71%	7.13E+02	3%	1.47E+03	7%	8.56E+01	<1%	2.10E+04
25	1.63E+03	24%	4.62E+03	69%	1.66E+02	2%	2.11E+02	3%	4.25E+01	1%	6.67E+03
50	8.87E+02	29%	2.06E+03	67%	6.04E+01	2%	5.46E+01	2%	2.61E+01	1%	3.08E+03
75	4.84E+02	33%	9.15E+02	63%	2.20E+01	2%	1.42E+01	1%	1.61E+01	1%	1.45E+03
95	2.02E+02	40%	2.86E+02	57%	5.13E+00	1%	2.04E+00	<1%	7.98E+00	2%	5.03E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-5. Loading Rates for the Commencement Bay Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.64E+00	8%	9.18E+00	44%	6.01E-01	3%	9.18E+00	44%	7.76E-02	<1%	2.07E+01
25	7.53E-01	9%	4.02E+00	47%	2.76E-01	3%	3.48E+00	41%	4.75E-02	1%	8.58E+00
50	4.39E-01	9%	2.27E+00	49%	1.61E-01	3%	1.77E+00	38%	3.38E-02	1%	4.67E+00
75	2.53E-01	10%	1.28E+00	50%	9.40E-02	4%	9.03E-01	35%	2.40E-02	1%	2.55E+00
95	1.20E-01	11%	5.60E-01	52%	4.32E-02	4%	3.42E-01	32%	1.47E-02	1%	1.08E+00
Cadmium (MT/year)											
5	1.01E+00	14%	4.08E+00	57%	3.28E-01	5%	1.66E+00	23%	4.56E-02	1%	7.12E+00
25	3.46E-01	18%	1.27E+00	67%	1.13E-01	6%	1.33E-01	7%	2.46E-02	1%	1.89E+00
50	1.65E-01	20%	5.67E-01	69%	5.37E-02	7%	2.30E-02	3%	1.61E-02	2%	8.24E-01
75	7.84E-02	21%	2.52E-01	68%	2.56E-02	7%	3.99E-03	1%	1.05E-02	3%	3.71E-01
95	2.70E-02	22%	7.87E-02	65%	8.80E-03	7%	3.20E-04	<1%	5.65E-03	5%	1.20E-01
Copper (MT/year)											
5	1.21E+01	23%	2.35E+01	44%	3.87E+00	7%	1.28E+01	24%	7.71E-01	1%	5.29E+01
25	5.03E+00	26%	8.90E+00	45%	1.21E+00	6%	3.98E+00	20%	4.53E-01	2%	1.96E+01
50	2.74E+00	28%	4.53E+00	46%	5.37E-01	5%	1.77E+00	18%	3.13E-01	3%	9.90E+00
75	1.50E+00	30%	2.31E+00	46%	2.39E-01	5%	7.89E-01	16%	2.16E-01	4%	5.05E+00
95	6.24E-01	32%	8.75E-01	45%	7.46E-02	4%	2.46E-01	13%	1.27E-01	7%	1.95E+00
Lead (MT/year)											
5	1.46E+01	8%	1.34E+02	75%	3.56E+00	2%	2.02E+01	11%	5.18E+00	3%	1.77E+02
25	4.77E+00	11%	3.12E+01	74%	1.17E+00	3%	3.19E+00	8%	1.68E+00	4%	4.20E+01
50	2.19E+00	14%	1.13E+01	72%	5.37E-01	3%	8.86E-01	6%	7.65E-01	5%	1.57E+01
75	1.01E+00	17%	4.12E+00	69%	2.47E-01	4%	2.46E-01	4%	3.49E-01	6%	5.98E+00
95	3.31E-01	22%	9.62E-01	63%	8.10E-02	5%	3.89E-02	3%	1.13E-01	7%	1.53E+00
Zinc (MT/year)											
5	5.79E+01	21%	1.76E+02	65%	7.74E+00	3%	2.55E+01	9%	4.80E+00	2%	2.72E+02
25	2.42E+01	23%	6.68E+01	64%	2.41E+00	2%	7.96E+00	8%	2.54E+00	2%	1.04E+02
50	1.32E+01	25%	3.40E+01	64%	1.07E+00	2%	3.54E+00	7%	1.63E+00	3%	5.34E+01
75	7.18E+00	26%	1.73E+01	63%	4.78E-01	2%	1.58E+00	6%	1.05E+00	4%	2.76E+01
95	3.00E+00	28%	6.57E+00	61%	1.49E-01	1%	4.92E-01	5%	5.57E-01	5%	1.08E+01
Mercury (kg/year)											
5	2.59E+02	49%	1.34E+02	26%	2.02E+01	4%	1.04E+02	20%	6.47E+00	1%	5.24E+02
25	6.04E+01	50%	3.12E+01	26%	2.90E+00	2%	2.44E+01	20%	1.97E+00	2%	1.21E+02
50	2.19E+01	50%	1.13E+01	26%	7.52E-01	2%	8.86E+00	20%	8.61E-01	2%	4.38E+01
75	7.98E+00	50%	4.12E+00	26%	1.95E-01	1%	3.22E+00	20%	3.77E-01	2%	1.59E+01
95	1.86E+00	50%	9.62E-01	26%	2.80E-02	1%	7.52E-01	20%	1.15E-01	3%	3.72E+00
Total PCBs (kg/year)											
5	8.84E+01	11%	6.08E+02	73%	2.88E+01	3%	1.08E+02	13%	No studies were available to characterize total PCBs in highway runoff		8.34E+02
25	1.27E+01	11%	8.74E+01	77%	4.14E+00	4%	9.57E+00	8%			1.14E+02
50	3.29E+00	11%	2.27E+01	79%	1.07E+00	4%	1.77E+00	6%			2.88E+01
75	8.54E-01	12%	5.88E+00	80%	2.79E-01	4%	3.28E-01	4%			7.35E+00
95	1.23E-01	12%	8.45E-01	82%	4.00E-02	4%	2.90E-02	3%			1.04E+00
Total PBDEs (g/year)											
5	5.89E+01	6%	5.35E+02	50%	8.65E+01	8%	3.80E+02	36%	No studies were available to characterize total PBDEs in highway runoff		1.06E+03
25	8.46E+00	4%	1.25E+02	62%	1.24E+01	6%	5.46E+01	27%			2.00E+02
50	2.19E+00	3%	4.53E+01	70%	3.22E+00	5%	1.42E+01	22%			6.49E+01
75	5.70E-01	3%	1.65E+01	76%	8.37E-01	4%	3.68E+00	17%			2.16E+01
95	8.18E-02	2%	3.85E+00	84%	1.20E-01	3%	5.28E-01	12%			4.58E+00
Carcinogenic PAHs (MT/year)											
5	1.29E+00	34%	2.00E+00	52%	1.90E-01	5%	2.85E-01	7%	5.58E-02	1%	3.83E+00
25	3.02E-01	34%	4.68E-01	53%	4.43E-02	5%	4.10E-02	5%	2.45E-02	3%	8.79E-01
50	1.10E-01	34%	1.70E-01	53%	1.61E-02	5%	1.06E-02	3%	1.38E-02	4%	3.20E-01
75	3.99E-02	34%	6.18E-02	52%	5.86E-03	5%	2.76E-03	2%	7.80E-03	7%	1.18E-01
95	9.31E-03	32%	1.44E-02	50%	1.37E-03	5%	3.96E-04	1%	3.42E-03	12%	2.89E-02

Table C-5 (continued). Loading Rates for the Commencement Bay Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	1.04E+00	37%	1.34E+00	48%	1.27E-01	5%	2.38E-01	9%	3.67E-02	1%	2.77E+00
25	2.41E-01	38%	3.12E-01	49%	2.96E-02	5%	3.41E-02	5%	1.38E-02	2%	6.31E-01
50	8.78E-02	39%	1.13E-01	50%	1.07E-02	5%	8.86E-03	4%	6.99E-03	3%	2.28E-01
75	3.19E-02	39%	4.12E-02	50%	3.91E-03	5%	2.30E-03	3%	3.54E-03	4%	8.29E-02
95	7.45E-03	38%	9.62E-03	49%	9.11E-04	5%	3.30E-04	2%	1.33E-03	7%	1.96E-02
Low MW PAHs (MT/year)											
5	3.88E+00	43%	4.01E+00	45%	3.80E-01	4%	7.13E-01	8%	3.26E-03	<1%	8.99E+00
25	9.06E-01	45%	9.35E-01	46%	8.87E-02	4%	1.02E-01	5%	2.20E-03	<1%	2.03E+00
50	3.29E-01	45%	3.40E-01	47%	3.22E-02	4%	2.66E-02	4%	1.68E-03	<1%	7.30E-01
75	1.20E-01	45%	1.24E-01	47%	1.17E-02	4%	6.90E-03	3%	1.27E-03	<1%	2.63E-01
95	2.79E-02	46%	2.88E-02	47%	2.73E-03	4%	9.91E-04	2%	8.60E-04	1%	6.14E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	2.95E+01	8%	3.04E+02	81%	2.88E+01	8%	1.08E+01	3%	3.17E-01	<1%	3.74E+02
25	4.23E+00	8%	4.37E+01	82%	4.14E+00	8%	9.57E-01	2%	1.85E-01	<1%	5.32E+01
50	1.10E+00	8%	1.13E+01	82%	1.07E+00	8%	1.77E-01	1%	1.27E-01	1%	1.38E+01
75	2.85E-01	8%	2.94E+00	81%	2.79E-01	8%	3.28E-02	1%	8.73E-02	2%	3.63E+00
95	4.09E-02	7%	4.22E-01	76%	4.00E-02	7%	2.90E-03	1%	5.10E-02	9%	5.57E-01
Total Dioxin TEQs (g/year)											
5	2.95E+01	14%	1.52E+02	74%	1.44E+01	7%	1.08E+01	5%	No studies were available to characterize total dioxin TEQs in highway runoff		2.07E+02
25	4.23E+00	15%	2.18E+01	75%	2.07E+00	7%	9.57E-01	3%			2.91E+01
50	1.10E+00	15%	5.67E+00	76%	5.37E-01	7%	1.77E-01	2%			7.48E+00
75	2.85E-01	15%	1.47E+00	76%	1.39E-01	7%	3.28E-02	2%			1.93E+00
95	4.09E-02	15%	2.11E-01	77%	2.00E-02	7%	2.90E-03	1%			2.75E-01
DDT and Metabolites (kg/year)											
5	5.89E-01	<1%	3.04E+01	16%	1.73E+01	9%	1.43E+02	75%	No studies were available to characterize DDT and metabolites in highway runoff		1.91E+02
25	8.46E-02	<1%	4.37E+00	16%	2.48E+00	9%	2.05E+01	75%			2.74E+01
50	2.19E-02	<1%	1.13E+00	16%	6.45E-01	9%	5.32E+00	75%			7.12E+00
75	5.70E-03	<1%	2.94E-01	16%	1.67E-01	9%	1.38E+00	75%			1.85E+00
95	8.18E-04	<1%	4.22E-02	16%	2.40E-02	9%	1.98E-01	75%			2.65E-01
Triclopyr (MT/year)											
5	2.01E-01	14%	9.13E-01	62%	1.73E-01	12%	1.90E-01	13%	No studies were available to characterize triclopyr in highway runoff		1.48E+00
25	1.78E-02	9%	1.31E-01	65%	2.48E-02	12%	2.73E-02	14%			2.01E-01
50	3.29E-03	6%	3.40E-02	67%	6.45E-03	13%	7.09E-03	14%			5.08E-02
75	6.10E-04	5%	8.83E-03	68%	1.67E-03	13%	1.84E-03	14%			1.29E-02
95	5.39E-05	3%	1.27E-03	69%	2.40E-04	13%	2.64E-04	14%			1.83E-03
Nonylphenol (MT/year)											
5	1.18E+01	46%	9.13E+00	36%	8.65E-01	3%	3.25E+00	13%	3.24E-01	1%	2.53E+01
25	1.69E+00	47%	1.31E+00	37%	1.24E-01	3%	2.87E-01	8%	1.61E-01	4%	3.57E+00
50	4.39E-01	46%	3.40E-01	35%	3.22E-02	3%	5.32E-02	6%	9.85E-02	10%	9.63E-01
75	1.14E-01	41%	8.83E-02	31%	8.37E-03	3%	9.85E-03	4%	6.04E-02	22%	2.81E-01
95	1.64E-02	27%	1.27E-02	21%	1.20E-03	2%	8.71E-04	1%	2.99E-02	49%	6.10E-02
TPH (MT/year)											
5	2.89E+03	9%	2.45E+04	73%	1.27E+03	4%	4.76E+03	14%	1.24E+02	<1%	3.35E+04
25	1.21E+03	12%	7.64E+03	77%	2.96E+02	3%	6.83E+02	7%	6.14E+01	1%	9.89E+03
50	6.58E+02	15%	3.40E+03	78%	1.07E+02	2%	1.77E+02	4%	3.77E+01	1%	4.38E+03
75	3.59E+02	18%	1.51E+03	76%	3.91E+01	2%	4.60E+01	2%	2.32E+01	1%	1.98E+03
95	1.50E+02	23%	4.72E+02	73%	9.11E+00	1%	6.60E+00	1%	1.15E+01	2%	6.50E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-6. Loading Rates for the South Sound (East) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.08E+00	6%	9.21E+00	51%	8.15E-01	5%	6.73E+00	38%	6.86E-02	<1%	1.79E+01
25	4.95E-01	7%	4.04E+00	54%	3.75E-01	5%	2.55E+00	34%	4.20E-02	1%	7.50E+00
50	2.88E-01	7%	2.28E+00	55%	2.19E-01	5%	1.30E+00	32%	2.99E-02	1%	4.11E+00
75	1.66E-01	7%	1.28E+00	57%	1.27E-01	6%	6.62E-01	29%	2.12E-02	1%	2.26E+00
95	7.91E-02	8%	5.62E-01	58%	5.86E-02	6%	2.51E-01	26%	1.30E-02	1%	9.64E-01
Cadmium (MT/year)											
5	6.61E-01	10%	4.10E+00	63%	4.45E-01	7%	1.22E+00	19%	4.03E-02	1%	6.46E+00
25	2.27E-01	13%	1.28E+00	72%	1.53E-01	9%	9.75E-02	5%	2.18E-02	1%	1.78E+00
50	1.08E-01	14%	5.69E-01	73%	7.28E-02	9%	1.69E-02	2%	1.42E-02	2%	7.81E-01
75	5.15E-02	15%	2.53E-01	72%	3.47E-02	10%	2.92E-03	1%	9.25E-03	3%	3.52E-01
95	1.77E-02	16%	7.91E-02	69%	1.19E-02	10%	2.35E-04	<1%	5.00E-03	4%	1.14E-01
Copper (MT/year)											
5	7.92E+00	17%	2.36E+01	50%	5.24E+00	11%	9.35E+00	20%	6.81E-01	1%	4.68E+01
25	3.31E+00	19%	8.94E+00	52%	1.64E+00	10%	2.92E+00	17%	4.00E-01	2%	1.72E+01
50	1.80E+00	21%	4.55E+00	53%	7.28E-01	8%	1.30E+00	15%	2.77E-01	3%	8.66E+00
75	9.82E-01	22%	2.32E+00	53%	3.24E-01	7%	5.78E-01	13%	1.91E-01	4%	4.40E+00
95	4.10E-01	24%	8.79E-01	52%	1.01E-01	6%	1.80E-01	11%	1.12E-01	7%	1.68E+00
Lead (MT/year)											
5	9.56E+00	6%	1.34E+02	80%	4.83E+00	3%	1.48E+01	9%	4.58E+00	3%	1.68E+02
25	3.13E+00	8%	3.13E+01	79%	1.58E+00	4%	2.34E+00	6%	1.48E+00	4%	3.98E+01
50	1.44E+00	10%	1.14E+01	76%	7.28E-01	5%	6.50E-01	4%	6.76E-01	5%	1.49E+01
75	6.64E-01	12%	4.14E+00	74%	3.35E-01	6%	1.80E-01	3%	3.09E-01	5%	5.63E+00
95	2.18E-01	15%	9.65E-01	68%	1.10E-01	8%	2.85E-02	2%	1.00E-01	7%	1.42E+00
Zinc (MT/year)											
5	3.80E+01	15%	1.77E+02	71%	1.05E+01	4%	1.87E+01	8%	4.24E+00	2%	2.48E+02
25	1.59E+01	17%	6.70E+01	71%	3.27E+00	3%	5.84E+00	6%	2.25E+00	2%	9.43E+01
50	8.65E+00	18%	3.41E+01	71%	1.46E+00	3%	2.60E+00	5%	1.45E+00	3%	4.83E+01
75	4.72E+00	19%	1.74E+01	70%	6.48E-01	3%	1.16E+00	5%	9.29E-01	4%	2.48E+01
95	1.97E+00	20%	6.59E+00	69%	2.02E-01	2%	3.61E-01	4%	4.92E-01	5%	9.62E+00
Mercury (kg/year)											
5	1.70E+02	41%	1.34E+02	32%	2.74E+01	7%	7.66E+01	19%	5.72E+00	1%	4.14E+02
25	3.97E+01	42%	3.13E+01	33%	3.93E+00	4%	1.79E+01	19%	1.74E+00	2%	9.45E+01
50	1.44E+01	42%	1.14E+01	33%	1.02E+00	3%	6.50E+00	19%	7.61E-01	2%	3.41E+01
75	5.24E+00	42%	4.14E+00	34%	2.65E-01	2%	2.36E+00	19%	3.33E-01	3%	1.23E+01
95	1.22E+00	42%	9.65E-01	34%	3.80E-02	1%	5.51E-01	19%	1.01E-01	4%	2.88E+00
Total PCBs (kg/year)											
5	5.81E+01	7%	6.11E+02	78%	3.91E+01	5%	7.93E+01	10%	No studies were available to characterize total PCBs in highway runoff		7.87E+02
25	8.34E+00	8%	8.77E+01	81%	5.61E+00	5%	7.01E+00	6%			1.09E+02
50	2.16E+00	8%	2.28E+01	82%	1.46E+00	5%	1.30E+00	5%			2.77E+01
75	5.61E-01	8%	5.91E+00	83%	3.78E-01	5%	2.41E-01	3%			7.09E+00
95	8.06E-02	8%	8.48E-01	84%	5.43E-02	5%	2.13E-02	2%			1.00E+00
Total PBDEs (g/year)											
5	3.87E+01	4%	5.37E+02	55%	1.17E+02	12%	2.79E+02	29%	No studies were available to characterize total PBDEs in highway runoff		9.72E+02
25	5.56E+00	3%	1.25E+02	67%	1.68E+01	9%	4.00E+01	21%			1.88E+02
50	1.44E+00	2%	4.55E+01	74%	4.37E+00	7%	1.04E+01	17%			6.17E+01
75	3.74E-01	2%	1.66E+01	80%	1.13E+00	5%	2.70E+00	13%			2.08E+01
95	5.37E-02	1%	3.86E+00	86%	1.63E-01	4%	3.87E-01	9%			4.47E+00
Carcinogenic PAHs (MT/year)											
5	8.50E-01	25%	2.01E+00	60%	2.58E-01	8%	2.09E-01	6%	4.93E-02	1%	3.38E+00
25	1.98E-01	25%	4.70E-01	60%	6.01E-02	8%	3.00E-02	4%	2.17E-02	3%	7.80E-01
50	7.21E-02	25%	1.71E-01	60%	2.19E-02	8%	7.79E-03	3%	1.22E-02	4%	2.85E-01
75	2.62E-02	25%	6.21E-02	59%	7.94E-03	8%	2.02E-03	2%	6.90E-03	7%	1.05E-01
95	6.12E-03	24%	1.45E-02	56%	1.85E-03	7%	2.90E-04	1%	3.03E-03	12%	2.58E-02

Table C-6 (continued). Loading Rates for the South Sound (East) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	6.80E-01	28%	1.34E+00	56%	1.72E-01	7%	1.74E-01	7%	3.24E-02	1%	2.40E+00
25	1.59E-01	29%	3.13E-01	57%	4.01E-02	7%	2.50E-02	5%	1.22E-02	2%	5.49E-01
50	5.77E-02	29%	1.14E-01	57%	1.46E-02	7%	6.50E-03	3%	6.18E-03	3%	1.99E-01
75	2.10E-02	29%	4.14E-02	57%	5.30E-03	7%	1.69E-03	2%	3.13E-03	4%	7.25E-02
95	4.89E-03	28%	9.65E-03	56%	1.24E-03	7%	2.42E-04	1%	1.18E-03	7%	1.72E-02
Low MW PAHs (MT/year)											
5	2.55E+00	33%	4.03E+00	53%	5.15E-01	7%	5.23E-01	7%	2.89E-03	<1%	7.62E+00
25	5.95E-01	34%	9.39E-01	54%	1.20E-01	7%	7.51E-02	4%	1.95E-03	<1%	1.73E+00
50	2.16E-01	35%	3.41E-01	55%	4.37E-02	7%	1.95E-02	3%	1.48E-03	<1%	6.22E-01
75	7.87E-02	35%	1.24E-01	55%	1.59E-02	7%	5.06E-03	2%	1.13E-03	1%	2.25E-01
95	1.83E-02	35%	2.90E-02	55%	3.71E-03	7%	7.26E-04	1%	7.60E-04	1%	5.25E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	1.94E+01	5%	3.05E+02	82%	3.91E+01	11%	7.93E+00	2%	2.80E-01	<1%	3.72E+02
25	2.78E+00	5%	4.39E+01	83%	5.61E+00	11%	7.01E-01	1%	1.63E-01	<1%	5.31E+01
50	7.21E-01	5%	1.14E+01	82%	1.46E+00	11%	1.30E-01	1%	1.12E-01	1%	1.38E+01
75	1.87E-01	5%	2.95E+00	82%	3.78E-01	10%	2.41E-02	1%	7.72E-02	2%	3.62E+00
95	2.69E-02	5%	4.24E-01	77%	5.43E-02	10%	2.13E-03	<1%	4.51E-02	8%	5.52E-01
Total Dioxin TEQs (g/year)											
5	1.94E+01	10%	1.53E+02	77%	1.95E+01	10%	7.93E+00	4%	No studies were available to characterize total dioxin TEQs in highway runoff		2.00E+02
25	2.78E+00	10%	2.19E+01	78%	2.81E+00	10%	7.01E-01	2%			2.82E+01
50	7.21E-01	10%	5.69E+00	78%	7.28E-01	10%	1.30E-01	2%			7.27E+00
75	1.87E-01	10%	1.48E+00	79%	1.89E-01	10%	2.41E-02	1%			1.88E+00
95	2.69E-02	10%	2.12E-01	79%	2.71E-02	10%	2.13E-03	1%			2.68E-01
DDT and Metabolites (kg/year)											
5	3.87E-01	<1%	3.05E+01	19%	2.35E+01	15%	1.05E+02	66%	No studies were available to characterize DDT and metabolites in highway runoff		1.59E+02
25	5.56E-02	<1%	4.39E+00	19%	3.37E+00	15%	1.50E+01	66%			2.28E+01
50	1.44E-02	<1%	1.14E+00	19%	8.74E-01	15%	3.90E+00	66%			5.92E+00
75	3.74E-03	<1%	2.95E-01	19%	2.27E-01	15%	1.01E+00	66%			1.54E+00
95	5.37E-04	<1%	4.24E-02	19%	3.26E-02	15%	1.45E-01	66%			2.21E-01
Triclopyr (MT/year)											
5	1.32E-01	9%	9.16E-01	64%	2.35E-01	16%	1.39E-01	10%	No studies were available to characterize triclopyr in highway runoff		1.42E+00
25	1.17E-02	6%	1.32E-01	67%	3.37E-02	17%	2.00E-02	10%			1.97E-01
50	2.16E-03	4%	3.41E-02	68%	8.74E-03	17%	5.20E-03	10%			5.02E-02
75	4.01E-04	3%	8.86E-03	69%	2.27E-03	18%	1.35E-03	10%			1.29E-02
95	3.54E-05	2%	1.27E-03	70%	3.26E-04	18%	1.94E-04	11%			1.83E-03
Nonylphenol (MT/year)											
5	7.74E+00	37%	9.16E+00	44%	1.17E+00	6%	2.38E+00	11%	2.87E-01	1%	2.07E+01
25	1.11E+00	38%	1.32E+00	45%	1.68E-01	6%	2.10E-01	7%	1.42E-01	5%	2.95E+00
50	2.88E-01	36%	3.41E-01	43%	4.37E-02	5%	3.90E-02	5%	8.71E-02	11%	8.00E-01
75	7.49E-02	32%	8.86E-02	38%	1.13E-02	5%	7.22E-03	3%	5.34E-02	23%	2.35E-01
95	1.07E-02	21%	1.27E-02	24%	1.63E-03	3%	6.38E-04	1%	2.64E-02	51%	5.22E-02
TPH (MT/year)											
5	1.90E+03	6%	2.46E+04	77%	1.72E+03	5%	3.49E+03	11%	1.09E+02	<1%	3.18E+04
25	7.94E+02	8%	7.67E+03	81%	4.01E+02	4%	5.01E+02	5%	5.43E+01	1%	9.42E+03
50	4.33E+02	10%	3.41E+03	82%	1.46E+02	4%	1.30E+02	3%	3.34E+01	1%	4.16E+03
75	2.36E+02	13%	1.52E+03	82%	5.30E+01	3%	3.37E+01	2%	2.05E+01	1%	1.86E+03
95	9.85E+01	16%	4.74E+02	79%	1.24E+01	2%	4.84E+00	1%	1.02E+01	2%	6.00E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-7. Loading Rates for the South Sound (West) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	3.79E-01	4%	4.47E+00	49%	2.15E-01	2%	4.07E+00	44%	4.53E-02	<1%	9.17E+00
25	1.75E-01	5%	1.96E+00	52%	9.88E-02	3%	1.54E+00	41%	2.77E-02	1%	3.80E+00
50	1.02E-01	5%	1.10E+00	53%	5.76E-02	3%	7.85E-01	38%	1.97E-02	1%	2.07E+00
75	5.86E-02	5%	6.22E-01	55%	3.36E-02	3%	4.00E-01	35%	1.40E-02	1%	1.13E+00
95	2.79E-02	6%	2.73E-01	57%	1.54E-02	3%	1.52E-01	32%	8.58E-03	2%	4.76E-01
Cadmium (MT/year)											
5	2.33E-01	8%	1.99E+00	64%	1.17E-01	4%	7.35E-01	24%	2.66E-02	1%	3.10E+00
25	8.02E-02	10%	6.20E-01	76%	4.03E-02	5%	5.90E-02	7%	1.44E-02	2%	8.13E-01
50	3.82E-02	11%	2.76E-01	78%	1.92E-02	5%	1.02E-02	3%	9.37E-03	3%	3.53E-01
75	1.82E-02	12%	1.23E-01	78%	9.14E-03	6%	1.77E-03	1%	6.10E-03	4%	1.58E-01
95	6.25E-03	12%	3.83E-02	75%	3.14E-03	6%	1.42E-04	<1%	3.30E-03	6%	5.12E-02
Copper (MT/year)											
5	2.80E+00	13%	1.14E+01	53%	1.38E+00	6%	5.65E+00	26%	4.50E-01	2%	2.17E+01
25	1.17E+00	15%	4.33E+00	54%	4.31E-01	5%	1.76E+00	22%	2.64E-01	3%	7.96E+00
50	6.36E-01	16%	2.21E+00	55%	1.92E-01	5%	7.85E-01	20%	1.83E-01	5%	4.00E+00
75	3.47E-01	17%	1.12E+00	55%	8.54E-02	4%	3.50E-01	17%	1.26E-01	6%	2.03E+00
95	1.45E-01	19%	4.26E-01	55%	2.67E-02	3%	1.09E-01	14%	7.42E-02	10%	7.81E-01
Lead (MT/year)											
5	3.37E+00	4%	6.50E+01	80%	1.27E+00	2%	8.94E+00	11%	3.02E+00	4%	8.17E+01
25	1.11E+00	6%	1.52E+01	79%	4.17E-01	2%	1.41E+00	7%	9.78E-01	5%	1.91E+01
50	5.09E-01	7%	5.52E+00	78%	1.92E-01	3%	3.93E-01	6%	4.46E-01	6%	7.06E+00
75	2.34E-01	9%	2.01E+00	76%	8.84E-02	3%	1.09E-01	4%	2.04E-01	8%	2.64E+00
95	7.68E-02	12%	4.68E-01	71%	2.90E-02	4%	1.72E-02	3%	6.60E-02	10%	6.57E-01
Zinc (MT/year)											
5	1.34E+01	12%	8.57E+01	74%	2.76E+00	2%	1.13E+01	10%	2.80E+00	2%	1.16E+02
25	5.60E+00	13%	3.25E+01	74%	8.62E-01	2%	3.53E+00	8%	1.48E+00	3%	4.40E+01
50	3.05E+00	14%	1.66E+01	74%	3.84E-01	2%	1.57E+00	7%	9.54E-01	4%	2.25E+01
75	1.66E+00	14%	8.43E+00	73%	1.71E-01	1%	6.99E-01	6%	6.13E-01	5%	1.16E+01
95	6.95E-01	15%	3.19E+00	71%	5.33E-02	1%	2.18E-01	5%	3.25E-01	7%	4.49E+00
Mercury (kg/year)											
5	6.00E+01	33%	6.50E+01	36%	7.21E+00	4%	4.63E+01	25%	3.77E+00	2%	1.82E+02
25	1.40E+01	33%	1.52E+01	36%	1.04E+00	2%	1.08E+01	26%	1.15E+00	3%	4.22E+01
50	5.09E+00	33%	5.52E+00	36%	2.69E-01	2%	3.93E+00	26%	5.03E-01	3%	1.53E+01
75	1.85E+00	33%	2.01E+00	36%	6.97E-02	1%	1.43E+00	26%	2.20E-01	4%	5.57E+00
95	4.32E-01	33%	4.68E-01	36%	1.00E-02	1%	3.33E-01	25%	6.69E-02	5%	1.31E+00
Total PCBs (kg/year)											
5	2.05E+01	5%	2.96E+02	79%	1.03E+01	3%	4.80E+01	13%	No studies were available to characterize total PCBs in highway runoff		3.75E+02
25	2.94E+00	6%	4.25E+01	83%	1.48E+00	3%	4.24E+00	8%			5.12E+01
50	7.63E-01	6%	1.10E+01	85%	3.84E-01	3%	7.85E-01	6%			1.30E+01
75	1.98E-01	6%	2.86E+00	87%	9.96E-02	3%	1.45E-01	4%			3.31E+00
95	2.84E-02	6%	4.11E-01	88%	1.43E-02	3%	1.29E-02	3%			4.67E-01
Total PBDEs (g/year)											
5	1.37E+01	3%	2.60E+02	55%	3.09E+01	7%	1.69E+02	36%	No studies were available to characterize total PBDEs in highway runoff		4.73E+02
25	1.96E+00	2%	6.07E+01	66%	4.44E+00	5%	2.42E+01	27%			9.13E+01
50	5.09E-01	2%	2.21E+01	74%	1.15E+00	4%	6.28E+00	21%			3.00E+01
75	1.32E-01	1%	8.02E+00	80%	2.99E-01	3%	1.63E+00	16%			1.01E+01
95	1.90E-02	1%	1.87E+00	86%	4.29E-02	2%	2.34E-01	11%			2.17E+00
Carcinogenic PAHs (MT/year)											
5	3.00E-01	20%	9.76E-01	65%	6.79E-02	5%	1.26E-01	8%	3.26E-02	2%	1.50E+00
25	7.00E-02	20%	2.28E-01	66%	1.58E-02	5%	1.82E-02	5%	1.43E-02	4%	3.46E-01
50	2.54E-02	20%	8.28E-02	65%	5.76E-03	5%	4.71E-03	4%	8.07E-03	6%	1.27E-01
75	9.25E-03	20%	3.01E-02	64%	2.09E-03	4%	1.22E-03	3%	4.55E-03	10%	4.72E-02
95	2.16E-03	18%	7.02E-03	59%	4.88E-04	4%	1.76E-04	1%	2.00E-03	17%	1.18E-02

Table C-7 (continued). Loading Rates for the South Sound (West) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	2.40E-01	23%	6.50E-01	61%	4.53E-02	4%	1.05E-01	10%	2.14E-02	2%	1.06E+00
25	5.60E-02	23%	1.52E-01	63%	1.06E-02	4%	1.51E-02	6%	8.05E-03	3%	2.41E-01
50	2.04E-02	23%	5.52E-02	63%	3.84E-03	4%	3.93E-03	4%	4.08E-03	5%	8.74E-02
75	7.40E-03	23%	2.01E-02	63%	1.40E-03	4%	1.02E-03	3%	2.07E-03	6%	3.19E-02
95	1.73E-03	23%	4.68E-03	61%	3.26E-04	4%	1.46E-04	2%	7.77E-04	10%	7.65E-03
Low MW PAHs (MT/year)											
5	9.00E-01	27%	1.95E+00	59%	1.36E-01	4%	3.16E-01	10%	1.90E-03	<1%	3.31E+00
25	2.10E-01	28%	4.55E-01	61%	3.17E-02	4%	4.54E-02	6%	1.29E-03	<1%	7.44E-01
50	7.63E-02	29%	1.66E-01	62%	1.15E-02	4%	1.18E-02	4%	9.78E-04	<1%	2.66E-01
75	2.78E-02	29%	6.02E-02	63%	4.19E-03	4%	3.06E-03	3%	7.44E-04	1%	9.59E-02
95	6.47E-03	29%	1.40E-02	63%	9.77E-04	4%	4.39E-04	2%	5.02E-04	2%	2.24E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	6.83E+00	4%	1.48E+02	87%	1.03E+01	6%	4.80E+00	3%	1.85E-01	<1%	1.70E+02
25	9.81E-01	4%	2.13E+01	88%	1.48E+00	6%	4.24E-01	2%	1.08E-01	<1%	2.43E+01
50	2.54E-01	4%	5.52E+00	87%	3.84E-01	6%	7.85E-02	1%	7.41E-02	1%	6.31E+00
75	6.60E-02	4%	1.43E+00	86%	9.96E-02	6%	1.45E-02	1%	5.10E-02	3%	1.66E+00
95	9.48E-03	4%	2.06E-01	79%	1.43E-02	5%	1.29E-03	<1%	2.97E-02	11%	2.60E-01
Total Dioxin TEQs (g/year)											
5	6.83E+00	8%	7.40E+01	82%	5.15E+00	6%	4.80E+00	5%	No studies were available to characterize total dioxin TEQs in highway runoff		9.08E+01
25	9.81E-01	8%	1.06E+01	83%	7.40E-01	6%	4.24E-01	3%			1.28E+01
50	2.54E-01	8%	2.76E+00	84%	1.92E-01	6%	7.85E-02	2%			3.28E+00
75	6.60E-02	8%	7.16E-01	85%	4.98E-02	6%	1.45E-02	2%			8.46E-01
95	9.48E-03	8%	1.03E-01	85%	7.15E-03	6%	1.29E-03	1%			1.21E-01
DDT and Metabolites (kg/year)											
5	1.37E-01	<1%	1.48E+01	18%	6.18E+00	7%	6.32E+01	75%	No studies were available to characterize DDT and metabolites in highway runoff		8.43E+01
25	1.96E-02	<1%	2.13E+00	18%	8.88E-01	7%	9.08E+00	75%			1.21E+01
50	5.09E-03	<1%	5.52E-01	18%	2.30E-01	7%	2.36E+00	75%			3.14E+00
75	1.32E-03	<1%	1.43E-01	18%	5.98E-02	7%	6.11E-01	75%			8.16E-01
95	1.90E-04	<1%	2.06E-02	18%	8.58E-03	7%	8.78E-02	75%			1.17E-01
Triclopyr (MT/year)											
5	4.66E-02	7%	4.44E-01	70%	6.18E-02	10%	8.43E-02	13%	No studies were available to characterize triclopyr in highway runoff		6.37E-01
25	4.12E-03	5%	6.38E-02	72%	8.88E-03	10%	1.21E-02	14%			8.89E-02
50	7.63E-04	3%	1.66E-02	73%	2.30E-03	10%	3.14E-03	14%			2.28E-02
75	1.41E-04	2%	4.29E-03	73%	5.98E-04	10%	8.15E-04	14%			5.85E-03
95	1.25E-05	2%	6.17E-04	74%	8.58E-05	10%	1.17E-04	14%			8.32E-04
Nonylphenol (MT/year)											
5	2.73E+00	30%	4.44E+00	49%	3.09E-01	3%	1.44E+00	16%	1.89E-01	2%	9.11E+00
25	3.92E-01	30%	6.38E-01	49%	4.44E-02	3%	1.27E-01	10%	9.37E-02	7%	1.30E+00
50	1.02E-01	28%	1.66E-01	46%	1.15E-02	3%	2.36E-02	7%	5.75E-02	16%	3.60E-01
75	2.64E-02	24%	4.29E-02	38%	2.99E-03	3%	4.36E-03	4%	3.52E-02	31%	1.12E-01
95	3.79E-03	13%	6.17E-03	22%	4.29E-04	2%	3.86E-04	1%	1.74E-02	62%	2.82E-02
TPH (MT/year)											
5	6.71E+02	4%	1.19E+04	78%	4.53E+02	3%	2.11E+03	14%	7.21E+01	<1%	1.52E+04
25	2.80E+02	6%	3.72E+03	84%	1.06E+02	2%	3.03E+02	7%	3.58E+01	1%	4.44E+03
50	1.53E+02	8%	1.66E+03	85%	3.84E+01	2%	7.85E+01	4%	2.20E+01	1%	1.95E+03
75	8.32E+01	10%	7.37E+02	85%	1.40E+01	2%	2.04E+01	2%	1.35E+01	2%	8.68E+02
95	3.47E+01	13%	2.30E+02	83%	3.26E+00	1%	2.93E+00	1%	6.72E+00	2%	2.78E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-8. Loading Rates for the Hood Canal (South) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	5.82E-02	<1%	4.08E+00	18%	8.40E-02	<1%	1.88E+01	81%	6.27E-02	<1%	2.31E+01
25	2.68E-02	<1%	1.79E+00	20%	3.86E-02	<1%	7.13E+00	79%	3.84E-02	<1%	9.02E+00
50	1.56E-02	<1%	1.01E+00	21%	2.25E-02	<1%	3.63E+00	77%	2.73E-02	1%	4.70E+00
75	8.98E-03	<1%	5.67E-01	23%	1.31E-02	1%	1.85E+00	75%	1.94E-02	1%	2.46E+00
95	4.29E-03	<1%	2.49E-01	26%	6.04E-03	1%	7.01E-01	72%	1.19E-02	1%	9.72E-01
Cadmium (MT/year)											
5	3.57E-02	1%	1.81E+00	34%	4.59E-02	1%	3.40E+00	64%	3.68E-02	1%	5.33E+00
25	1.23E-02	1%	5.65E-01	64%	1.58E-02	2%	2.73E-01	31%	1.99E-02	2%	8.86E-01
50	5.85E-03	2%	2.52E-01	77%	7.51E-03	2%	4.72E-02	15%	1.30E-02	4%	3.25E-01
75	2.79E-03	2%	1.12E-01	83%	3.58E-03	3%	8.17E-03	6%	8.45E-03	6%	1.35E-01
95	9.58E-04	2%	3.50E-02	83%	1.23E-03	3%	6.55E-04	2%	4.57E-03	11%	4.24E-02
Copper (MT/year)											
5	4.29E-01	1%	1.04E+01	27%	5.41E-01	1%	2.61E+01	68%	6.23E-01	2%	3.82E+01
25	1.79E-01	1%	3.95E+00	31%	1.69E-01	1%	8.15E+00	64%	3.66E-01	3%	1.28E+01
50	9.75E-02	2%	2.01E+00	33%	7.51E-02	1%	3.63E+00	60%	2.53E-01	4%	6.07E+00
75	5.32E-02	2%	1.03E+00	35%	3.34E-02	1%	1.62E+00	56%	1.75E-01	6%	2.90E+00
95	2.22E-02	2%	3.89E-01	38%	1.04E-02	1%	5.04E-01	49%	1.03E-01	10%	1.03E+00
Lead (MT/year)											
5	5.17E-01	<1%	5.94E+01	56%	4.98E-01	<1%	4.13E+01	39%	4.18E+00	4%	1.06E+02
25	1.70E-01	1%	1.38E+01	63%	1.63E-01	1%	6.54E+00	30%	1.35E+00	6%	2.21E+01
50	7.80E-02	1%	5.03E+00	66%	7.51E-02	1%	1.81E+00	24%	6.18E-01	8%	7.62E+00
75	3.59E-02	1%	1.83E+00	68%	3.46E-02	1%	5.04E-01	19%	2.82E-01	11%	2.69E+00
95	1.18E-02	2%	4.27E-01	69%	1.13E-02	2%	7.97E-02	13%	9.14E-02	15%	6.21E-01
Zinc (MT/year)											
5	2.06E+00	1%	7.82E+01	57%	1.08E+00	1%	5.23E+01	38%	3.88E+00	3%	1.38E+02
25	8.59E-01	2%	2.96E+01	60%	3.37E-01	1%	1.63E+01	33%	2.05E+00	4%	4.92E+01
50	4.68E-01	2%	1.51E+01	62%	1.50E-01	1%	7.26E+00	30%	1.32E+00	5%	2.43E+01
75	2.55E-01	2%	7.69E+00	64%	6.69E-02	1%	3.23E+00	27%	8.49E-01	7%	1.21E+01
95	1.07E-01	2%	2.92E+00	65%	2.09E-02	<1%	1.01E+00	22%	4.50E-01	10%	4.50E+00
Mercury (kg/year)											
5	9.20E+00	3%	5.94E+01	20%	2.82E+00	1%	2.14E+02	74%	5.23E+00	2%	2.91E+02
25	2.15E+00	3%	1.38E+01	20%	4.05E-01	1%	4.99E+01	74%	1.59E+00	2%	6.79E+01
50	7.80E-01	3%	5.03E+00	20%	1.05E-01	<1%	1.81E+01	73%	6.96E-01	3%	2.48E+01
75	2.84E-01	3%	1.83E+00	20%	2.73E-02	<1%	6.60E+00	73%	3.05E-01	3%	9.04E+00
95	6.62E-02	3%	4.27E-01	20%	3.92E-03	<1%	1.54E+00	72%	9.27E-02	4%	2.13E+00
Total PCBs (kg/year)											
5	3.14E+00	1%	2.70E+02	54%	4.03E+00	1%	2.22E+02	44%	No studies were available to characterize total PCBs in highway runoff		4.99E+02
25	4.51E-01	1%	3.88E+01	65%	5.79E-01	1%	1.96E+01	33%			5.94E+01
50	1.17E-01	1%	1.01E+01	72%	1.50E-01	1%	3.63E+00	26%			1.40E+01
75	3.04E-02	1%	2.61E+00	78%	3.90E-02	1%	6.72E-01	20%			3.35E+00
95	4.36E-03	1%	3.75E-01	84%	5.60E-03	1%	5.94E-02	13%			4.45E-01
Total PBDEs (g/year)											
5	2.09E+00	<1%	2.37E+02	23%	1.21E+01	1%	7.79E+02	76%	No studies were available to characterize total PBDEs in highway runoff		1.03E+03
25	3.01E-01	<1%	5.54E+01	33%	1.74E+00	1%	1.12E+02	66%			1.69E+02
50	7.80E-02	<1%	2.01E+01	41%	4.51E-01	1%	2.90E+01	58%			4.97E+01
75	2.03E-02	<1%	7.32E+00	49%	1.17E-01	1%	7.54E+00	50%			1.50E+01
95	2.91E-03	<1%	1.71E+00	61%	1.68E-02	1%	1.08E+00	39%			2.81E+00
Carcinogenic PAHs (MT/year)											
5	4.60E-02	3%	8.90E-01	56%	2.66E-02	2%	5.84E-01	37%	4.51E-02	3%	1.59E+00
25	1.07E-02	3%	2.08E-01	63%	6.20E-03	2%	8.39E-02	26%	1.98E-02	6%	3.28E-01
50	3.90E-03	3%	7.55E-02	66%	2.25E-03	2%	2.18E-02	19%	1.12E-02	10%	1.15E-01
75	1.42E-03	3%	2.75E-02	66%	8.19E-04	2%	5.65E-03	14%	6.30E-03	15%	4.16E-02
95	3.31E-04	3%	6.40E-03	61%	1.91E-04	2%	8.12E-04	8%	2.77E-03	26%	1.05E-02

Table C-8 (continued). Loading Rates for the Hood Canal (South) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	3.68E-02	3%	5.94E-01	51%	1.77E-02	2%	4.87E-01	42%	2.97E-02	3%	1.16E+00
25	8.59E-03	4%	1.38E-01	60%	4.13E-03	2%	6.99E-02	30%	1.11E-02	5%	2.32E-01
50	3.12E-03	4%	5.03E-02	64%	1.50E-03	2%	1.81E-02	23%	5.65E-03	7%	7.88E-02
75	1.13E-03	4%	1.83E-02	66%	5.46E-04	2%	4.71E-03	17%	2.86E-03	10%	2.76E-02
95	2.65E-04	4%	4.27E-03	67%	1.27E-04	2%	6.76E-04	11%	1.08E-03	17%	6.41E-03
Low MW PAHs (MT/year)											
5	1.38E-01	4%	1.78E+00	52%	5.31E-02	2%	1.46E+00	43%	2.64E-03	<1%	3.44E+00
25	3.22E-02	5%	4.15E-01	62%	1.24E-02	2%	2.10E-01	31%	1.78E-03	<1%	6.72E-01
50	1.17E-02	5%	1.51E-01	68%	4.51E-03	2%	5.44E-02	24%	1.35E-03	1%	2.23E-01
75	4.26E-03	6%	5.49E-02	72%	1.64E-03	2%	1.41E-02	19%	1.03E-03	1%	7.60E-02
95	9.93E-04	6%	1.28E-02	76%	3.82E-04	2%	2.03E-03	12%	6.95E-04	4%	1.69E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	1.05E+00	1%	1.35E+02	83%	4.03E+00	2%	2.22E+01	14%	2.56E-01	<1%	1.63E+02
25	1.50E-01	1%	1.94E+01	87%	5.79E-01	3%	1.96E+00	9%	1.49E-01	1%	2.22E+01
50	3.90E-02	1%	5.03E+00	88%	1.50E-01	3%	3.63E-01	6%	1.03E-01	2%	5.69E+00
75	1.01E-02	1%	1.31E+00	87%	3.90E-02	3%	6.72E-02	5%	7.06E-02	5%	1.49E+00
95	1.45E-03	1%	1.88E-01	78%	5.60E-03	2%	5.94E-03	2%	4.12E-02	17%	2.42E-01
Total Dioxin TEQs (g/year)											
5	1.05E+00	1%	6.75E+01	73%	2.02E+00	2%	2.22E+01	24%	No studies were available to characterize total dioxin TEQs in highway runoff		9.28E+01
25	1.50E-01	1%	9.70E+00	80%	2.89E-01	2%	1.96E+00	16%			1.21E+01
50	3.90E-02	1%	2.52E+00	84%	7.51E-02	3%	3.63E-01	12%			2.99E+00
75	1.01E-02	1%	6.53E-01	87%	1.95E-02	3%	6.72E-02	9%			7.50E-01
95	1.45E-03	1%	9.38E-02	90%	2.80E-03	3%	5.94E-03	6%			1.04E-01
DDT and Metabolites (kg/year)											
5	2.09E-02	<1%	1.35E+01	4%	2.42E+00	1%	2.92E+02	95%	No studies were available to characterize DDT and metabolites in highway runoff		3.08E+02
25	3.01E-03	<1%	1.94E+00	4%	3.47E-01	1%	4.20E+01	95%			4.43E+01
50	7.80E-04	<1%	5.03E-01	4%	9.01E-02	1%	1.09E+01	95%			1.15E+01
75	2.03E-04	<1%	1.31E-01	4%	2.34E-02	1%	2.83E+00	95%			2.98E+00
95	2.91E-05	<1%	1.88E-02	4%	3.36E-03	1%	4.06E-01	95%			4.28E-01
Triclopyr (MT/year)											
5	7.15E-03	1%	4.05E-01	49%	2.42E-02	3%	3.90E-01	47%	No studies were available to characterize triclopyr in highway runoff		8.26E-01
25	6.32E-04	1%	5.82E-02	49%	3.47E-03	3%	5.59E-02	47%			1.18E-01
50	1.17E-04	<1%	1.51E-02	49%	9.01E-04	3%	1.45E-02	47%			3.06E-02
75	2.17E-05	<1%	3.92E-03	49%	2.34E-04	3%	3.77E-03	47%			7.94E-03
95	1.92E-06	<1%	5.63E-04	49%	3.36E-05	3%	5.41E-04	47%			1.14E-03
Nonylphenol (MT/year)											
5	4.19E-01	4%	4.05E+00	35%	1.21E-01	1%	6.65E+00	58%	2.62E-01	2%	1.15E+01
25	6.01E-02	4%	5.82E-01	42%	1.74E-02	1%	5.88E-01	43%	1.30E-01	9%	1.38E+00
50	1.56E-02	4%	1.51E-01	42%	4.51E-03	1%	1.09E-01	30%	7.96E-02	22%	3.60E-01
75	4.05E-03	4%	3.92E-02	35%	1.17E-03	1%	2.02E-02	18%	4.88E-02	43%	1.13E-01
95	5.82E-04	2%	5.63E-03	17%	1.68E-04	1%	1.78E-03	6%	2.42E-02	75%	3.23E-02
TPH (MT/year)											
5	1.03E+02	<1%	1.09E+04	52%	1.77E+02	1%	9.74E+03	46%	9.99E+01	<1%	2.10E+04
25	4.30E+01	1%	3.39E+03	69%	4.13E+01	1%	1.40E+03	28%	4.96E+01	1%	4.93E+03
50	2.34E+01	1%	1.51E+03	78%	1.50E+01	1%	3.63E+02	19%	3.05E+01	2%	1.94E+03
75	1.28E+01	2%	6.72E+02	84%	5.46E+00	1%	9.42E+01	12%	1.87E+01	2%	8.03E+02
95	5.33E+00	2%	2.10E+02	88%	1.27E+00	1%	1.35E+01	6%	9.31E+00	4%	2.39E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-9. Loading Rates for the Hood Canal (North) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.54E-02	1%	7.31E-01	46%	4.51E-03	<1%	8.24E-01	52%	6.12E-03	<1%	1.58E+00
25	7.07E-03	1%	3.20E-01	50%	2.08E-03	<1%	3.12E-01	48%	3.74E-03	1%	6.45E-01
50	4.12E-03	1%	1.81E-01	52%	1.21E-03	<1%	1.59E-01	46%	2.66E-03	1%	3.48E-01
75	2.37E-03	1%	1.02E-01	54%	7.06E-04	<1%	8.10E-02	43%	1.89E-03	1%	1.88E-01
95	1.13E-03	1%	4.46E-02	57%	3.25E-04	<1%	3.07E-02	39%	1.16E-03	1%	7.79E-02
Cadmium (MT/year)											
5	9.44E-03	2%	3.25E-01	66%	2.46E-03	1%	1.49E-01	30%	3.59E-03	1%	4.89E-01
25	3.24E-03	3%	1.01E-01	85%	8.47E-04	1%	1.19E-02	10%	1.94E-03	2%	1.19E-01
50	1.55E-03	3%	4.52E-02	90%	4.03E-04	1%	2.07E-03	4%	1.26E-03	3%	5.04E-02
75	7.36E-04	3%	2.01E-02	90%	1.92E-04	1%	3.58E-04	2%	8.24E-04	4%	2.22E-02
95	2.53E-04	4%	6.27E-03	89%	6.61E-05	1%	2.87E-05	<1%	4.45E-04	6%	7.07E-03
Copper (MT/year)											
5	1.13E-01	4%	1.87E+00	58%	2.90E-02	1%	1.14E+00	36%	6.07E-02	2%	3.22E+00
25	4.73E-02	4%	7.09E-01	61%	9.06E-03	1%	3.57E-01	31%	3.57E-02	3%	1.16E+00
50	2.58E-02	4%	3.61E-01	63%	4.03E-03	1%	1.59E-01	28%	2.47E-02	4%	5.75E-01
75	1.40E-02	5%	1.84E-01	64%	1.80E-03	1%	7.08E-02	25%	1.71E-02	6%	2.88E-01
95	5.86E-03	5%	6.97E-02	64%	5.61E-04	1%	2.21E-02	20%	1.00E-02	9%	1.08E-01
Lead (MT/year)											
5	1.37E-01	1%	1.06E+01	82%	2.67E-02	<1%	1.81E+00	14%	4.08E-01	3%	1.30E+01
25	4.47E-02	2%	2.48E+00	84%	8.76E-03	<1%	2.86E-01	10%	1.32E-01	4%	2.96E+00
50	2.06E-02	2%	9.03E-01	85%	4.03E-03	<1%	7.95E-02	7%	6.03E-02	6%	1.07E+00
75	9.48E-03	2%	3.28E-01	84%	1.86E-03	<1%	2.21E-02	6%	2.75E-02	7%	3.89E-01
95	3.11E-03	3%	7.66E-02	83%	6.09E-04	1%	3.49E-03	4%	8.91E-03	10%	9.27E-02
Zinc (MT/year)											
5	5.43E-01	3%	1.40E+01	81%	5.81E-02	<1%	2.29E+00	13%	3.78E-01	2%	1.73E+01
25	2.27E-01	4%	5.32E+00	82%	1.81E-02	<1%	7.14E-01	11%	2.00E-01	3%	6.48E+00
50	1.24E-01	4%	2.71E+00	82%	8.07E-03	<1%	3.18E-01	10%	1.29E-01	4%	3.29E+00
75	6.74E-02	4%	1.38E+00	82%	3.59E-03	<1%	1.42E-01	8%	8.28E-02	5%	1.68E+00
95	2.81E-02	4%	5.23E-01	82%	1.12E-03	<1%	4.42E-02	7%	4.39E-02	7%	6.40E-01
Mercury (kg/year)											
5	2.43E+00	11%	1.06E+01	46%	1.52E-01	1%	9.37E+00	41%	5.10E-01	2%	2.31E+01
25	5.67E-01	10%	2.48E+00	46%	2.18E-02	<1%	2.19E+00	40%	1.55E-01	3%	5.41E+00
50	2.06E-01	10%	9.03E-01	46%	5.65E-03	<1%	7.95E-01	40%	6.79E-02	3%	1.98E+00
75	7.49E-02	10%	3.28E-01	45%	1.47E-03	<1%	2.89E-01	40%	2.97E-02	4%	7.23E-01
95	1.75E-02	10%	7.66E-02	45%	2.10E-04	<1%	6.74E-02	39%	9.04E-03	5%	1.71E-01
Total PCBs (kg/year)											
5	8.29E-01	1%	4.85E+01	82%	2.17E-01	<1%	9.71E+00	16%	No studies were available to characterize total PCBs in highway runoff		5.92E+01
25	1.19E-01	1%	6.96E+00	87%	3.11E-02	<1%	8.58E-01	11%			7.97E+00
50	3.09E-02	2%	1.81E+00	90%	8.07E-03	<1%	1.59E-01	8%			2.00E+00
75	8.02E-03	2%	4.69E-01	92%	2.09E-03	<1%	2.94E-02	6%			5.08E-01
95	1.15E-03	2%	6.73E-02	94%	3.01E-04	<1%	2.60E-03	4%			7.14E-02
Total PBDEs (g/year)											
5	5.53E-01	1%	4.26E+01	55%	6.50E-01	1%	3.41E+01	44%	No studies were available to characterize total PBDEs in highway runoff		7.79E+01
25	7.94E-02	1%	9.94E+00	66%	9.33E-02	1%	4.90E+00	33%			1.50E+01
50	2.06E-02	<1%	3.61E+00	73%	2.42E-02	<1%	1.27E+00	26%			4.93E+00
75	5.35E-03	<1%	1.31E+00	79%	6.28E-03	<1%	3.30E-01	20%			1.66E+00
95	7.68E-04	<1%	3.06E-01	86%	9.02E-04	<1%	4.74E-02	13%			3.55E-01
Carcinogenic PAHs (MT/year)											
5	1.21E-02	6%	1.60E-01	79%	1.43E-03	1%	2.56E-02	13%	4.40E-03	2%	2.03E-01
25	2.83E-03	6%	3.73E-02	81%	3.33E-04	1%	3.68E-03	8%	1.93E-03	4%	4.60E-02
50	1.03E-03	6%	1.35E-02	81%	1.21E-04	1%	9.54E-04	6%	1.09E-03	7%	1.67E-02
75	3.75E-04	6%	4.93E-03	79%	4.40E-05	1%	2.48E-04	4%	6.15E-04	10%	6.21E-03
95	8.74E-05	6%	1.15E-03	74%	1.03E-05	1%	3.55E-05	2%	2.70E-04	17%	1.55E-03

Table C-9 (continued). Loading Rates for the Hood Canal (North) Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	9.72E-03	7%	1.06E-01	75%	9.51E-04	1%	2.13E-02	15%	2.89E-03	2%	1.41E-01
25	2.27E-03	7%	2.48E-02	79%	2.22E-04	1%	3.06E-03	10%	1.09E-03	3%	3.15E-02
50	8.24E-04	7%	9.03E-03	80%	8.07E-05	1%	7.95E-04	7%	5.51E-04	5%	1.13E-02
75	3.00E-04	7%	3.28E-03	80%	2.93E-05	1%	2.06E-04	5%	2.79E-04	7%	4.10E-03
95	6.99E-05	7%	7.66E-04	78%	6.84E-06	1%	2.96E-05	3%	1.05E-04	11%	9.77E-04
Low MW PAHs (MT/year)											
5	3.64E-02	9%	3.19E-01	76%	2.85E-03	1%	6.40E-02	15%	2.57E-04	<1%	4.23E-01
25	8.50E-03	9%	7.45E-02	80%	6.66E-04	1%	9.19E-03	10%	1.74E-04	<1%	9.30E-02
50	3.09E-03	9%	2.71E-02	82%	2.42E-04	1%	2.38E-03	7%	1.32E-04	<1%	3.29E-02
75	1.12E-03	10%	9.85E-03	84%	8.80E-05	1%	6.19E-04	5%	1.00E-04	1%	1.18E-02
95	2.62E-04	10%	2.30E-03	84%	2.05E-05	1%	8.89E-05	3%	6.78E-05	2%	2.74E-03
bis(2-Ethylhexyl)phthalate (MT/year)											
5	2.76E-01	1%	2.42E+01	94%	2.17E-01	1%	9.71E-01	4%	2.50E-02	<1%	2.57E+01
25	3.97E-02	1%	3.48E+00	95%	3.11E-02	1%	8.58E-02	2%	1.46E-02	<1%	3.65E+00
50	1.03E-02	1%	9.03E-01	95%	8.07E-03	1%	1.59E-02	2%	1.00E-02	1%	9.47E-01
75	2.67E-03	1%	2.34E-01	94%	2.09E-03	1%	2.94E-03	1%	6.88E-03	3%	2.49E-01
95	3.84E-04	1%	3.37E-02	87%	3.01E-04	1%	2.60E-04	1%	4.02E-03	10%	3.86E-02
Total Dioxin TEQs (g/year)											
5	2.76E-01	2%	1.21E+01	90%	1.08E-01	1%	9.71E-01	7%	No studies were available to characterize total dioxin TEQs in highway runoff		1.35E+01
25	3.97E-02	2%	1.74E+00	93%	1.55E-02	1%	8.58E-02	5%			1.88E+00
50	1.03E-02	2%	4.52E-01	94%	4.03E-03	1%	1.59E-02	3%			4.82E-01
75	2.67E-03	2%	1.17E-01	95%	1.05E-03	1%	2.94E-03	2%			1.24E-01
95	3.84E-04	2%	1.68E-02	95%	1.50E-04	1%	2.60E-04	1%			1.76E-02
DDT and Metabolites (kg/year)											
5	5.53E-03	<1%	2.42E+00	16%	1.30E-01	1%	1.28E+01	83%	No studies were available to characterize DDT and metabolites in highway runoff		1.54E+01
25	7.94E-04	<1%	3.48E-01	16%	1.87E-02	1%	1.84E+00	83%			2.21E+00
50	2.06E-04	<1%	9.03E-02	16%	4.84E-03	1%	4.77E-01	83%			5.72E-01
75	5.35E-05	<1%	2.34E-02	16%	1.26E-03	1%	1.24E-01	83%			1.49E-01
95	7.68E-06	<1%	3.37E-03	16%	1.80E-04	1%	1.78E-02	83%			2.13E-02
Triclopyr (MT/year)											
5	1.89E-03	2%	7.27E-02	78%	1.30E-03	1%	1.71E-02	18%	No studies were available to characterize triclopyr in highway runoff		9.30E-02
25	1.67E-04	1%	1.04E-02	79%	1.87E-04	1%	2.45E-03	19%			1.32E-02
50	3.09E-05	1%	2.71E-03	79%	4.84E-05	1%	6.36E-04	19%			3.42E-03
75	5.72E-06	1%	7.03E-04	79%	1.26E-05	1%	1.65E-04	19%			8.86E-04
95	5.06E-07	<1%	1.01E-04	80%	1.80E-06	1%	2.37E-05	19%			1.27E-04
Nonylphenol (MT/year)											
5	1.11E-01	10%	7.27E-01	63%	6.50E-03	1%	2.91E-01	25%	2.56E-02	2%	1.16E+00
25	1.59E-02	10%	1.04E-01	65%	9.33E-04	1%	2.58E-02	16%	1.27E-02	8%	1.60E-01
50	4.12E-03	9%	2.71E-02	62%	2.42E-04	1%	4.77E-03	11%	7.76E-03	18%	4.40E-02
75	1.07E-03	8%	7.03E-03	51%	6.28E-05	0%	8.83E-04	6%	4.76E-03	34%	1.38E-02
95	1.54E-04	4%	1.01E-03	28%	9.02E-06	0%	7.81E-05	2%	2.36E-03	65%	3.61E-03
TPH (MT/year)											
5	2.72E+01	1%	1.95E+03	80%	9.51E+00	<1%	4.27E+02	18%	9.74E+00	<1%	2.42E+03
25	1.13E+01	2%	6.09E+02	88%	2.22E+00	<1%	6.13E+01	9%	4.84E+00	1%	6.88E+02
50	6.18E+00	2%	2.71E+02	91%	8.07E-01	<1%	1.59E+01	5%	2.97E+00	1%	2.97E+02
75	3.37E+00	3%	1.21E+02	93%	2.93E-01	<1%	4.13E+00	3%	1.83E+00	1%	1.30E+02
95	1.41E+00	3%	3.76E+01	93%	6.84E-02	<1%	5.92E-01	1%	9.08E-01	2%	4.06E+01

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-10. Loading Rates for the Sinclair/Dyes Inlet Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	3.29E-01	8%	2.90E+00	70%	1.80E-02	<1%	8.32E-01	20%	3.73E-02	1%	4.12E+00
25	1.52E-01	9%	1.27E+00	72%	8.30E-03	<1%	3.15E-01	18%	2.29E-02	1%	1.77E+00
50	8.83E-02	9%	7.17E-01	73%	4.84E-03	<1%	1.61E-01	16%	1.63E-02	2%	9.87E-01
75	5.09E-02	9%	4.04E-01	73%	2.82E-03	1%	8.18E-02	15%	1.16E-02	2%	5.51E-01
95	2.43E-02	10%	1.77E-01	74%	1.30E-03	1%	3.10E-02	13%	7.07E-03	3%	2.41E-01
Cadmium (MT/year)											
5	2.02E-01	12%	1.29E+00	77%	9.85E-03	1%	1.50E-01	9%	2.19E-02	1%	1.67E+00
25	6.96E-02	14%	4.02E-01	81%	3.39E-03	1%	1.21E-02	2%	1.19E-02	2%	4.99E-01
50	3.31E-02	15%	1.79E-01	80%	1.61E-03	1%	2.09E-03	1%	7.72E-03	3%	2.24E-01
75	1.58E-02	16%	7.97E-02	78%	7.68E-04	1%	3.61E-04	<1%	5.03E-03	5%	1.02E-01
95	5.43E-03	16%	2.49E-02	75%	2.64E-04	1%	2.90E-05	<1%	2.72E-03	8%	3.33E-02
Copper (MT/year)											
5	2.43E+00	21%	7.42E+00	65%	1.16E-01	1%	1.16E+00	10%	3.71E-01	3%	1.15E+01
25	1.01E+00	23%	2.81E+00	63%	3.62E-02	1%	3.61E-01	8%	2.18E-01	5%	4.44E+00
50	5.52E-01	24%	1.43E+00	62%	1.61E-02	1%	1.61E-01	7%	1.51E-01	7%	2.31E+00
75	3.01E-01	25%	7.30E-01	60%	7.18E-03	1%	7.15E-02	6%	1.04E-01	9%	1.21E+00
95	1.26E-01	26%	2.77E-01	57%	2.24E-03	<1%	2.23E-02	5%	6.12E-02	13%	4.88E-01
Lead (MT/year)											
5	2.93E+00	6%	4.22E+01	85%	1.07E-01	<1%	1.83E+00	4%	2.49E+00	5%	4.96E+01
25	9.59E-01	8%	9.85E+00	83%	3.50E-02	<1%	2.89E-01	2%	8.06E-01	7%	1.19E+01
50	4.42E-01	10%	3.58E+00	80%	1.61E-02	<1%	8.03E-02	2%	3.68E-01	8%	4.49E+00
75	2.03E-01	12%	1.30E+00	76%	7.43E-03	<1%	2.23E-02	1%	1.68E-01	10%	1.70E+00
95	6.66E-02	15%	3.04E-01	71%	2.43E-03	1%	3.53E-03	1%	5.44E-02	13%	4.31E-01
Zinc (MT/year)											
5	1.16E+01	16%	5.57E+01	77%	2.32E-01	<1%	2.31E+00	3%	2.31E+00	3%	7.22E+01
25	4.86E+00	17%	2.11E+01	75%	7.25E-02	<1%	7.22E-01	3%	1.22E+00	4%	2.80E+01
50	2.65E+00	18%	1.07E+01	74%	3.23E-02	<1%	3.21E-01	2%	7.87E-01	5%	1.45E+01
75	1.44E+00	19%	5.48E+00	72%	1.44E-02	<1%	1.43E-01	2%	5.06E-01	7%	7.58E+00
95	6.03E-01	20%	2.07E+00	69%	4.48E-03	<1%	4.46E-02	1%	2.68E-01	9%	3.00E+00
Mercury (kg/year)											
5	5.21E+01	48%	4.22E+01	39%	6.06E-01	1%	9.47E+00	9%	3.11E+00	3%	1.08E+02
25	1.21E+01	48%	9.85E+00	39%	8.71E-02	<1%	2.21E+00	9%	9.47E-01	4%	2.52E+01
50	4.42E+00	48%	3.58E+00	39%	2.26E-02	<1%	8.03E-01	9%	4.14E-01	4%	9.24E+00
75	1.61E+00	47%	1.30E+00	38%	5.86E-03	<1%	2.92E-01	9%	1.81E-01	5%	3.39E+00
95	3.75E-01	47%	3.04E-01	38%	8.42E-04	<1%	6.81E-02	8%	5.52E-02	7%	8.03E-01
Total PCBs (kg/year)											
5	1.78E+01	8%	1.92E+02	87%	8.66E-01	<1%	9.81E+00	4%	No studies were available to characterize total PCBs in highway runoff		2.21E+02
25	2.55E+00	8%	2.76E+01	89%	1.24E-01	<1%	8.67E-01	3%			3.12E+01
50	6.63E-01	8%	7.17E+00	89%	3.23E-02	<1%	1.61E-01	2%			8.02E+00
75	1.72E-01	8%	1.86E+00	90%	8.37E-03	<1%	2.97E-02	1%			2.07E+00
95	2.47E-02	8%	2.67E-01	90%	1.20E-03	<1%	2.63E-03	1%			2.96E-01
Total PBDEs (g/year)											
5	1.19E+01	5%	1.69E+02	78%	2.60E+00	1%	3.45E+01	16%	No studies were available to characterize total PBDEs in highway runoff		2.18E+02
25	1.70E+00	4%	3.94E+01	85%	3.73E-01	1%	4.95E+00	11%			4.64E+01
50	4.42E-01	3%	1.43E+01	89%	9.68E-02	1%	1.28E+00	8%			1.62E+01
75	1.15E-01	2%	5.21E+00	92%	2.51E-02	<1%	3.33E-01	6%			5.68E+00
95	1.65E-02	1%	1.22E+00	95%	3.61E-03	<1%	4.79E-02	4%			1.28E+00
Carcinogenic PAHs (MT/year)											
5	2.60E-01	27%	6.34E-01	67%	5.71E-03	1%	2.59E-02	3%	2.69E-02	3%	9.52E-01
25	6.07E-02	27%	1.48E-01	66%	1.33E-03	1%	3.71E-03	2%	1.18E-02	5%	2.25E-01
50	2.21E-02	26%	5.37E-02	64%	4.84E-04	1%	9.64E-04	1%	6.65E-03	8%	8.39E-02
75	8.03E-03	25%	1.95E-02	62%	1.76E-04	1%	2.50E-04	1%	3.75E-03	12%	3.18E-02
95	1.87E-03	23%	4.56E-03	56%	4.11E-05	1%	3.59E-05	<1%	1.65E-03	20%	8.16E-03

Table C-10 (continued). Loading Rates for the Sinclair/Dyes Inlet Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	2.08E-01	31%	4.22E-01	63%	3.80E-03	1%	2.15E-02	3%	1.77E-02	3%	6.74E-01
25	4.86E-02	31%	9.85E-02	62%	8.88E-04	1%	3.09E-03	2%	6.64E-03	4%	1.58E-01
50	1.77E-02	30%	3.58E-02	62%	3.23E-04	1%	8.03E-04	1%	3.36E-03	6%	5.80E-02
75	6.42E-03	30%	1.30E-02	61%	1.17E-04	1%	2.08E-04	1%	1.70E-03	8%	2.15E-02
95	1.50E-03	29%	3.04E-03	58%	2.74E-05	1%	2.99E-05	1%	6.40E-04	12%	5.24E-03
Low MW PAHs (MT/year)											
5	7.81E-01	37%	1.27E+00	60%	1.14E-02	1%	6.46E-02	3%	1.57E-03	<1%	2.13E+00
25	1.82E-01	37%	2.96E-01	60%	2.66E-03	1%	9.28E-03	2%	1.06E-03	<1%	4.91E-01
50	6.63E-02	37%	1.07E-01	60%	9.68E-04	1%	2.41E-03	1%	8.06E-04	<1%	1.78E-01
75	2.41E-02	37%	3.91E-02	60%	3.52E-04	1%	6.25E-04	1%	6.13E-04	1%	6.48E-02
95	5.62E-03	37%	9.12E-03	59%	8.21E-05	1%	8.98E-05	1%	4.14E-04	3%	1.53E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	5.93E+00	6%	9.61E+01	92%	8.66E-01	1%	9.81E-01	1%	1.52E-01	<1%	1.04E+02
25	8.51E-01	6%	1.38E+01	92%	1.24E-01	1%	8.67E-02	1%	8.89E-02	1%	1.50E+01
50	2.21E-01	6%	3.58E+00	92%	3.23E-02	1%	1.61E-02	<1%	6.11E-02	2%	3.91E+00
75	5.73E-02	6%	9.30E-01	89%	8.37E-03	1%	2.97E-03	<1%	4.20E-02	4%	1.04E+00
95	8.23E-03	5%	1.34E-01	80%	1.20E-03	1%	2.63E-04	<1%	2.45E-02	15%	1.68E-01
Total Dioxin TEQs (g/year)											
5	5.93E+00	11%	4.81E+01	87%	4.33E-01	1%	9.81E-01	2%	No studies were available to characterize total dioxin TEQs in highway runoff		5.54E+01
25	8.51E-01	11%	6.90E+00	87%	6.22E-02	1%	8.67E-02	1%			7.90E+00
50	2.21E-01	11%	1.79E+00	88%	1.61E-02	1%	1.61E-02	1%			2.04E+00
75	5.73E-02	11%	4.65E-01	88%	4.19E-03	1%	2.97E-03	1%			5.29E-01
95	8.23E-03	11%	6.68E-02	88%	6.01E-04	1%	2.63E-04	<1%			7.59E-02
DDT and Metabolites (kg/year)											
5	1.19E-01	1%	9.61E+00	41%	5.20E-01	2%	1.29E+01	56%	No studies were available to characterize DDT and metabolites in highway runoff		2.32E+01
25	1.70E-02	1%	1.38E+00	41%	7.46E-02	2%	1.86E+00	56%			3.33E+00
50	4.42E-03	1%	3.58E-01	41%	1.94E-02	2%	4.82E-01	56%			8.64E-01
75	1.15E-03	1%	9.30E-02	41%	5.02E-03	2%	1.25E-01	56%			2.24E-01
95	1.65E-04	1%	1.34E-02	41%	7.22E-04	2%	1.80E-02	56%			3.22E-02
Triclopyr (MT/year)											
5	4.05E-02	12%	2.88E-01	82%	5.20E-03	1%	1.72E-02	5%	No studies were available to characterize triclopyr in highway runoff		3.51E-01
25	3.58E-03	7%	4.14E-02	86%	7.46E-04	2%	2.48E-03	5%			4.82E-02
50	6.63E-04	5%	1.07E-02	88%	1.94E-04	2%	6.42E-04	5%			1.22E-02
75	1.23E-04	4%	2.79E-03	89%	5.02E-05	2%	1.67E-04	5%			3.13E-03
95	1.08E-05	2%	4.01E-04	91%	7.22E-06	2%	2.39E-05	5%			4.43E-04
Nonylphenol (MT/year)											
5	2.37E+00	41%	2.88E+00	50%	2.60E-02	<1%	2.94E-01	5%	1.56E-01	3%	5.73E+00
25	3.40E-01	40%	4.14E-01	48%	3.73E-03	<1%	2.60E-02	3%	7.73E-02	9%	8.62E-01
50	8.83E-02	35%	1.07E-01	43%	9.68E-04	<1%	4.82E-03	2%	4.74E-02	19%	2.49E-01
75	2.29E-02	28%	2.79E-02	34%	2.51E-04	<1%	8.92E-04	1%	2.91E-02	36%	8.10E-02
95	3.29E-03	15%	4.01E-03	18%	3.61E-05	<1%	7.89E-05	<1%	1.44E-02	66%	2.18E-02
TPH (MT/year)											
5	5.82E+02	7%	7.74E+03	87%	3.80E+01	<1%	4.31E+02	5%	5.95E+01	1%	8.85E+03
25	2.43E+02	9%	2.41E+03	88%	8.88E+00	<1%	6.19E+01	2%	2.95E+01	1%	2.76E+03
50	1.33E+02	11%	1.07E+03	86%	3.23E+00	<1%	1.61E+01	1%	1.82E+01	1%	1.24E+03
75	7.22E+01	13%	4.78E+02	84%	1.17E+00	<1%	4.17E+00	1%	1.12E+01	2%	5.67E+02
95	3.02E+01	16%	1.49E+02	80%	2.74E-01	<1%	5.98E-01	<1%	5.54E+00	3%	1.86E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-11. Loading Rates for the Admiralty Inlet Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	7.19E-02	2%	1.45E+00	49%	2.10E-01	7%	1.22E+00	41%	1.75E-02	1%	2.97E+00
25	3.31E-02	3%	6.35E-01	51%	9.67E-02	8%	4.62E-01	37%	1.07E-02	1%	1.24E+00
50	1.93E-02	3%	3.58E-01	53%	5.64E-02	8%	2.35E-01	35%	7.59E-03	1%	6.77E-01
75	1.11E-02	3%	2.02E-01	54%	3.29E-02	9%	1.20E-01	32%	5.40E-03	1%	3.71E-01
95	5.30E-03	3%	8.85E-02	56%	1.51E-02	10%	4.55E-02	29%	3.30E-03	2%	1.58E-01
Cadmium (MT/year)											
5	4.42E-02	4%	6.45E-01	62%	1.15E-01	11%	2.20E-01	21%	1.03E-02	1%	1.03E+00
25	1.52E-02	5%	2.01E-01	72%	3.95E-02	14%	1.77E-02	6%	5.54E-03	2%	2.79E-01
50	7.24E-03	6%	8.95E-02	73%	1.88E-02	15%	3.06E-03	3%	3.61E-03	3%	1.22E-01
75	3.45E-03	6%	3.99E-02	72%	8.95E-03	16%	5.30E-04	1%	2.35E-03	4%	5.51E-02
95	1.18E-03	7%	1.24E-02	69%	3.08E-03	17%	4.25E-05	<1%	1.27E-03	7%	1.80E-02
Copper (MT/year)											
5	5.30E-01	7%	3.71E+00	50%	1.35E+00	18%	1.70E+00	23%	1.73E-01	2%	7.46E+00
25	2.21E-01	8%	1.41E+00	52%	4.22E-01	16%	5.29E-01	20%	1.02E-01	4%	2.68E+00
50	1.21E-01	9%	7.16E-01	54%	1.88E-01	14%	2.35E-01	18%	7.04E-02	5%	1.33E+00
75	6.57E-02	10%	3.65E-01	55%	8.36E-02	13%	1.05E-01	16%	4.87E-02	7%	6.68E-01
95	2.74E-02	11%	1.38E-01	55%	2.61E-02	10%	3.27E-02	13%	2.86E-02	11%	2.53E-01
Lead (MT/year)											
5	6.40E-01	2%	2.11E+01	79%	1.25E+00	5%	2.68E+00	10%	1.16E+00	4%	2.68E+01
25	2.10E-01	3%	4.93E+00	78%	4.08E-01	6%	4.24E-01	7%	3.77E-01	6%	6.34E+00
50	9.65E-02	4%	1.79E+00	76%	1.88E-01	8%	1.18E-01	5%	1.72E-01	7%	2.37E+00
75	4.44E-02	5%	6.51E-01	73%	8.65E-02	10%	3.27E-02	4%	7.86E-02	9%	8.93E-01
95	1.46E-02	6%	1.52E-01	67%	2.83E-02	13%	5.17E-03	2%	2.54E-02	11%	2.25E-01
Zinc (MT/year)											
5	2.54E+00	7%	2.78E+01	74%	2.70E+00	7%	3.39E+00	9%	1.08E+00	3%	3.75E+01
25	1.06E+00	8%	1.05E+01	75%	8.44E-01	6%	1.06E+00	8%	5.71E-01	4%	1.41E+01
50	5.79E-01	8%	5.37E+00	75%	3.76E-01	5%	4.71E-01	7%	3.67E-01	5%	7.17E+00
75	3.15E-01	9%	2.74E+00	75%	1.67E-01	5%	2.10E-01	6%	2.36E-01	6%	3.67E+00
95	1.32E-01	9%	1.04E+00	73%	5.22E-02	4%	6.54E-02	5%	1.25E-01	9%	1.41E+00
Mercury (kg/year)											
5	1.14E+01	21%	2.11E+01	38%	7.06E+00	13%	1.39E+01	25%	1.45E+00	3%	5.49E+01
25	2.65E+00	22%	4.93E+00	40%	1.01E+00	8%	3.24E+00	26%	4.43E-01	4%	1.23E+01
50	9.65E-01	22%	1.79E+00	41%	2.63E-01	6%	1.18E+00	27%	1.94E-01	4%	4.39E+00
75	3.51E-01	22%	6.51E-01	41%	6.83E-02	4%	4.28E-01	27%	8.47E-02	5%	1.58E+00
95	8.18E-02	22%	1.52E-01	41%	9.80E-03	3%	9.99E-02	27%	2.58E-02	7%	3.69E-01
Total PCBs (kg/year)											
5	3.88E+00	3%	9.61E+01	77%	1.01E+01	8%	1.44E+01	12%	No studies were available to characterize total PCBs in highway runoff		1.24E+02
25	5.58E-01	3%	1.38E+01	81%	1.45E+00	8%	1.27E+00	7%			1.71E+01
50	1.45E-01	3%	3.58E+00	83%	3.76E-01	9%	2.35E-01	5%			4.34E+00
75	3.76E-02	3%	9.29E-01	84%	9.75E-02	9%	4.36E-02	4%			1.11E+00
95	5.39E-03	3%	1.33E-01	85%	1.40E-02	9%	3.86E-03	2%			1.57E-01
Total PBDEs (g/year)											
5	2.59E+00	2%	8.45E+01	50%	3.02E+01	18%	5.06E+01	30%	No studies were available to characterize total PBDEs in highway runoff		1.68E+02
25	3.72E-01	1%	1.97E+01	62%	4.34E+00	14%	7.26E+00	23%			3.17E+01
50	9.65E-02	1%	7.16E+00	70%	1.13E+00	11%	1.88E+00	18%			1.03E+01
75	2.50E-02	1%	2.60E+00	76%	2.93E-01	9%	4.89E-01	14%			3.41E+00
95	3.60E-03	<1%	6.08E-01	84%	4.20E-02	6%	7.02E-02	10%			7.23E-01
Carcinogenic PAHs (MT/year)											
5	5.69E-02	12%	3.17E-01	65%	6.65E-02	14%	3.79E-02	8%	1.25E-02	3%	4.91E-01
25	1.33E-02	12%	7.39E-02	65%	1.55E-02	14%	5.44E-03	5%	5.51E-03	5%	1.14E-01
50	4.82E-03	12%	2.69E-02	64%	5.64E-03	13%	1.41E-03	3%	3.11E-03	7%	4.18E-02
75	1.75E-03	11%	9.77E-03	62%	2.05E-03	13%	3.67E-04	2%	1.75E-03	11%	1.57E-02
95	4.09E-04	10%	2.28E-03	57%	4.78E-04	12%	5.27E-05	1%	7.70E-04	19%	3.99E-03

Table C-11 (continued). Loading Rates for the Admiralty Inlet Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	4.55E-02	13%	2.11E-01	62%	4.43E-02	13%	3.16E-02	9%	8.25E-03	2%	3.41E-01
25	1.06E-02	14%	4.93E-02	63%	1.03E-02	13%	4.54E-03	6%	3.10E-03	4%	7.78E-02
50	3.86E-03	14%	1.79E-02	63%	3.76E-03	13%	1.18E-03	4%	1.57E-03	6%	2.83E-02
75	1.40E-03	14%	6.51E-03	63%	1.37E-03	13%	3.06E-04	3%	7.96E-04	8%	1.04E-02
95	3.27E-04	13%	1.52E-03	61%	3.19E-04	13%	4.39E-05	2%	2.99E-04	12%	2.51E-03
Low MW PAHs (MT/year)											
5	1.71E-01	17%	6.33E-01	61%	1.33E-01	13%	9.48E-02	9%	7.34E-04	<1%	1.03E+00
25	3.98E-02	17%	1.48E-01	64%	3.10E-02	13%	1.36E-02	6%	4.95E-04	<1%	2.33E-01
50	1.45E-02	17%	5.37E-02	64%	1.13E-02	14%	3.53E-03	4%	3.77E-04	<1%	8.34E-02
75	5.26E-03	17%	1.95E-02	65%	4.10E-03	14%	9.17E-04	3%	2.87E-04	1%	3.01E-02
95	1.23E-03	17%	4.56E-03	64%	9.56E-04	14%	1.32E-04	2%	1.93E-04	3%	7.07E-03
bis(2-Ethylhexyl)phthalate (MT/year)											
5	1.29E+00	2%	4.81E+01	79%	1.01E+01	17%	1.44E+00	2%	7.12E-02	<1%	6.09E+01
25	1.86E-01	2%	6.90E+00	79%	1.45E+00	17%	1.27E-01	1%	4.15E-02	<1%	8.70E+00
50	4.82E-02	2%	1.79E+00	79%	3.76E-01	17%	2.35E-02	1%	2.86E-02	1%	2.27E+00
75	1.25E-02	2%	4.65E-01	78%	9.75E-02	16%	4.36E-03	1%	1.96E-02	3%	5.99E-01
95	1.80E-03	2%	6.67E-02	71%	1.40E-02	15%	3.86E-04	<1%	1.15E-02	12%	9.44E-02
Total Dioxin TEQs (g/year)											
5	1.29E+00	4%	2.40E+01	76%	5.04E+00	16%	1.44E+00	5%	No studies were available to characterize total dioxin TEQs in highway runoff		3.18E+01
25	1.86E-01	4%	3.45E+00	77%	7.24E-01	16%	1.27E-01	3%			4.49E+00
50	4.82E-02	4%	8.95E-01	78%	1.88E-01	16%	2.35E-02	2%			1.16E+00
75	1.25E-02	4%	2.32E-01	78%	4.88E-02	16%	4.36E-03	1%			2.98E-01
95	1.80E-03	4%	3.34E-02	78%	7.00E-03	16%	3.86E-04	1%			4.26E-02
DDT and Metabolites (kg/year)											
5	2.59E-02	<1%	4.81E+00	16%	6.05E+00	20%	1.90E+01	64%	No studies were available to characterize DDT and metabolites in highway runoff		2.98E+01
25	3.72E-03	<1%	6.90E-01	16%	8.69E-01	20%	2.72E+00	64%			4.28E+00
50	9.65E-04	<1%	1.79E-01	16%	2.25E-01	20%	7.06E-01	64%			1.11E+00
75	2.50E-04	<1%	4.65E-02	16%	5.85E-02	20%	1.83E-01	64%			2.89E-01
95	3.60E-05	<1%	6.67E-03	16%	8.40E-03	20%	2.63E-02	64%			4.14E-02
Triclopyr (MT/year)											
5	8.84E-03	4%	1.44E-01	60%	6.05E-02	25%	2.53E-02	11%	No studies were available to characterize triclopyr in highway runoff		2.39E-01
25	7.81E-04	2%	2.07E-02	61%	8.69E-03	26%	3.63E-03	11%			3.38E-02
50	1.45E-04	2%	5.37E-03	62%	2.25E-03	26%	9.42E-04	11%			8.71E-03
75	2.68E-05	1%	1.39E-03	62%	5.85E-04	26%	2.44E-04	11%			2.25E-03
95	2.37E-06	1%	2.00E-04	62%	8.40E-05	26%	3.51E-05	11%			3.22E-04
Nonylphenol (MT/year)											
5	5.18E-01	19%	1.44E+00	52%	3.02E-01	11%	4.31E-01	16%	7.29E-02	3%	2.77E+00
25	7.44E-02	19%	2.07E-01	52%	4.34E-02	11%	3.81E-02	10%	3.61E-02	9%	3.99E-01
50	1.93E-02	17%	5.37E-02	47%	1.13E-02	10%	7.06E-03	6%	2.21E-02	20%	1.13E-01
75	5.01E-03	14%	1.39E-02	38%	2.93E-03	8%	1.31E-03	4%	1.36E-02	37%	3.68E-02
95	7.19E-04	7%	2.00E-03	20%	4.20E-04	4%	1.16E-04	1%	6.72E-03	67%	9.98E-03
TPH (MT/year)											
5	1.27E+02	2%	3.87E+03	76%	4.43E+02	9%	6.32E+02	12%	2.78E+01	1%	5.10E+03
25	5.31E+01	4%	1.21E+03	82%	1.03E+02	7%	9.07E+01	6%	1.38E+01	1%	1.47E+03
50	2.89E+01	5%	5.37E+02	85%	3.76E+01	6%	2.35E+01	4%	8.48E+00	1%	6.36E+02
75	1.58E+01	6%	2.39E+02	85%	1.37E+01	5%	6.11E+00	2%	5.22E+00	2%	2.80E+02
95	6.59E+00	7%	7.46E+01	85%	3.19E+00	4%	8.78E-01	1%	2.59E+00	3%	8.79E+01

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-12. Loading Rates for the Strait of Juan de Fuca Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	5.98E-01	2%	5.39E+00	18%	1.24E+00	4%	2.20E+01	75%	1.87E-01	1%	2.94E+01
25	2.75E-01	2%	2.36E+00	20%	5.70E-01	5%	8.32E+00	71%	1.14E-01	1%	1.16E+01
50	1.60E-01	3%	1.33E+00	22%	3.32E-01	5%	4.24E+00	69%	8.14E-02	1%	6.14E+00
75	9.24E-02	3%	7.50E-01	23%	1.94E-01	6%	2.16E+00	66%	5.79E-02	2%	3.25E+00
95	4.40E-02	3%	3.29E-01	25%	8.91E-02	7%	8.18E-01	62%	3.54E-02	3%	1.32E+00
Cadmium (MT/year)											
5	3.68E-01	5%	2.40E+00	32%	6.76E-01	9%	3.97E+00	53%	1.10E-01	1%	7.52E+00
25	1.26E-01	9%	7.48E-01	50%	2.32E-01	16%	3.18E-01	21%	5.93E-02	4%	1.48E+00
50	6.02E-02	10%	3.33E-01	56%	1.11E-01	19%	5.51E-02	9%	3.87E-02	6%	5.98E-01
75	2.87E-02	11%	1.48E-01	56%	5.27E-02	20%	9.54E-03	4%	2.52E-02	10%	2.64E-01
95	9.86E-03	11%	4.62E-02	52%	1.81E-02	20%	7.65E-04	1%	1.36E-02	15%	8.86E-02
Copper (MT/year)											
5	4.41E+00	8%	1.38E+01	24%	7.97E+00	14%	3.05E+01	52%	1.86E+00	3%	5.85E+01
25	1.84E+00	9%	5.23E+00	26%	2.49E+00	12%	9.52E+00	47%	1.09E+00	5%	2.02E+01
50	1.00E+00	10%	2.66E+00	27%	1.11E+00	11%	4.24E+00	43%	7.55E-01	8%	9.77E+00
75	5.47E-01	11%	1.36E+00	28%	4.93E-01	10%	1.89E+00	39%	5.22E-01	11%	4.80E+00
95	2.28E-01	13%	5.14E-01	29%	1.54E-01	9%	5.89E-01	33%	3.07E-01	17%	1.79E+00
Lead (MT/year)											
5	5.32E+00	4%	7.85E+01	52%	7.34E+00	5%	4.83E+01	32%	1.25E+01	8%	1.52E+02
25	1.74E+00	5%	1.83E+01	54%	2.40E+00	7%	7.64E+00	22%	4.04E+00	12%	3.41E+01
50	8.02E-01	6%	6.66E+00	53%	1.11E+00	9%	2.12E+00	17%	1.84E+00	15%	1.25E+01
75	3.69E-01	8%	2.42E+00	51%	5.10E-01	11%	5.88E-01	12%	8.42E-01	18%	4.73E+00
95	1.21E-01	10%	5.65E-01	46%	1.67E-01	14%	9.31E-02	8%	2.73E-01	22%	1.22E+00
Zinc (MT/year)											
5	2.12E+01	10%	1.03E+02	49%	1.59E+01	7%	6.10E+01	29%	1.16E+01	5%	2.13E+02
25	8.84E+00	11%	3.92E+01	50%	4.97E+00	6%	1.90E+01	24%	6.13E+00	8%	7.82E+01
50	4.81E+00	12%	2.00E+01	51%	2.21E+00	6%	8.48E+00	22%	3.94E+00	10%	3.94E+01
75	2.62E+00	13%	1.02E+01	51%	9.85E-01	5%	3.77E+00	19%	2.53E+00	13%	2.01E+01
95	1.10E+00	14%	3.86E+00	50%	3.08E-01	4%	1.18E+00	15%	1.34E+00	17%	7.78E+00
Mercury (kg/year)											
5	9.46E+01	20%	7.85E+01	16%	4.16E+01	9%	2.50E+02	52%	1.56E+01	3%	4.80E+02
25	2.21E+01	20%	1.83E+01	17%	5.97E+00	5%	5.83E+01	53%	4.74E+00	4%	1.09E+02
50	8.02E+00	20%	6.66E+00	17%	1.55E+00	4%	2.12E+01	54%	2.08E+00	5%	3.95E+01
75	2.92E+00	20%	2.42E+00	17%	4.02E-01	3%	7.71E+00	54%	9.08E-01	6%	1.44E+01
95	6.81E-01	20%	5.65E-01	17%	5.77E-02	2%	1.80E+00	53%	2.77E-01	8%	3.38E+00
Total PCBs (kg/year)											
5	3.23E+01	5%	3.57E+02	50%	5.94E+01	8%	2.59E+02	37%	No studies were available to characterize total PCBs in highway runoff		7.08E+02
25	4.64E+00	5%	5.13E+01	59%	8.53E+00	10%	2.29E+01	26%			8.74E+01
50	1.20E+00	6%	1.33E+01	63%	2.21E+00	11%	4.24E+00	20%			2.10E+01
75	3.12E-01	6%	3.46E+00	67%	5.75E-01	11%	7.85E-01	15%			5.13E+00
95	4.49E-02	6%	4.96E-01	72%	8.25E-02	12%	6.94E-02	10%			6.93E-01
Total PBDEs (g/year)											
5	2.15E+01	2%	3.14E+02	22%	1.78E+02	13%	9.10E+02	64%	No studies were available to characterize total PBDEs in highway runoff		1.42E+03
25	3.09E+00	1%	7.32E+01	31%	2.56E+01	11%	1.31E+02	56%			2.33E+02
50	8.02E-01	1%	2.66E+01	39%	6.64E+00	10%	3.39E+01	50%			6.80E+01
75	2.08E-01	1%	9.68E+00	47%	1.72E+00	8%	8.80E+00	43%			2.04E+01
95	2.99E-02	1%	2.26E+00	59%	2.47E-01	7%	1.26E+00	33%			3.80E+00
Carcinogenic PAHs (MT/year)											
5	4.73E-01	17%	1.18E+00	41%	3.92E-01	14%	6.83E-01	24%	1.34E-01	5%	2.86E+00
25	1.10E-01	17%	2.75E-01	43%	9.13E-02	14%	9.80E-02	15%	5.90E-02	9%	6.33E-01
50	4.01E-02	17%	9.99E-02	43%	3.32E-02	14%	2.54E-02	11%	3.33E-02	14%	2.32E-01
75	1.46E-02	17%	3.63E-02	41%	1.21E-02	14%	6.60E-03	7%	1.88E-02	21%	8.84E-02
95	3.40E-03	14%	8.47E-03	35%	2.82E-03	12%	9.48E-04	4%	8.25E-03	35%	2.39E-02

Table C-12 (continued). Loading Rates for the Strait of Juan de Fuca Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	3.78E-01	18%	7.85E-01	38%	2.61E-01	13%	5.69E-01	27%	8.84E-02	4%	2.08E+00
25	8.83E-02	20%	1.83E-01	41%	6.09E-02	14%	8.17E-02	18%	3.32E-02	7%	4.47E-01
50	3.21E-02	20%	6.66E-02	42%	2.21E-02	14%	2.12E-02	13%	1.68E-02	11%	1.59E-01
75	1.17E-02	20%	2.42E-02	42%	8.05E-03	14%	5.50E-03	9%	8.53E-03	15%	5.80E-02
95	2.72E-03	19%	5.65E-03	40%	1.88E-03	13%	7.90E-04	6%	3.21E-03	23%	1.42E-02
Low MW PAHs (MT/year)											
5	1.42E+00	23%	2.35E+00	38%	7.83E-01	12%	1.71E+00	27%	7.87E-03	<1%	6.27E+00
25	3.31E-01	25%	5.49E-01	42%	1.83E-01	14%	2.45E-01	19%	5.31E-03	<1%	1.31E+00
50	1.20E-01	27%	2.00E-01	44%	6.64E-02	15%	6.36E-02	14%	4.04E-03	1%	4.54E-01
75	4.38E-02	27%	7.26E-02	45%	2.41E-02	15%	1.65E-02	10%	3.07E-03	2%	1.60E-01
95	1.02E-02	27%	1.69E-02	46%	5.63E-03	15%	2.37E-03	6%	2.07E-03	6%	3.72E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	1.08E+01	4%	1.79E+02	65%	5.94E+01	22%	2.59E+01	9%	7.63E-01	<1%	2.75E+02
25	1.55E+00	4%	2.57E+01	67%	8.53E+00	22%	2.29E+00	6%	4.45E-01	1%	3.85E+01
50	4.01E-01	4%	6.66E+00	67%	2.21E+00	22%	4.24E-01	4%	3.06E-01	3%	1.00E+01
75	1.04E-01	4%	1.73E+00	64%	5.75E-01	21%	7.85E-02	3%	2.10E-01	8%	2.70E+00
95	1.50E-02	3%	2.48E-01	52%	8.25E-02	17%	6.94E-03	1%	1.23E-01	26%	4.75E-01
Total Dioxin TEQs (g/year)											
5	1.08E+01	7%	8.93E+01	57%	2.97E+01	19%	2.59E+01	17%	No studies were available to characterize total dioxin TEQs in highway runoff		1.56E+02
25	1.55E+00	7%	1.28E+01	61%	4.27E+00	20%	2.29E+00	11%			2.09E+01
50	4.01E-01	8%	3.33E+00	63%	1.11E+00	21%	4.24E-01	8%			5.26E+00
75	1.04E-01	8%	8.64E-01	65%	2.87E-01	22%	7.85E-02	6%			1.33E+00
95	1.50E-02	8%	1.24E-01	66%	4.12E-02	22%	6.94E-03	4%			1.87E-01
DDT and Metabolites (kg/year)											
5	2.15E-01	<1%	1.79E+01	5%	3.56E+01	9%	3.41E+02	86%	No studies were available to characterize DDT and metabolites in highway runoff		3.95E+02
25	3.09E-02	<1%	2.57E+00	5%	5.12E+00	9%	4.90E+01	86%			5.67E+01
50	8.02E-03	<1%	6.66E-01	5%	1.33E+00	9%	1.27E+01	86%			1.47E+01
75	2.08E-03	<1%	1.73E-01	5%	3.45E-01	9%	3.30E+00	86%			3.82E+00
95	2.99E-04	<1%	2.48E-02	5%	4.95E-02	9%	4.74E-01	86%			5.49E-01
Triclopyr (MT/year)											
5	7.35E-02	5%	5.36E-01	38%	3.56E-01	25%	4.55E-01	32%	No studies were available to characterize triclopyr in highway runoff		1.42E+00
25	6.50E-03	3%	7.70E-02	38%	5.12E-02	26%	6.53E-02	33%			2.00E-01
50	1.20E-03	2%	2.00E-02	39%	1.33E-02	26%	1.70E-02	33%			5.14E-02
75	2.23E-04	2%	5.18E-03	39%	3.45E-03	26%	4.40E-03	33%			1.33E-02
95	1.97E-05	1%	7.44E-04	39%	4.95E-04	26%	6.32E-04	33%			1.89E-03
Nonylphenol (MT/year)											
5	4.31E+00	22%	5.36E+00	27%	1.78E+00	9%	7.77E+00	39%	7.82E-01	4%	2.00E+01
25	6.18E-01	23%	7.70E-01	28%	2.56E-01	9%	6.87E-01	25%	3.87E-01	14%	2.72E+00
50	1.60E-01	20%	2.00E-01	25%	6.64E-02	8%	1.27E-01	16%	2.37E-01	30%	7.91E-01
75	4.16E-02	15%	5.18E-02	19%	1.72E-02	6%	2.36E-02	8%	1.46E-01	52%	2.80E-01
95	5.98E-03	7%	7.44E-03	8%	2.47E-03	3%	2.08E-03	2%	7.20E-02	80%	9.00E-02
TPH (MT/year)											
5	1.06E+03	4%	1.44E+04	48%	2.61E+03	9%	1.14E+04	38%	2.98E+02	1%	2.97E+04
25	4.42E+02	6%	4.49E+03	61%	6.09E+02	8%	1.63E+03	22%	1.48E+02	2%	7.32E+03
50	2.41E+02	8%	2.00E+03	67%	2.21E+02	7%	4.24E+02	14%	9.09E+01	3%	2.97E+03
75	1.31E+02	10%	8.89E+02	70%	8.05E+01	6%	1.10E+02	9%	5.59E+01	4%	1.27E+03
95	5.48E+01	14%	2.77E+02	70%	1.88E+01	5%	1.58E+01	4%	2.78E+01	7%	3.95E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-13. Loading Rates for the Strait of Georgia Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.27E+00	3%	1.03E+01	28%	6.79E+00	18%	1.82E+01	50%	1.75E-01	<1%	3.67E+01
25	5.82E-01	4%	4.49E+00	30%	3.12E+00	21%	6.91E+00	45%	1.07E-01	1%	1.52E+01
50	3.39E-01	4%	2.53E+00	31%	1.82E+00	22%	3.52E+00	42%	7.59E-02	1%	8.29E+00
75	1.95E-01	4%	1.43E+00	32%	1.06E+00	23%	1.79E+00	40%	5.40E-02	1%	4.53E+00
95	9.32E-02	5%	6.26E-01	33%	4.89E-01	25%	6.79E-01	35%	3.31E-02	2%	1.92E+00
Cadmium (MT/year)											
5	7.77E-01	6%	4.56E+00	37%	3.71E+00	30%	3.29E+00	26%	1.03E-01	1%	1.24E+01
25	2.67E-01	8%	1.42E+00	43%	1.27E+00	39%	2.64E-01	8%	5.54E-02	2%	3.28E+00
50	1.27E-01	9%	6.33E-01	44%	6.07E-01	42%	4.57E-02	3%	3.61E-02	2%	1.45E+00
75	6.06E-02	9%	2.82E-01	43%	2.89E-01	44%	7.92E-03	1%	2.35E-02	4%	6.63E-01
95	2.08E-02	9%	8.80E-02	40%	9.94E-02	45%	6.35E-04	<1%	1.27E-02	6%	2.22E-01
Copper (MT/year)											
5	9.32E+00	9%	2.62E+01	25%	4.37E+01	41%	2.53E+01	24%	1.73E+00	2%	1.06E+02
25	3.89E+00	11%	9.95E+00	27%	1.36E+01	37%	7.91E+00	22%	1.02E+00	3%	3.64E+01
50	2.12E+00	12%	5.07E+00	29%	6.07E+00	35%	3.52E+00	20%	7.04E-01	4%	1.75E+01
75	1.16E+00	14%	2.58E+00	30%	2.70E+00	32%	1.57E+00	18%	4.87E-01	6%	8.49E+00
95	4.83E-01	16%	9.78E-01	32%	8.43E-01	27%	4.89E-01	16%	2.86E-01	9%	3.08E+00
Lead (MT/year)											
5	1.13E+01	4%	1.49E+02	59%	4.02E+01	16%	4.01E+01	16%	1.16E+01	5%	2.53E+02
25	3.69E+00	6%	3.48E+01	56%	1.32E+01	21%	6.34E+00	10%	3.77E+00	6%	6.18E+01
50	1.70E+00	7%	1.27E+01	53%	6.07E+00	25%	1.76E+00	7%	1.72E+00	7%	2.39E+01
75	7.81E-01	8%	4.61E+00	49%	2.80E+00	30%	4.88E-01	5%	7.86E-01	8%	9.46E+00
95	2.56E-01	10%	1.07E+00	42%	9.16E-01	36%	7.73E-02	3%	2.54E-01	10%	2.58E+00
Zinc (MT/year)											
5	4.48E+01	11%	1.97E+02	50%	8.74E+01	22%	5.07E+01	13%	1.08E+01	3%	3.90E+02
25	1.87E+01	13%	7.46E+01	52%	2.73E+01	19%	1.58E+01	11%	5.72E+00	4%	1.42E+02
50	1.02E+01	14%	3.80E+01	53%	1.21E+01	17%	7.04E+00	10%	3.68E+00	5%	7.10E+01
75	5.55E+00	15%	1.94E+01	54%	5.40E+00	15%	3.13E+00	9%	2.36E+00	7%	3.58E+01
95	2.32E+00	17%	7.34E+00	54%	1.69E+00	12%	9.78E-01	7%	1.25E+00	9%	1.36E+01
Mercury (kg/year)											
5	2.00E+02	25%	1.49E+02	19%	2.28E+02	29%	2.07E+02	26%	1.45E+01	2%	8.00E+02
25	4.67E+01	28%	3.48E+01	21%	3.28E+01	20%	4.84E+01	29%	4.43E+00	3%	1.67E+02
50	1.70E+01	29%	1.27E+01	22%	8.50E+00	15%	1.76E+01	31%	1.94E+00	3%	5.77E+01
75	6.17E+00	31%	4.61E+00	23%	2.21E+00	11%	6.40E+00	32%	8.47E-01	4%	2.02E+01
95	1.44E+00	31%	1.07E+00	23%	3.17E-01	7%	1.49E+00	33%	2.58E-01	6%	4.58E+00
Total PCBs (kg/year)											
5	6.83E+01	5%	6.80E+02	53%	3.26E+02	25%	2.15E+02	17%	No studies were available to characterize total PCBs in highway runoff		1.29E+03
25	9.81E+00	6%	9.76E+01	56%	4.68E+01	27%	1.90E+01	11%			1.73E+02
50	2.55E+00	6%	2.53E+01	58%	1.21E+01	28%	3.52E+00	8%			4.35E+01
75	6.61E-01	6%	6.57E+00	60%	3.15E+00	29%	6.52E-01	6%			1.10E+01
95	9.49E-02	6%	9.44E-01	61%	4.52E-01	29%	5.76E-02	4%			1.55E+00
Total PBDEs (g/year)											
5	4.55E+01	2%	5.97E+02	25%	9.77E+02	41%	7.55E+02	32%	No studies were available to characterize total PBDEs in highway runoff		2.38E+03
25	6.54E+00	2%	1.39E+02	35%	1.40E+02	36%	1.08E+02	27%			3.95E+02
50	1.70E+00	1%	5.07E+01	43%	3.64E+01	31%	2.82E+01	24%			1.17E+02
75	4.40E-01	1%	1.84E+01	52%	9.45E+00	27%	7.31E+00	21%			3.56E+01
95	6.32E-02	1%	4.30E+00	64%	1.36E+00	20%	1.05E+00	16%			6.77E+00
Carcinogenic PAHs (MT/year)											
5	1.00E+00	16%	2.24E+00	37%	2.15E+00	35%	5.67E-01	9%	1.25E-01	2%	6.08E+00
25	2.33E-01	17%	5.23E-01	38%	5.01E-01	36%	8.14E-02	6%	5.51E-02	4%	1.39E+00
50	8.49E-02	17%	1.90E-01	37%	1.82E-01	36%	2.11E-02	4%	3.11E-02	6%	5.09E-01
75	3.09E-02	16%	6.91E-02	37%	6.62E-02	35%	5.48E-03	3%	1.75E-02	9%	1.89E-01
95	7.20E-03	15%	1.61E-02	34%	1.54E-02	33%	7.87E-04	2%	7.70E-03	16%	4.72E-02

Table C13 (continued). Loading Rates for the Strait of Georgia Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	8.00E-01	19%	1.49E+00	35%	1.43E+00	33%	4.72E-01	11%	8.25E-02	2%	4.28E+00
25	1.87E-01	19%	3.48E-01	36%	3.34E-01	35%	6.78E-02	7%	3.10E-02	3%	9.68E-01
50	6.79E-02	19%	1.27E-01	36%	1.21E-01	35%	1.76E-02	5%	1.57E-02	4%	3.49E-01
75	2.47E-02	19%	4.61E-02	36%	4.41E-02	35%	4.57E-03	4%	7.96E-03	6%	1.27E-01
95	5.76E-03	19%	1.07E-02	35%	1.03E-02	34%	6.56E-04	2%	2.99E-03	10%	3.04E-02
Low MW PAHs (MT/year)											
5	3.00E+00	23%	4.48E+00	34%	4.29E+00	33%	1.42E+00	11%	7.34E-03	<1%	1.32E+01
25	7.00E-01	24%	1.05E+00	35%	1.00E+00	34%	2.03E-01	7%	4.95E-03	<1%	2.96E+00
50	2.55E-01	24%	3.80E-01	36%	3.64E-01	35%	5.28E-02	5%	3.77E-03	<1%	1.06E+00
75	9.26E-02	24%	1.38E-01	36%	1.32E-01	35%	1.37E-02	4%	2.87E-03	1%	3.80E-01
95	2.16E-02	24%	3.22E-02	36%	3.09E-02	35%	1.97E-03	2%	1.93E-03	2%	8.86E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	2.28E+01	3%	3.40E+02	48%	3.26E+02	46%	2.15E+01	3%	7.12E-01	<1%	7.11E+02
25	3.27E+00	3%	4.88E+01	48%	4.68E+01	46%	1.90E+00	2%	4.15E-01	<1%	1.01E+02
50	8.49E-01	3%	1.27E+01	48%	1.21E+01	46%	3.52E-01	1%	2.86E-01	1%	2.63E+01
75	2.20E-01	3%	3.29E+00	48%	3.15E+00	46%	6.52E-02	1%	1.96E-01	3%	6.92E+00
95	3.16E-02	3%	4.72E-01	44%	4.52E-01	42%	5.76E-03	1%	1.15E-01	11%	1.08E+00
Total Dioxin TEQs (g/year)											
5	2.28E+01	6%	1.70E+02	45%	1.63E+02	43%	2.15E+01	6%	No studies were available to characterize total dioxin TEQs in highway runoff		3.77E+02
25	3.27E+00	6%	2.44E+01	46%	2.34E+01	44%	1.90E+00	4%			5.30E+01
50	8.49E-01	6%	6.33E+00	47%	6.07E+00	45%	3.52E-01	3%			1.36E+01
75	2.20E-01	6%	1.64E+00	47%	1.58E+00	45%	6.52E-02	2%			3.50E+00
95	3.16E-02	6%	2.36E-01	47%	2.26E-01	45%	5.76E-03	1%			5.00E-01
DDT and Metabolites (kg/year)											
5	4.55E-01	<1%	3.40E+01	7%	1.95E+02	38%	2.83E+02	55%	No studies were available to characterize DDT and metabolites in highway runoff		5.13E+02
25	6.54E-02	<1%	4.88E+00	7%	2.81E+01	38%	4.07E+01	55%			7.37E+01
50	1.70E-02	<1%	1.27E+00	7%	7.29E+00	38%	1.06E+01	55%			1.91E+01
75	4.40E-03	<1%	3.29E-01	7%	1.89E+00	38%	2.74E+00	55%			4.96E+00
95	6.32E-04	<1%	4.72E-02	7%	2.71E-01	38%	3.93E-01	55%			7.13E-01
Triclopyr (MT/year)											
5	1.55E-01	4%	1.02E+00	29%	1.95E+00	56%	3.78E-01	11%	No studies were available to characterize triclopyr in highway runoff		3.51E+00
25	1.37E-02	3%	1.46E-01	30%	2.81E-01	57%	5.42E-02	11%			4.95E-01
50	2.55E-03	2%	3.80E-02	30%	7.29E-02	57%	1.41E-02	11%			1.27E-01
75	4.72E-04	1%	9.86E-03	30%	1.89E-02	57%	3.65E-03	11%			3.29E-02
95	4.17E-05	1%	1.42E-03	30%	2.71E-03	58%	5.25E-04	11%			4.70E-03
Nonylphenol (MT/year)											
5	9.11E+00	25%	1.02E+01	28%	9.77E+00	27%	6.45E+00	18%	7.29E-01	2%	3.63E+01
25	1.31E+00	26%	1.46E+00	29%	1.40E+00	27%	5.70E-01	11%	3.61E-01	7%	5.11E+00
50	3.39E-01	24%	3.80E-01	27%	3.64E-01	26%	1.06E-01	7%	2.21E-01	16%	1.41E+00
75	8.81E-02	20%	9.86E-02	23%	9.45E-02	22%	1.96E-02	4%	1.36E-01	31%	4.37E-01
95	1.26E-02	12%	1.42E-02	13%	1.36E-02	12%	1.73E-03	2%	6.72E-02	61%	1.09E-01
TPH (MT/year)											
5	2.24E+03	4%	2.74E+04	51%	1.43E+04	27%	9.44E+03	18%	2.78E+02	1%	5.36E+04
25	9.34E+02	7%	8.54E+03	60%	3.34E+03	23%	1.36E+03	9%	1.38E+02	1%	1.43E+04
50	5.09E+02	9%	3.80E+03	64%	1.21E+03	20%	3.52E+02	6%	8.48E+01	1%	5.96E+03
75	2.77E+02	11%	1.69E+03	66%	4.41E+02	17%	9.13E+01	4%	5.22E+01	2%	2.55E+03
95	1.16E+02	15%	5.28E+02	67%	1.03E+02	13%	1.31E+01	2%	2.59E+01	3%	7.86E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-14. Loading Rates for the Whidbey Basin Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	1.01E+00	1%	1.91E+01	19%	5.35E+00	5%	7.59E+01	75%	2.16E-01	<1%	1.02E+02
25	4.66E-01	1%	8.38E+00	21%	2.46E+00	6%	2.88E+01	72%	1.32E-01	<1%	4.02E+01
50	2.71E-01	1%	4.73E+00	22%	1.43E+00	7%	1.46E+01	69%	9.42E-02	<1%	2.12E+01
75	1.56E-01	1%	2.66E+00	24%	8.36E-01	7%	7.46E+00	67%	6.70E-02	1%	1.12E+01
95	7.45E-02	2%	1.17E+00	26%	3.85E-01	9%	2.83E+00	63%	4.10E-02	1%	4.50E+00
Cadmium (MT/year)											
5	6.22E-01	2%	8.50E+00	33%	2.92E+00	11%	1.37E+01	53%	1.27E-01	<1%	2.59E+01
25	2.14E-01	4%	2.65E+00	53%	1.00E+00	20%	1.10E+00	22%	6.87E-02	1%	5.04E+00
50	1.02E-01	5%	1.18E+00	59%	4.78E-01	24%	1.90E-01	10%	4.48E-02	2%	2.00E+00
75	4.85E-02	6%	5.26E-01	61%	2.28E-01	26%	3.30E-02	4%	2.92E-02	3%	8.64E-01
95	1.67E-02	6%	1.64E-01	59%	7.83E-02	28%	2.65E-03	1%	1.58E-02	6%	2.77E-01
Copper (MT/year)											
5	7.46E+00	4%	4.90E+01	25%	3.44E+01	17%	1.05E+02	53%	2.15E+00	1%	1.98E+02
25	3.11E+00	5%	1.86E+01	28%	1.07E+01	16%	3.29E+01	49%	1.26E+00	2%	6.66E+01
50	1.70E+00	5%	9.45E+00	30%	4.78E+00	15%	1.46E+01	47%	8.73E-01	3%	3.14E+01
75	9.25E-01	6%	4.81E+00	32%	2.13E+00	14%	6.52E+00	43%	6.03E-01	4%	1.50E+01
95	3.86E-01	7%	1.82E+00	35%	6.64E-01	13%	2.04E+00	39%	3.55E-01	7%	5.26E+00
Lead (MT/year)											
5	9.00E+00	2%	2.79E+02	56%	3.17E+01	6%	1.67E+02	33%	1.44E+01	3%	5.00E+02
25	2.95E+00	3%	6.50E+01	59%	1.04E+01	9%	2.64E+01	24%	4.67E+00	4%	1.09E+02
50	1.36E+00	3%	2.36E+01	60%	4.78E+00	12%	7.32E+00	19%	2.13E+00	5%	3.92E+01
75	6.25E-01	4%	8.59E+00	60%	2.20E+00	15%	2.03E+00	14%	9.74E-01	7%	1.44E+01
95	2.05E-01	6%	2.00E+00	56%	7.21E-01	20%	3.22E-01	9%	3.15E-01	9%	3.57E+00
Zinc (MT/year)											
5	3.58E+01	5%	3.67E+02	53%	6.88E+01	10%	2.11E+02	30%	1.34E+01	2%	6.96E+02
25	1.49E+01	6%	1.39E+02	56%	2.15E+01	9%	6.58E+01	26%	7.09E+00	3%	2.48E+02
50	8.14E+00	7%	7.09E+01	58%	9.56E+00	8%	2.93E+01	24%	4.56E+00	4%	1.22E+02
75	4.44E+00	7%	3.61E+01	59%	4.26E+00	7%	1.30E+01	21%	2.93E+00	5%	6.08E+01
95	1.85E+00	8%	1.37E+01	61%	1.33E+00	6%	4.07E+00	18%	1.55E+00	7%	2.25E+01
Mercury (kg/year)											
5	1.60E+02	11%	2.79E+02	19%	1.80E+02	12%	8.64E+02	58%	1.80E+01	1%	1.50E+03
25	3.73E+01	11%	6.50E+01	19%	2.58E+01	8%	2.01E+02	60%	5.49E+00	2%	3.35E+02
50	1.36E+01	11%	2.36E+01	20%	6.69E+00	6%	7.32E+01	61%	2.40E+00	2%	1.20E+02
75	4.94E+00	11%	8.59E+00	20%	1.74E+00	4%	2.66E+01	62%	1.05E+00	2%	4.29E+01
95	1.15E+00	12%	2.00E+00	20%	2.49E-01	3%	6.21E+00	63%	3.20E-01	3%	9.94E+00
Total PCBs (kg/year)											
5	5.46E+01	2%	1.27E+03	51%	2.57E+02	10%	8.95E+02	36%	No studies were available to characterize total PCBs in highway runoff		2.47E+03
25	7.85E+00	3%	1.82E+02	60%	3.68E+01	12%	7.91E+01	26%			3.06E+02
50	2.04E+00	3%	4.73E+01	64%	9.56E+00	13%	1.46E+01	20%			7.35E+01
75	5.28E-01	3%	1.23E+01	68%	2.48E+00	14%	2.71E+00	15%			1.80E+01
95	7.59E-02	3%	1.76E+00	72%	3.56E-01	15%	2.40E-01	10%			2.43E+00
Total PBDEs (g/year)											
5	3.64E+01	1%	1.11E+03	22%	7.70E+02	15%	3.14E+03	62%	No studies were available to characterize total PBDEs in highway runoff		5.07E+03
25	5.23E+00	1%	2.60E+02	31%	1.11E+02	13%	4.52E+02	55%			8.27E+02
50	1.36E+00	1%	9.45E+01	39%	2.87E+01	12%	1.17E+02	48%			2.42E+02
75	3.52E-01	<1%	3.44E+01	47%	7.44E+00	10%	3.04E+01	42%			7.26E+01
95	5.06E-02	<1%	8.02E+00	59%	1.07E+00	8%	4.37E+00	32%			1.35E+01
Carcinogenic PAHs (MT/year)											
5	8.00E-01	9%	4.18E+00	45%	1.69E+00	18%	2.36E+00	26%	1.56E-01	2%	9.18E+00
25	1.87E-01	10%	9.75E-01	50%	3.94E-01	20%	3.39E-01	17%	6.83E-02	3%	1.96E+00
50	6.79E-02	10%	3.54E-01	51%	1.43E-01	21%	8.79E-02	13%	3.85E-02	6%	6.92E-01
75	2.47E-02	10%	1.29E-01	51%	5.21E-02	21%	2.28E-02	9%	2.18E-02	9%	2.50E-01
95	5.76E-03	9%	3.01E-02	49%	1.22E-02	20%	3.28E-03	5%	9.55E-03	16%	6.08E-02

Table C-14 (continued). Loading Rates for the Whidbey Basin Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	6.40E-01	10%	2.79E+00	42%	1.13E+00	17%	1.97E+00	30%	1.02E-01	2%	6.62E+00
25	1.49E-01	11%	6.50E-01	47%	2.63E-01	19%	2.82E-01	20%	3.85E-02	3%	1.38E+00
50	5.43E-02	11%	2.36E-01	49%	9.56E-02	20%	7.32E-02	15%	1.95E-02	4%	4.79E-01
75	1.97E-02	12%	8.59E-02	51%	3.48E-02	21%	1.90E-02	11%	9.87E-03	6%	1.69E-01
95	4.61E-03	12%	2.00E-02	51%	8.11E-03	21%	2.73E-03	7%	3.71E-03	9%	3.92E-02
Low MW PAHs (MT/year)											
5	2.40E+00	12%	8.36E+00	42%	3.38E+00	17%	5.90E+00	29%	9.10E-03	<1%	2.00E+01
25	5.60E-01	13%	1.95E+00	47%	7.89E-01	19%	8.47E-01	20%	6.14E-03	<1%	4.15E+00
50	2.04E-01	14%	7.09E-01	50%	2.87E-01	20%	2.20E-01	15%	4.67E-03	<1%	1.42E+00
75	7.40E-02	15%	2.58E-01	52%	1.04E-01	21%	5.70E-02	11%	3.55E-03	1%	4.97E-01
95	1.73E-02	15%	6.01E-02	54%	2.43E-02	22%	8.19E-03	7%	2.40E-03	2%	1.12E-01
bis(2-Ethylhexyl)phthalate (MT/year)											
5	1.82E+01	2%	6.34E+02	63%	2.57E+02	26%	8.95E+01	9%	8.83E-01	<1%	9.99E+02
25	2.62E+00	2%	9.10E+01	66%	3.68E+01	27%	7.91E+00	6%	5.15E-01	<1%	1.39E+02
50	6.79E-01	2%	2.36E+01	66%	9.56E+00	27%	1.46E+00	4%	3.54E-01	1%	3.57E+01
75	1.76E-01	2%	6.13E+00	66%	2.48E+00	27%	2.71E-01	3%	2.44E-01	3%	9.30E+00
95	2.53E-02	2%	8.80E-01	62%	3.56E-01	25%	2.40E-02	2%	1.42E-01	10%	1.43E+00
Total Dioxin TEQs (g/year)											
5	1.82E+01	3%	3.17E+02	57%	1.28E+02	23%	8.95E+01	16%	No studies were available to characterize total dioxin TEQs in highway runoff		5.53E+02
25	2.62E+00	4%	4.55E+01	61%	1.84E+01	25%	7.91E+00	11%			7.45E+01
50	6.79E-01	4%	1.18E+01	63%	4.78E+00	26%	1.46E+00	8%			1.87E+01
75	1.76E-01	4%	3.07E+00	64%	1.24E+00	26%	2.71E-01	6%			4.75E+00
95	2.53E-02	4%	4.40E-01	66%	1.78E-01	27%	2.40E-02	4%			6.68E-01
DDT and Metabolites (kg/year)											
5	3.64E-01	<1%	6.34E+01	5%	1.54E+02	11%	1.18E+03	84%	No studies were available to characterize DDT and metabolites in highway runoff		1.40E+03
25	5.23E-02	<1%	9.10E+00	5%	2.21E+01	11%	1.69E+02	84%			2.01E+02
50	1.36E-02	<1%	2.36E+00	5%	5.74E+00	11%	4.39E+01	84%			5.21E+01
75	3.52E-03	<1%	6.13E-01	5%	1.49E+00	11%	1.14E+01	84%			1.35E+01
95	5.06E-04	<1%	8.80E-02	5%	2.14E-01	11%	1.64E+00	84%			1.94E+00
Triclopyr (MT/year)											
5	1.24E-01	2%	1.90E+00	37%	1.54E+00	30%	1.57E+00	31%	No studies were available to characterize triclopyr in highway runoff		5.14E+00
25	1.10E-02	2%	2.73E-01	37%	2.21E-01	30%	2.26E-01	31%			7.31E-01
50	2.04E-03	1%	7.09E-02	38%	5.74E-02	30%	5.86E-02	31%			1.89E-01
75	3.77E-04	1%	1.84E-02	38%	1.49E-02	30%	1.52E-02	31%			4.89E-02
95	3.33E-05	<1%	2.64E-03	38%	2.14E-03	31%	2.18E-03	31%			7.00E-03
Nonylphenol (MT/year)											
5	7.29E+00	12%	1.90E+01	31%	7.70E+00	12%	2.68E+01	43%	9.04E-01	1%	6.17E+01
25	1.05E+00	14%	2.73E+00	35%	1.11E+00	14%	2.37E+00	31%	4.48E-01	6%	7.70E+00
50	2.71E-01	14%	7.09E-01	36%	2.87E-01	14%	4.39E-01	22%	2.75E-01	14%	1.98E+00
75	7.05E-02	12%	1.84E-01	32%	7.44E-02	13%	8.14E-02	14%	1.68E-01	29%	5.79E-01
95	1.01E-02	7%	2.64E-02	19%	1.07E-02	8%	7.20E-03	5%	8.34E-02	61%	1.38E-01
TPH (MT/year)											
5	1.79E+03	2%	5.10E+04	49%	1.13E+04	11%	3.93E+04	38%	3.45E+02	<1%	1.04E+05
25	7.47E+02	3%	1.59E+04	63%	2.63E+03	10%	5.65E+03	22%	1.71E+02	1%	2.51E+04
50	4.07E+02	4%	7.09E+03	71%	9.56E+02	10%	1.46E+03	15%	1.05E+02	1%	1.00E+04
75	2.22E+02	5%	3.16E+03	76%	3.48E+02	8%	3.80E+02	9%	6.47E+01	2%	4.17E+03
95	9.27E+01	7%	9.85E+02	79%	8.11E+01	7%	5.46E+01	4%	3.21E+01	3%	1.25E+03

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Table C-15. Loading Rates for the San Juan Islands Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Arsenic (MT/year)											
5	4.28E-01	6%	3.15E+00	43%	7.92E-01	11%	2.92E+00	40%	1.27E-02	<1%	7.31E+00
25	1.97E-01	6%	1.38E+00	45%	3.65E-01	12%	1.11E+00	36%	7.78E-03	<1%	3.06E+00
50	1.15E-01	7%	7.79E-01	46%	2.13E-01	13%	5.64E-01	34%	5.53E-03	<1%	1.68E+00
75	6.60E-02	7%	4.39E-01	48%	1.24E-01	13%	2.87E-01	31%	3.93E-03	<1%	9.20E-01
95	3.15E-02	8%	1.92E-01	49%	5.70E-02	15%	1.09E-01	28%	2.41E-03	1%	3.92E-01
Cadmium (MT/year)											
5	2.63E-01	10%	1.40E+00	53%	4.33E-01	16%	5.28E-01	20%	7.47E-03	<1%	2.63E+00
25	9.04E-02	13%	4.37E-01	60%	1.49E-01	21%	4.24E-02	6%	4.03E-03	1%	7.23E-01
50	4.30E-02	14%	1.95E-01	61%	7.08E-02	22%	7.33E-03	2%	2.63E-03	1%	3.18E-01
75	2.05E-02	14%	8.66E-02	60%	3.37E-02	23%	1.27E-03	1%	1.71E-03	1%	1.44E-01
95	7.05E-03	15%	2.70E-02	58%	1.16E-02	25%	1.02E-04	<1%	9.25E-04	2%	4.67E-02
Copper (MT/year)											
5	3.15E+00	15%	8.07E+00	39%	5.10E+00	25%	4.06E+00	20%	1.26E-01	1%	2.05E+01
25	1.32E+00	18%	3.06E+00	42%	1.59E+00	22%	1.27E+00	17%	7.42E-02	1%	7.31E+00
50	7.17E-01	20%	1.56E+00	43%	7.08E-01	20%	5.64E-01	16%	5.13E-02	1%	3.60E+00
75	3.91E-01	22%	7.93E-01	44%	3.15E-01	18%	2.51E-01	14%	3.54E-02	2%	1.79E+00
95	1.63E-01	25%	3.01E-01	45%	9.84E-02	15%	7.84E-02	12%	2.08E-02	3%	6.61E-01
Lead (MT/year)											
5	3.80E+00	6%	4.59E+01	74%	4.70E+00	8%	6.42E+00	10%	8.48E-01	1%	6.17E+01
25	1.25E+00	8%	1.07E+01	72%	1.54E+00	10%	1.02E+00	7%	2.74E-01	2%	1.48E+01
50	5.74E-01	10%	3.89E+00	70%	7.08E-01	13%	2.82E-01	5%	1.25E-01	2%	5.58E+00
75	2.64E-01	12%	1.42E+00	66%	3.26E-01	15%	7.83E-02	4%	5.72E-02	3%	2.14E+00
95	8.66E-02	16%	3.30E-01	60%	1.07E-01	19%	1.24E-02	2%	1.85E-02	3%	5.54E-01
Zinc (MT/year)											
5	1.51E+01	16%	6.05E+01	64%	1.02E+01	11%	8.12E+00	9%	7.86E-01	1%	9.47E+01
25	6.32E+00	18%	2.29E+01	65%	3.18E+00	9%	2.54E+00	7%	4.16E-01	1%	3.54E+01
50	3.44E+00	19%	1.17E+01	65%	1.42E+00	8%	1.13E+00	6%	2.68E-01	1%	1.79E+01
75	1.88E+00	21%	5.95E+00	65%	6.31E-01	7%	5.02E-01	6%	1.72E-01	2%	9.13E+00
95	7.84E-01	22%	2.25E+00	65%	1.97E-01	6%	1.57E-01	5%	9.12E-02	3%	3.48E+00
Mercury (kg/year)											
5	6.77E+01	39%	4.59E+01	26%	2.66E+01	15%	3.33E+01	19%	1.06E+00	1%	1.74E+02
25	1.58E+01	41%	1.07E+01	28%	3.82E+00	10%	7.76E+00	20%	3.22E-01	1%	3.84E+01
50	5.74E+00	42%	3.89E+00	29%	9.92E-01	7%	2.82E+00	21%	1.41E-01	1%	1.36E+01
75	2.09E+00	43%	1.42E+00	29%	2.57E-01	5%	1.03E+00	21%	6.17E-02	1%	4.85E+00
95	4.87E-01	44%	3.30E-01	30%	3.70E-02	3%	2.39E-01	22%	1.88E-02	2%	1.11E+00
Total PCBs (kg/year)											
5	2.31E+01	8%	2.09E+02	69%	3.80E+01	12%	3.45E+01	11%	No studies were available to characterize total PCBs in highway runoff		3.05E+02
25	3.32E+00	8%	3.00E+01	72%	5.46E+00	13%	3.05E+00	7%			4.18E+01
50	8.61E-01	8%	7.79E+00	73%	1.42E+00	13%	5.64E-01	5%			1.06E+01
75	2.23E-01	8%	2.02E+00	74%	3.68E-01	14%	1.05E-01	4%			2.72E+00
95	3.21E-02	8%	2.90E-01	76%	5.28E-02	14%	9.24E-03	2%			3.84E-01
Total PBDEs (g/year)											
5	1.54E+01	4%	1.84E+02	42%	1.14E+02	26%	1.21E+02	28%	No studies were available to characterize total PBDEs in highway runoff		4.34E+02
25	2.21E+00	3%	4.28E+01	54%	1.64E+01	21%	1.74E+01	22%			7.88E+01
50	5.74E-01	2%	1.56E+01	63%	4.25E+00	17%	4.51E+00	18%			2.49E+01
75	1.49E-01	2%	5.66E+00	70%	1.10E+00	14%	1.17E+00	14%			8.08E+00
95	2.14E-02	1%	1.32E+00	79%	1.58E-01	9%	1.68E-01	10%			1.67E+00
Carcinogenic PAHs (MT/year)											
5	3.38E-01	25%	6.88E-01	50%	2.51E-01	18%	9.08E-02	7%	9.14E-03	1%	1.38E+00
25	7.89E-02	25%	1.61E-01	51%	5.84E-02	19%	1.30E-02	4%	4.01E-03	1%	3.15E-01
50	2.87E-02	25%	5.84E-02	51%	2.13E-02	19%	3.39E-03	3%	2.26E-03	2%	1.14E-01
75	1.04E-02	25%	2.12E-02	51%	7.73E-03	19%	8.78E-04	2%	1.28E-03	3%	4.15E-02
95	2.43E-03	25%	4.95E-03	50%	1.80E-03	18%	1.26E-04	1%	5.61E-04	6%	9.88E-03

Table C-15 (continued). Loading Rates for the San Juan Islands Study Area by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial		Residential		Agriculture		Forest/Field/Other		Highways		Total Loading
	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	Annual Loading	% of Total Loading	
Other High MW PAHs (MT/year)											
5	2.71E-01	28%	4.59E-01	47%	1.67E-01	17%	7.57E-02	8%	6.01E-03	1%	9.78E-01
25	6.31E-02	28%	1.07E-01	48%	3.90E-02	18%	1.09E-02	5%	2.26E-03	1%	2.22E-01
50	2.30E-02	29%	3.89E-02	49%	1.42E-02	18%	2.82E-03	4%	1.14E-03	1%	8.00E-02
75	8.35E-03	29%	1.42E-02	49%	5.15E-03	18%	7.32E-04	3%	5.80E-04	2%	2.90E-02
95	1.95E-03	29%	3.30E-03	49%	1.20E-03	18%	1.05E-04	2%	2.18E-04	3%	6.77E-03
Low MW PAHs (MT/year)											
5	1.01E+00	33%	1.38E+00	44%	5.01E-01	16%	2.27E-01	7%	5.35E-04	<1%	3.12E+00
25	2.37E-01	33%	3.21E-01	45%	1.17E-01	17%	3.26E-02	5%	3.61E-04	<1%	7.08E-01
50	8.61E-02	34%	1.17E-01	46%	4.25E-02	17%	8.46E-03	3%	2.74E-04	<1%	2.54E-01
75	3.13E-02	34%	4.25E-02	46%	1.55E-02	17%	2.20E-03	2%	2.09E-04	<1%	9.16E-02
95	7.30E-03	34%	9.91E-03	47%	3.60E-03	17%	3.15E-04	1%	1.41E-04	1%	2.13E-02
bis(2-Ethylhexyl)phthalate (MT/year)											
5	7.70E+00	5%	1.04E+02	68%	3.80E+01	25%	3.45E+00	2%	5.19E-02	<1%	1.54E+02
25	1.11E+00	5%	1.50E+01	68%	5.46E+00	25%	3.05E-01	1%	3.03E-02	<1%	2.19E+01
50	2.87E-01	5%	3.89E+00	69%	1.42E+00	25%	5.64E-02	1%	2.08E-02	<1%	5.67E+00
75	7.45E-02	5%	1.01E+00	68%	3.68E-01	25%	1.05E-02	1%	1.43E-02	1%	1.48E+00
95	1.07E-02	5%	1.45E-01	67%	5.28E-02	24%	9.24E-04	<1%	8.35E-03	4%	2.18E-01
Total Dioxin TEQs (g/year)											
5	7.70E+00	9%	5.22E+01	63%	1.90E+01	23%	3.45E+00	4%	No studies were available to characterize total dioxin TEQs in highway runoff		8.24E+01
25	1.11E+00	9%	7.50E+00	64%	2.73E+00	23%	3.05E-01	3%			1.16E+01
50	2.87E-01	10%	1.95E+00	65%	7.08E-01	24%	5.64E-02	2%			3.00E+00
75	7.45E-02	10%	5.05E-01	65%	1.84E-01	24%	1.05E-02	1%			7.74E-01
95	1.07E-02	10%	7.25E-02	66%	2.64E-02	24%	9.24E-04	1%			1.11E-01
DDT and Metabolites (kg/year)											
5	1.54E-01	<1%	1.04E+01	13%	2.28E+01	29%	4.54E+01	58%	No studies were available to characterize DDT and metabolites in highway runoff		7.88E+01
25	2.21E-02	<1%	1.50E+00	13%	3.28E+00	29%	6.52E+00	58%			1.13E+01
50	5.74E-03	<1%	3.89E-01	13%	8.50E-01	29%	1.69E+00	58%			2.94E+00
75	1.49E-03	<1%	1.01E-01	13%	2.21E-01	29%	4.39E-01	58%			7.62E-01
95	2.14E-04	<1%	1.45E-02	13%	3.17E-02	29%	6.31E-02	58%			1.09E-01
Triclopyr (MT/year)											
5	5.26E-02	8%	3.13E-01	48%	2.28E-01	35%	6.06E-02	9%	No studies were available to characterize triclopyr in highway runoff		6.55E-01
25	4.65E-03	5%	4.50E-02	49%	3.28E-02	36%	8.70E-03	10%			9.11E-02
50	8.61E-04	4%	1.17E-02	50%	8.50E-03	36%	2.26E-03	10%			2.33E-02
75	1.59E-04	3%	3.03E-03	51%	2.21E-03	37%	5.86E-04	10%			5.98E-03
95	1.41E-05	2%	4.35E-04	51%	3.17E-04	37%	8.41E-05	10%			8.50E-04
Nonylphenol (MT/year)											
5	3.08E+00	36%	3.13E+00	37%	1.14E+00	14%	1.03E+00	12%	5.31E-02	1%	8.44E+00
25	4.42E-01	38%	4.50E-01	38%	1.64E-01	14%	9.14E-02	8%	2.63E-02	2%	1.17E+00
50	1.15E-01	37%	1.17E-01	38%	4.25E-02	14%	1.69E-02	6%	1.61E-02	5%	3.07E-01
75	2.98E-02	35%	3.03E-02	36%	1.10E-02	13%	3.14E-03	4%	9.89E-03	12%	8.41E-02
95	4.28E-03	28%	4.35E-03	28%	1.58E-03	10%	2.77E-04	2%	4.90E-03	32%	1.54E-02
TPH (MT/year)											
5	7.57E+02	6%	8.41E+03	68%	1.67E+03	14%	1.51E+03	12%	2.02E+01	<1%	1.24E+04
25	3.16E+02	9%	2.62E+03	74%	3.90E+02	11%	2.17E+02	6%	1.01E+01	<1%	3.56E+03
50	1.72E+02	11%	1.17E+03	76%	1.42E+02	9%	5.64E+01	4%	6.18E+00	<1%	1.54E+03
75	9.38E+01	14%	5.20E+02	76%	5.15E+01	8%	1.46E+01	2%	3.80E+00	1%	6.84E+02
95	3.92E+01	18%	1.62E+02	75%	1.20E+01	6%	2.10E+00	1%	1.89E+00	1%	2.17E+02

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/year = Grams per year.
kg/year = Kilograms per year.
MT/year = Metric tons per year.

MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Appendix D

Tabular Summary of Unit Area Toxic Chemical Loading Estimates by Land Use Category

Table D-1. Unit Area Annual Loading Rates for the Entire Puget Sound Basin by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial	Residential	Agriculture	Forest/Field/Other	Highways
Arsenic (kg/km^2/year)					
5	4.94E+01	2.61E+01	1.23E+01	6.77E+00	2.27E+01
25	2.27E+01	1.14E+01	5.68E+00	2.57E+00	1.39E+01
50	1.33E+01	6.44E+00	3.31E+00	1.31E+00	9.90E+00
75	7.63E+00	3.63E+00	1.93E+00	6.66E-01	7.04E+00
95	3.63E+00	1.59E+00	8.87E-01	2.52E-01	4.31E+00
Cadmium (kg/km^2/year)					
5	3.03E+01	1.16E+01	6.73E+00	1.22E+00	1.34E+01
25	1.04E+01	3.62E+00	2.32E+00	9.81E-02	7.22E+00
50	4.97E+00	1.61E+00	1.10E+00	1.70E-02	4.70E+00
75	2.37E+00	7.17E-01	5.25E-01	2.94E-03	3.06E+00
95	8.14E-01	2.24E-01	1.81E-01	2.36E-04	1.66E+00
Copper (kg/km^2/year)					
5	3.64E+02	6.67E+01	7.94E+01	9.41E+00	2.26E+02
25	1.52E+02	2.53E+01	2.48E+01	2.94E+00	1.33E+02
50	8.28E+01	1.29E+01	1.10E+01	1.31E+00	9.17E+01
75	4.51E+01	6.56E+00	4.91E+00	5.82E-01	6.34E+01
95	1.88E+01	2.49E+00	1.53E+00	1.82E-01	3.73E+01
Lead (kg/km^2/year)					
5	4.39E+02	3.80E+02	7.31E+01	1.49E+01	1.52E+03
25	1.44E+02	8.86E+01	2.40E+01	2.35E+00	4.91E+02
50	6.63E+01	3.22E+01	1.10E+01	6.53E-01	2.24E+02
75	3.05E+01	1.17E+01	5.08E+00	1.81E-01	1.02E+02
95	9.99E+00	2.73E+00	1.66E+00	2.87E-02	3.31E+01
Zinc (kg/km^2/year)					
5	1.75E+03	5.00E+02	1.59E+02	1.88E+01	1.41E+03
25	7.29E+02	1.90E+02	4.96E+01	5.87E+00	7.45E+02
50	3.98E+02	9.66E+01	2.21E+01	2.61E+00	4.79E+02
75	2.17E+02	4.92E+01	9.82E+00	1.16E+00	3.08E+02
95	9.05E+01	1.86E+01	3.06E+00	3.63E-01	1.63E+02
Mercury (g/km^2/year)					
5	7.81E+03	3.80E+02	4.14E+02	7.70E+01	1.89E+03
25	1.82E+03	8.86E+01	5.95E+01	1.80E+01	5.77E+02
50	6.63E+02	3.22E+01	1.54E+01	6.53E+00	2.52E+02
75	2.41E+02	1.17E+01	4.01E+00	2.38E+00	1.10E+02
95	5.62E+01	2.73E+00	5.75E-01	5.54E-01	3.36E+01
Total PCBs (g/km^2/year)					
5	2.67E+03	1.73E+03	5.92E+02	7.98E+01	No studies were available to characterize total PCBs in highway runoff
25	3.83E+02	2.48E+02	8.50E+01	7.06E+00	
50	9.94E+01	6.44E+01	2.21E+01	1.31E+00	
75	2.58E+01	1.67E+01	5.72E+00	2.42E-01	
95	3.70E+00	2.40E+00	8.22E-01	2.14E-02	
Total PBDEs (mg/km^2/year)					
5	1.78E+03	1.52E+03	1.78E+03	2.81E+02	No studies were available to characterize total PBDEs in highway runoff
25	2.55E+02	3.54E+02	2.55E+02	4.03E+01	
50	6.63E+01	1.29E+02	6.62E+01	1.05E+01	
75	1.72E+01	4.68E+01	1.72E+01	2.71E+00	
95	2.47E+00	1.09E+01	2.47E+00	3.90E-01	
Carcinogenic PAHs (kg/km^2/year)					
5	3.91E+01	5.69E+00	3.90E+00	2.10E-01	1.63E+01
25	9.11E+00	1.33E+00	9.10E-01	3.02E-02	7.18E+00
50	3.31E+00	4.83E-01	3.31E-01	7.84E-03	4.05E+00
75	1.20E+00	1.76E-01	1.20E-01	2.03E-03	2.29E+00
95	2.81E-01	4.10E-02	2.81E-02	2.92E-04	1.00E+00

Table D-1 (continued). Unit Area Annual Loading Rates for the Entire Puget Sound Basin by Land Use Category.

Probability of Exceedance (percent)	Commercial/Industrial	Residential	Agriculture	Forest/Field/Other	Highways
Other High MW PAHs (kg/km^2/year)					
5	3.12E+01	3.80E+00	2.60E+00	1.75E-01	1.08E+01
25	7.29E+00	8.86E-01	6.07E-01	2.52E-02	4.04E+00
50	2.65E+00	3.22E-01	2.21E-01	6.53E-03	2.05E+00
75	9.64E-01	1.17E-01	8.02E-02	1.70E-03	1.04E+00
95	2.25E-01	2.73E-02	1.87E-02	2.43E-04	3.90E-01
Low MW PAHs (kg/km^2/year)					
5	1.17E+02	1.14E+01	7.80E+00	5.26E-01	9.57E-01
25	2.73E+01	2.66E+00	1.82E+00	7.55E-02	6.45E-01
50	9.94E+00	9.66E-01	6.62E-01	1.96E-02	4.91E-01
75	3.61E+00	3.51E-01	2.41E-01	5.09E-03	3.73E-01
95	8.43E-01	8.19E-02	5.61E-02	7.30E-04	2.52E-01
bis(2-Ethylhexyl)phthalate (kg/km^2/year)					
5	8.89E+02	8.64E+02	5.92E+02	7.98E+00	9.28E+01
25	1.28E+02	1.24E+02	8.50E+01	7.06E-01	5.41E+01
50	3.31E+01	3.22E+01	2.21E+01	1.31E-01	3.72E+01
75	8.60E+00	8.36E+00	5.72E+00	2.42E-02	2.56E+01
95	1.23E+00	1.20E+00	8.22E-01	2.14E-03	1.49E+01
Total Dioxin TEQs (mg/km^2/year)					
5	8.89E+02	4.32E+02	2.96E+02	7.98E+00	No studies were available to characterize total dioxin TEQs in highway runoff
25	1.28E+02	6.20E+01	4.25E+01	7.06E-01	
50	3.31E+01	1.61E+01	1.10E+01	1.31E-01	
75	8.60E+00	4.18E+00	2.86E+00	2.42E-02	
95	1.23E+00	6.00E-01	4.11E-01	2.14E-03	
DDT and Metabolites (g/km^2/year)					
5	1.78E+01	8.64E+01	3.55E+02	1.05E+02	No studies were available to characterize DDT and metabolites in highway runoff
25	2.55E+00	1.24E+01	5.10E+01	1.51E+01	
50	6.63E-01	3.22E+00	1.32E+01	3.92E+00	
75	1.72E-01	8.36E-01	3.43E+00	1.02E+00	
95	2.47E-02	1.20E-01	4.93E-01	1.46E-01	
Triclopyr (g/km^2/year)					
5	6.07E+03	2.59E+03	3.55E+03	1.40E+02	No studies were available to characterize triclopyr in highway runoff
25	5.37E+02	3.72E+02	5.10E+02	2.01E+01	
50	9.94E+01	9.66E+01	1.32E+02	5.23E+00	
75	1.84E+01	2.51E+01	3.43E+01	1.36E+00	
95	1.63E+00	3.60E+00	4.93E+00	1.95E-01	
Nonylphenol (kg/km^2/year)					
5	3.56E+02	2.59E+01	1.78E+01	2.39E+00	9.50E+01
25	5.11E+01	3.72E+00	2.55E+00	2.12E-01	4.70E+01
50	1.33E+01	9.66E-01	6.62E-01	3.92E-02	2.89E+01
75	3.44E+00	2.51E-01	1.72E-01	7.26E-03	1.77E+01
95	4.94E-01	3.60E-02	2.47E-02	6.42E-04	8.76E+00
TPH (MT/year)					
5	8.73E+01	6.95E+01	2.60E+01	3.51E+00	3.62E+01
25	3.65E+01	2.17E+01	6.07E+00	5.04E-01	1.80E+01
50	1.99E+01	9.66E+00	2.21E+00	1.31E-01	1.11E+01
75	1.08E+01	4.30E+00	8.02E-01	3.39E-02	6.80E+00
95	4.52E+00	1.34E+00	1.87E-01	4.87E-03	3.38E+00

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/km^2/year = grams per square kilometer per year.
kg/km^2/year = Kilograms per square kilometer per year.
MT/year = Metric tons per year.
mg/km^2/year = Milligrams per square kilometer per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.
PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Appendix E

Tabular Summary of Unit Area Toxic Chemical Loading Estimates for the Puget Sound Basin and 14 Study Areas in Ecology's Puget Sound Box Model

Table E-1. Unit Area Loading Rates for the Puget Sound Basin and the 14 Study Areas in Ecology's Puget Sound Box Model.

Probability of Exceedance (percent)	Main Basin	Port Gardner	Elliott Bay	Commencement Bay	South Sound (East)	South Sound (West)	Hood Canal (South)	Hood Canal (North)	Sinclair/Dyes Inlet	Admiralty Inlet	Strait of Juan de Fuca	Strait of Georgia	Whidbey Basin	San Juan Islands	Puget Sound Basin
Arsenic (kg/km^2/year)															
5	6.87E+00	1.26E+01	8.38E+00	7.68E+00	6.55E+00	5.83E+00	9.54E+00	4.58E+00	1.09E+01	1.01E+01	9.34E+00	1.01E+01	1.06E+01	1.10E+01	**9.55E+00**
25	2.97E+00	5.12E+00	3.59E+00	3.19E+00	2.74E+00	2.41E+00	3.73E+00	1.87E+00	4.69E+00	4.20E+00	3.70E+00	4.19E+00	4.21E+00	4.58E+00	**3.88E+00**
50	1.66E+00	2.75E+00	2.00E+00	1.74E+00	1.50E+00	1.31E+00	1.94E+00	1.01E+00	2.62E+00	2.30E+00	1.95E+00	2.28E+00	2.22E+00	2.51E+00	**2.08E+00**
75	9.32E-01	1.48E+00	1.12E+00	9.48E-01	8.27E-01	7.17E-01	1.02E+00	5.43E-01	1.46E+00	1.26E+00	1.03E+00	1.25E+00	1.17E+00	1.38E+00	**1.12E+00**
95	4.09E-01	6.12E-01	4.89E-01	4.02E-01	3.53E-01	3.03E-01	4.02E-01	2.26E-01	6.38E-01	5.35E-01	4.18E-01	5.29E-01	4.71E-01	5.88E-01	**4.64E-01**
Cadmium (kg/km^2/year)															
5	2.93E+00	3.80E+00	3.47E+00	2.65E+00	2.36E+00	1.97E+00	2.20E+00	1.42E+00	4.44E+00	3.51E+00	2.39E+00	3.43E+00	2.71E+00	3.95E+00	**2.88E+00**
25	8.90E-01	9.00E-01	1.04E+00	7.02E-01	6.51E-01	5.17E-01	3.66E-01	3.46E-01	1.32E+00	9.47E-01	4.72E-01	9.05E-01	5.28E-01	1.08E+00	**6.83E-01**
50	4.00E-01	3.80E-01	4.68E-01	3.06E-01	2.86E-01	2.24E-01	1.34E-01	1.46E-01	5.93E-01	4.15E-01	1.90E-01	3.99E-01	2.09E-01	4.77E-01	**2.89E-01**
75	1.81E-01	1.69E-01	2.15E-01	1.38E-01	1.29E-01	1.00E-01	5.58E-02	6.43E-02	2.70E-01	1.87E-01	8.40E-02	1.83E-01	9.05E-02	2.16E-01	**1.29E-01**
95	5.85E-02	5.45E-02	7.09E-02	4.48E-02	4.17E-02	3.25E-02	1.75E-02	2.05E-02	8.83E-02	6.11E-02	2.82E-02	6.10E-02	2.91E-02	7.00E-02	**4.20E-02**
Copper (kg/km^2/year)															
5	2.08E+01	2.79E+01	2.83E+01	1.97E+01	1.71E+01	1.38E+01	1.58E+01	9.32E+00	3.05E+01	2.53E+01	1.86E+01	2.93E+01	2.08E+01	3.07E+01	**2.19E+01**
25	8.07E+00	9.88E+00	1.10E+01	7.28E+00	6.29E+00	5.06E+00	5.30E+00	3.35E+00	1.18E+01	9.10E+00	6.41E+00	1.00E+01	6.97E+00	1.10E+01	**7.72E+00**
50	4.20E+00	4.86E+00	5.73E+00	3.68E+00	3.17E+00	2.54E+00	2.51E+00	1.66E+00	6.13E+00	4.52E+00	3.11E+00	4.82E+00	3.29E+00	5.39E+00	**3.78E+00**
75	2.19E+00	2.41E+00	3.01E+00	1.88E+00	1.61E+00	1.29E+00	1.20E+00	8.33E-01	3.22E+00	2.27E+00	1.53E+00	2.34E+00	1.57E+00	2.68E+00	**1.87E+00**
95	8.69E-01	8.98E-01	1.20E+00	7.24E-01	6.16E-01	4.96E-01	4.25E-01	3.13E-01	1.29E+00	8.59E-01	5.70E-01	8.48E-01	5.51E-01	9.92E-01	**6.96E-01**
Lead (kg/km^2/year)															
5	8.30E+01	8.88E+01	8.57E+01	6.58E+01	6.15E+01	5.19E+01	4.37E+01	3.77E+01	1.31E+02	9.11E+01	4.83E+01	6.96E+01	5.24E+01	9.24E+01	**6.45E+01**
25	2.01E+01	2.04E+01	2.14E+01	1.56E+01	1.46E+01	1.21E+01	9.12E+00	8.56E+00	3.17E+01	2.15E+01	1.09E+01	1.70E+01	1.15E+01	2.22E+01	**1.49E+01**
50	7.57E+00	7.48E+00	8.33E+00	5.84E+00	5.44E+00	4.48E+00	3.15E+00	3.09E+00	1.19E+01	8.03E+00	3.98E+00	6.59E+00	4.11E+00	8.37E+00	**5.53E+00**
75	2.88E+00	2.79E+00	3.29E+00	2.22E+00	2.06E+00	1.68E+00	1.11E+00	1.13E+00	4.52E+00	3.03E+00	1.50E+00	2.61E+00	1.51E+00	3.21E+00	**2.09E+00**
95	7.32E-01	6.96E-01	8.88E-01	5.67E-01	5.20E-01	4.17E-01	2.57E-01	2.68E-01	1.14E+00	7.65E-01	3.87E-01	7.10E-01	3.74E-01	8.31E-01	**5.31E-01**
Zinc (kg/km^2/year)															
5	1.29E+02	1.27E+02	1.53E+02	1.01E+02	9.09E+01	7.37E+01	5.68E+01	5.01E+01	1.91E+02	1.27E+02	6.78E+01	1.08E+02	7.29E+01	1.42E+02	**9.47E+01**
25	5.01E+01	4.74E+01	5.99E+01	3.86E+01	3.45E+01	2.79E+01	2.03E+01	1.88E+01	7.42E+01	4.78E+01	2.49E+01	3.91E+01	2.60E+01	5.30E+01	**3.52E+01**
50	2.60E+01	2.40E+01	3.14E+01	1.99E+01	1.77E+01	1.43E+01	1.00E+01	9.52E+00	3.85E+01	2.43E+01	1.25E+01	1.96E+01	1.28E+01	2.69E+01	**1.78E+01**
75	1.35E+01	1.22E+01	1.65E+01	1.03E+01	9.09E+00	7.36E+00	5.00E+00	4.85E+00	2.01E+01	1.24E+01	6.39E+00	9.86E+00	6.37E+00	1.37E+01	**9.07E+00**
95	5.32E+00	4.68E+00	6.59E+00	4.00E+00	3.52E+00	2.85E+00	1.86E+00	1.85E+00	7.94E+00	4.79E+00	2.47E+00	3.74E+00	2.36E+00	5.22E+00	**3.48E+00**
Mercury (g/km^2/year)															
5	2.23E+02	2.32E+02	3.65E+02	1.95E+02	1.51E+02	1.16E+02	1.20E+02	6.69E+01	2.85E+02	1.86E+02	1.53E+02	2.20E+02	1.57E+02	2.62E+02	**1.85E+02**
25	5.19E+01	5.29E+01	8.45E+01	4.49E+01	3.46E+01	2.68E+01	2.81E+01	1.57E+01	6.69E+01	4.16E+01	3.48E+01	4.60E+01	3.51E+01	5.76E+01	**4.19E+01**
50	1.89E+01	1.91E+01	3.07E+01	1.63E+01	1.25E+01	9.72E+00	1.02E+01	5.72E+00	2.45E+01	1.49E+01	1.26E+01	1.59E+01	1.25E+01	2.04E+01	**1.50E+01**
75	6.89E+00	6.91E+00	1.12E+01	5.91E+00	4.52E+00	3.54E+00	3.74E+00	2.09E+00	8.98E+00	5.37E+00	4.56E+00	5.57E+00	4.50E+00	7.27E+00	**5.42E+00**
95	1.62E+00	1.61E+00	2.61E+00	1.38E+00	1.05E+00	8.32E-01	8.80E-01	4.94E-01	2.13E+00	1.25E+00	1.07E+00	1.26E+00	1.04E+00	1.67E+00	**1.26E+00**
Total PCBs (g/km^2/year)															
5	3.85E+02	4.20E+02	4.10E+02	3.10E+02	2.88E+02	2.38E+02	2.06E+02	1.71E+02	5.85E+02	4.22E+02	2.25E+02	3.55E+02	2.59E+02	4.56E+02	**3.09E+02**
25	5.45E+01	5.55E+01	5.74E+01	4.23E+01	3.98E+01	3.25E+01	2.46E+01	2.31E+01	8.26E+01	5.80E+01	2.78E+01	4.77E+01	3.20E+01	6.27E+01	**4.08E+01**
50	1.41E+01	1.38E+01	1.47E+01	1.07E+01	1.01E+01	8.24E+00	5.77E+00	5.80E+00	2.13E+01	1.47E+01	6.67E+00	1.20E+01	7.70E+00	1.59E+01	**1.01E+01**
75	3.64E+00	3.49E+00	3.79E+00	2.73E+00	2.59E+00	2.10E+00	1.39E+00	1.47E+00	5.49E+00	3.76E+00	1.63E+00	3.04E+00	1.88E+00	4.07E+00	**2.55E+00**
95	5.20E-01	4.86E-01	5.40E-01	3.85E-01	3.68E-01	2.97E-01	1.84E-01	2.07E-01	7.84E-01	5.32E-01	2.20E-01	4.27E-01	2.55E-01	5.76E-01	**3.55E-01**
Total PBDEs (mg/km^2/year)															
5	3.65E+02	6.41E+02	4.34E+02	3.94E+02	3.56E+02	3.01E+02	4.26E+02	2.26E+02	5.78E+02	5.70E+02	4.53E+02	6.55E+02	5.31E+02	6.51E+02	**4.97E+02**
25	7.80E+01	1.15E+02	8.45E+01	7.44E+01	6.87E+01	5.80E+01	7.00E+01	4.34E+01	1.23E+02	1.07E+02	7.40E+01	1.09E+02	8.67E+01	1.18E+02	**8.70E+01**
50	2.71E+01	3.59E+01	2.79E+01	2.41E+01	2.26E+01	1.91E+01	2.05E+01	1.43E+01	4.28E+01	3.49E+01	2.16E+01	3.22E+01	2.53E+01	3.73E+01	**2.68E+01**
75	9.56E+00	1.16E+01	9.42E+00	8.02E+00	7.60E+00	6.41E+00	6.20E+00	4.79E+00	1.51E+01	1.16E+01	6.49E+00	9.81E+00	7.60E+00	1.21E+01	**8.49E+00**
95	2.16E+00	2.36E+00	2.04E+00	1.70E+00	1.63E+00	1.38E+00	1.16E+00	1.03E+00	3.40E+00	2.45E+00	1.21E+00	1.86E+00	1.41E+00	2.50E+00	**1.70E+00**
Carcinogenic PAHs (kg/km^2/year)															
5	1.81E+00	1.69E+00	2.44E+00	1.42E+00	1.24E+00	9.55E-01	6.58E-01	5.88E-01	2.52E+00	1.66E+00	9.09E-01	1.68E+00	9.62E-01	2.06E+00	**1.31E+00**
25	4.23E-01	3.79E-01	5.68E-01	3.27E-01	2.85E-01	2.20E-01	1.36E-01	1.33E-01	5.98E-01	3.86E-01	2.01E-01	3.84E-01	2.06E-01	4.72E-01	**2.94E-01**
50	1.55E-01	1.37E-01	2.08E-01	1.19E-01	1.04E-01	8.05E-02	4.74E-02	4.85E-02	2.22E-01	1.42E-01	7.37E-02	1.40E-01	7.25E-02	1.71E-01	**1.06E-01**
75	5.71E-02	5.05E-02	7.69E-02	4.39E-02	3.85E-02	3.00E-02	1.72E-02	1.80E-02	8.42E-02	5.32E-02	2.81E-02	5.21E-02	2.62E-02	6.23E-02	**3.92E-02**
95	1.38E-02	1.25E-02	1.87E-02	1.07E-02	9.43E-03	7.52E-03	4.34E-03	4.49E-03	2.16E-02	1.35E-02	7.60E-03	1.30E-02	6.37E-03	1.48E-02	**9.70E-03**

Table E-1 (continued). Unit Area Loading Rates for the Puget Sound Basin and the 14 Study Areas in Ecology's Puget Sound Box Model.

Probability of Exceedance (percent)	Main Basin	Port Gardner	Elliott Bay	Commencement Bay	South Sound (East)	South Sound (West)	Hood Canal (South)	Hood Canal (North)	Sinclair/Dyes Inlet	Admiralty Inlet	Strait of Juan de Fuca	Strait of Georgia	Whidbey Basin	San Juan Islands	Puget Sound Basin
Other High MW PAHs (kg/km^2/year)															
5	1.03E+02	2.39E+02	7.56E+01	1.40E+02	1.36E+02	7.43E+01	1.16E+02	1.49E+01	1.75E+01	1.40E+01	1.66E+02	2.19E+02	5.16E+02	3.64E+01	**1.87E+03**
25	2.40E+01	5.29E+01	1.75E+01	3.18E+01	3.11E+01	1.69E+01	2.31E+01	3.31E+00	4.09E+00	3.20E+00	3.57E+01	4.95E+01	1.08E+02	8.27E+00	**4.15E+02**
50	8.74E+00	1.89E+01	6.38E+00	1.15E+01	1.12E+01	6.11E+00	7.84E+00	1.19E+00	1.50E+00	1.16E+00	1.27E+01	1.78E+01	3.73E+01	2.98E+00	**1.48E+02**
75	3.20E+00	6.83E+00	2.33E+00	4.17E+00	4.10E+00	2.23E+00	2.74E+00	4.31E-01	5.57E-01	4.27E-01	4.62E+00	6.51E+00	1.32E+01	1.08E+00	**5.36E+01**
95	7.57E-01	1.61E+00	5.53E-01	9.89E-01	9.73E-01	5.35E-01	6.39E-01	1.03E-01	1.36E-01	1.03E-01	1.14E+00	1.56E+00	3.06E+00	2.52E-01	**1.27E+01**
Low MW PAHs (kg/km^2/year)															
5	4.28E+00	3.76E+00	6.18E+00	3.34E+00	2.79E+00	2.10E+00	1.42E+00	1.22E+00	5.64E+00	3.50E+00	1.99E+00	3.64E+00	2.10E+00	4.68E+00	**2.94E+00**
25	9.92E-01	8.26E-01	1.43E+00	7.56E-01	6.34E-01	4.72E-01	2.78E-01	2.69E-01	1.30E+00	7.90E-01	4.18E-01	8.14E-01	4.35E-01	1.06E+00	**6.46E-01**
50	3.60E-01	2.92E-01	5.17E-01	2.71E-01	2.28E-01	1.69E-01	9.22E-02	9.54E-02	4.72E-01	2.83E-01	1.44E-01	2.91E-01	1.49E-01	3.81E-01	**2.29E-01**
75	1.31E-01	1.04E-01	1.88E-01	9.78E-02	8.23E-02	6.09E-02	3.14E-02	3.41E-02	1.72E-01	1.02E-01	5.09E-02	1.05E-01	5.20E-02	1.37E-01	**8.18E-02**
95	3.06E-02	2.42E-02	4.39E-02	2.28E-02	1.92E-02	1.43E-02	6.99E-03	7.92E-03	4.06E-02	2.40E-02	1.18E-02	2.44E-02	1.18E-02	3.19E-02	**1.89E-02**
bis(2-Ethylhexyl)phthalate (kg/km^2/year)															
5	1.81E+02	1.83E+02	1.86E+02	1.39E+02	1.36E+02	1.08E+02	6.72E+01	7.45E+01	2.76E+02	2.07E+02	8.76E+01	1.96E+02	1.05E+02	2.30E+02	**1.38E+02**
25	2.59E+01	2.59E+01	2.66E+01	1.98E+01	1.94E+01	1.54E+01	9.19E+00	1.06E+01	3.97E+01	2.95E+01	1.22E+01	2.79E+01	1.46E+01	3.28E+01	**1.95E+01**
50	6.74E+00	6.71E+00	6.93E+00	5.13E+00	5.05E+00	4.01E+00	2.35E+00	2.74E+00	1.04E+01	7.69E+00	3.18E+00	7.24E+00	3.74E+00	8.51E+00	**5.04E+00**
75	1.77E+00	1.76E+00	1.82E+00	1.35E+00	1.32E+00	1.06E+00	6.17E-01	7.21E-01	2.76E+00	2.03E+00	8.57E-01	1.91E+00	9.74E-01	2.21E+00	**1.32E+00**
95	2.66E-01	2.72E-01	2.82E-01	2.07E-01	2.02E-01	1.65E-01	9.99E-02	1.12E-01	4.45E-01	3.20E-01	1.51E-01	2.97E-01	1.50E-01	3.27E-01	**2.06E-01**
Total Dioxin TEQs (mg/km^2/year)															
5	9.86E+01	9.96E+01	1.09E+02	7.69E+01	7.30E+01	5.77E+01	3.83E+01	3.90E+01	1.47E+02	1.08E+02	4.95E+01	1.04E+02	5.79E+01	1.24E+02	**7.54E+01**
25	1.41E+01	1.38E+01	1.55E+01	1.08E+01	1.03E+01	8.12E+00	5.00E+00	5.44E+00	2.10E+01	1.52E+01	6.65E+00	1.46E+01	7.80E+00	1.74E+01	**1.05E+01**
50	3.65E+00	3.53E+00	4.02E+00	2.78E+00	2.66E+00	2.09E+00	1.24E+00	1.39E+00	5.42E+00	3.92E+00	1.67E+00	3.75E+00	1.96E+00	4.49E+00	**2.67E+00**
75	9.45E-01	9.06E-01	1.04E+00	7.17E-01	6.87E-01	5.38E-01	3.10E-01	3.58E-01	1.40E+00	1.01E+00	4.24E-01	9.65E-01	4.98E-01	1.16E+00	**6.85E-01**
95	1.36E-01	1.29E-01	1.49E-01	1.02E-01	9.81E-02	7.67E-02	4.30E-02	5.10E-02	2.01E-01	1.44E-01	5.95E-02	1.38E-01	6.99E-02	1.66E-01	**9.72E-02**
DDT and Metabolites (g/km^2/year)															
5	3.42E+01	1.42E+02	5.57E+01	7.10E+01	5.82E+01	5.36E+01	1.27E+02	4.45E+01	6.15E+01	1.01E+02	1.26E+02	1.41E+02	1.46E+02	1.18E+02	**1.13E+02**
25	4.91E+00	2.05E+01	7.99E+00	1.02E+01	8.35E+00	7.70E+00	1.83E+01	6.38E+00	8.82E+00	1.45E+01	1.80E+01	2.03E+01	2.10E+01	1.70E+01	**1.62E+01**
50	1.28E+00	5.31E+00	2.07E+00	2.65E+00	2.17E+00	2.00E+00	4.75E+00	1.66E+00	2.29E+00	3.77E+00	4.68E+00	5.27E+00	5.45E+00	4.40E+00	**4.21E+00**
75	3.31E-01	1.38E+00	5.38E-01	6.86E-01	5.63E-01	5.18E-01	1.23E+00	4.30E-01	5.94E-01	9.79E-01	1.21E+00	1.37E+00	1.42E+00	1.14E+00	**1.09E+00**
95	4.75E-02	1.98E-01	7.73E-02	9.86E-02	8.08E-02	7.44E-02	1.77E-01	6.17E-02	8.53E-02	1.41E-01	1.74E-01	1.96E-01	2.03E-01	1.64E-01	**1.57E-01**
Triclopyr (g/km^2/year)															
5	6.25E+02	7.73E+02	7.47E+02	5.49E+02	5.20E+02	4.05E+02	3.41E+02	2.69E+02	9.31E+02	8.10E+02	4.52E+02	9.66E+02	5.38E+02	9.81E+02	**6.11E+02**
25	8.39E+01	1.08E+02	9.59E+01	7.47E+01	7.21E+01	5.65E+01	4.89E+01	3.83E+01	1.28E+02	1.15E+02	6.36E+01	1.36E+02	7.66E+01	1.37E+02	**8.52E+01**
50	2.11E+01	2.77E+01	2.35E+01	1.89E+01	1.84E+01	1.45E+01	1.27E+01	9.91E+00	3.25E+01	2.96E+01	1.63E+01	3.51E+01	1.98E+01	3.49E+01	**2.18E+01**
75	5.34E+00	7.14E+00	5.85E+00	4.81E+00	4.71E+00	3.72E+00	3.28E+00	2.57E+00	8.29E+00	7.64E+00	4.21E+00	9.06E+00	5.12E+00	8.97E+00	**5.61E+00**
95	7.50E-01	1.02E+00	8.06E-01	6.79E-01	6.69E-01	5.29E-01	4.71E-01	3.68E-01	1.17E+00	1.09E+00	6.01E-01	1.29E+00	7.33E-01	1.27E+00	**7.98E-01**
Nonylphenol (kg/km^2/year)															
5	1.16E+01	1.08E+01	1.76E+01	9.42E+00	7.59E+00	5.79E+00	4.75E+00	3.36E+00	1.52E+01	9.39E+00	6.36E+00	9.99E+00	6.47E+00	1.27E+01	**8.47E+00**
25	1.68E+00	1.47E+00	2.55E+00	1.33E+00	1.08E+00	8.23E-01	5.69E-01	4.62E-01	2.28E+00	1.35E+00	8.64E-01	1.41E+00	8.07E-01	1.76E+00	**1.16E+00**
50	4.52E-01	3.94E-01	6.87E-01	3.58E-01	2.93E-01	2.29E-01	1.49E-01	1.27E-01	6.60E-01	3.85E-01	2.52E-01	3.89E-01	2.08E-01	4.60E-01	**3.12E-01**
75	1.28E-01	1.18E-01	1.96E-01	1.04E-01	8.61E-02	7.11E-02	4.69E-02	4.00E-02	2.15E-01	1.25E-01	8.90E-02	1.20E-01	6.06E-02	1.26E-01	**9.38E-02**
95	2.53E-02	2.81E-02	3.92E-02	2.27E-02	1.91E-02	1.79E-02	1.34E-02	1.04E-02	5.78E-02	3.39E-02	2.86E-02	3.01E-02	1.44E-02	2.31E-02	**2.25E-02**
TPH (MT/km^2/year)															
5	1.52E+01	1.72E+01	1.60E+01	1.25E+01	1.16E+01	9.67E+00	8.67E+00	7.01E+00	2.35E+01	1.73E+01	9.45E+00	1.48E+01	1.09E+01	1.85E+01	**1.27E+01**
25	4.82E+00	4.74E+00	5.09E+00	3.68E+00	3.45E+00	2.82E+00	2.04E+00	1.99E+00	7.31E+00	4.98E+00	2.33E+00	3.94E+00	2.63E+00	5.33E+00	**3.46E+00**
50	2.20E+00	2.02E+00	2.36E+00	1.63E+00	1.52E+00	1.24E+00	8.03E-01	8.59E-01	3.30E+00	2.16E+00	9.46E-01	1.64E+00	1.05E+00	2.31E+00	**1.47E+00**
75	1.01E+00	8.88E-01	1.11E+00	7.36E-01	6.82E-01	5.51E-01	3.32E-01	3.77E-01	1.50E+00	9.50E-01	4.03E-01	7.04E-01	4.37E-01	1.02E+00	**6.45E-01**
95	3.35E-01	2.80E-01	3.84E-01	2.41E-01	2.20E-01	1.76E-01	9.89E-02	1.18E-01	4.93E-01	2.98E-01	1.25E-01	2.16E-01	1.30E-01	3.26E-01	**2.04E-01**

The precision of the data in this table is only two significant figures.

DDT = Dichlorodiphenyltrichloroethane.
g/km2/year = grams per square kilometer per year.
kg/km2/year = Kilograms per square kilometer per year.
MT/year = Metric tons per year.

mg/km2/year = Milligrams per square kilometer per year.
MW = Molecular weight.
PAHs = Polyaromatic hydrocarbons.
PBDEs = Polybrominated biphenyl ethers.

PCBs = Polychlorinated biphenyls.
TEQs = Toxicity equivalents.
TPH = Total petroleum hydrocarbon.

Appendix F

Graphical Summaries Comparing Absolute Toxic Chemical Loading Estimates across the Land Use Categories in the Puget Sound Basin

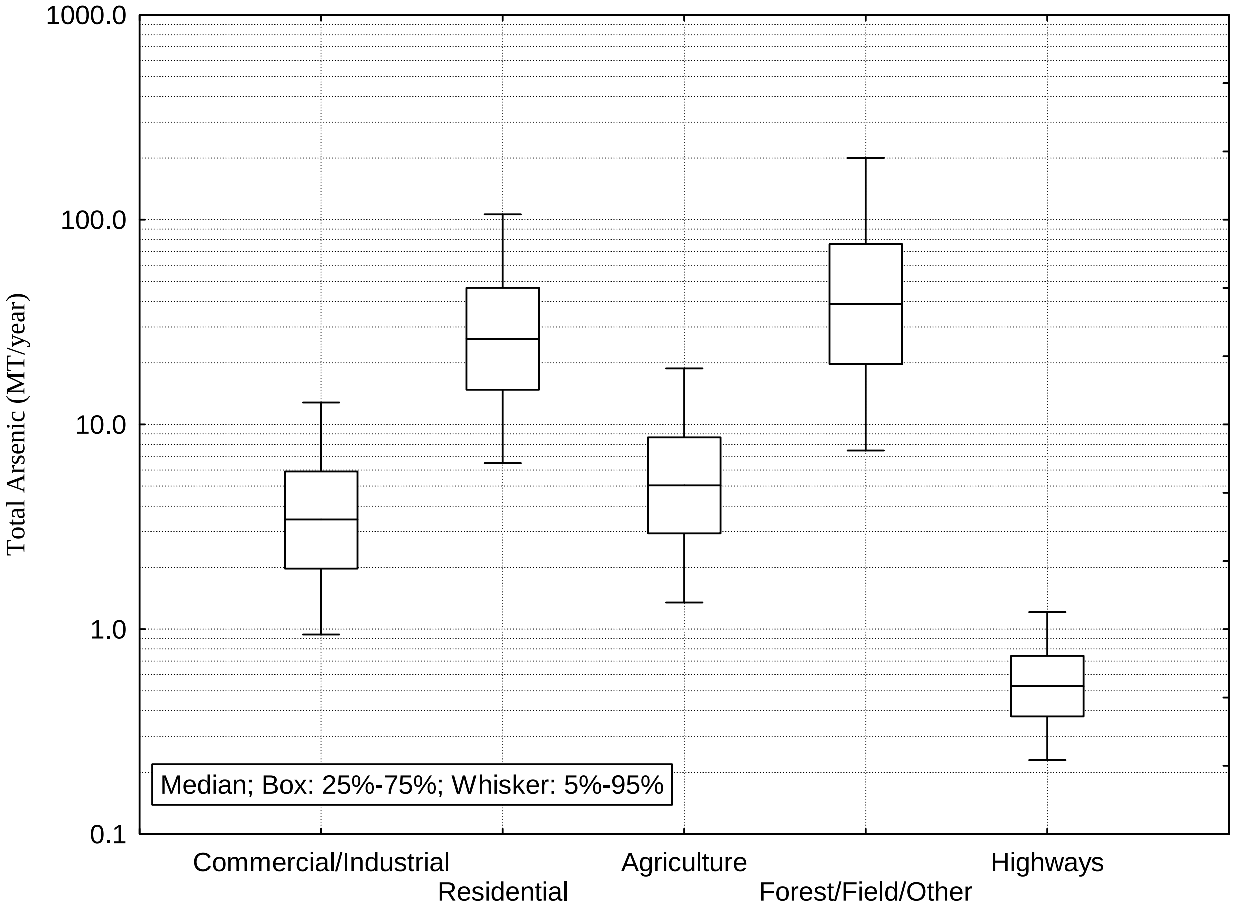

Figure F-1. Total Arsenic Loading Rates by Land Use Category in the Puget Sound Basin.

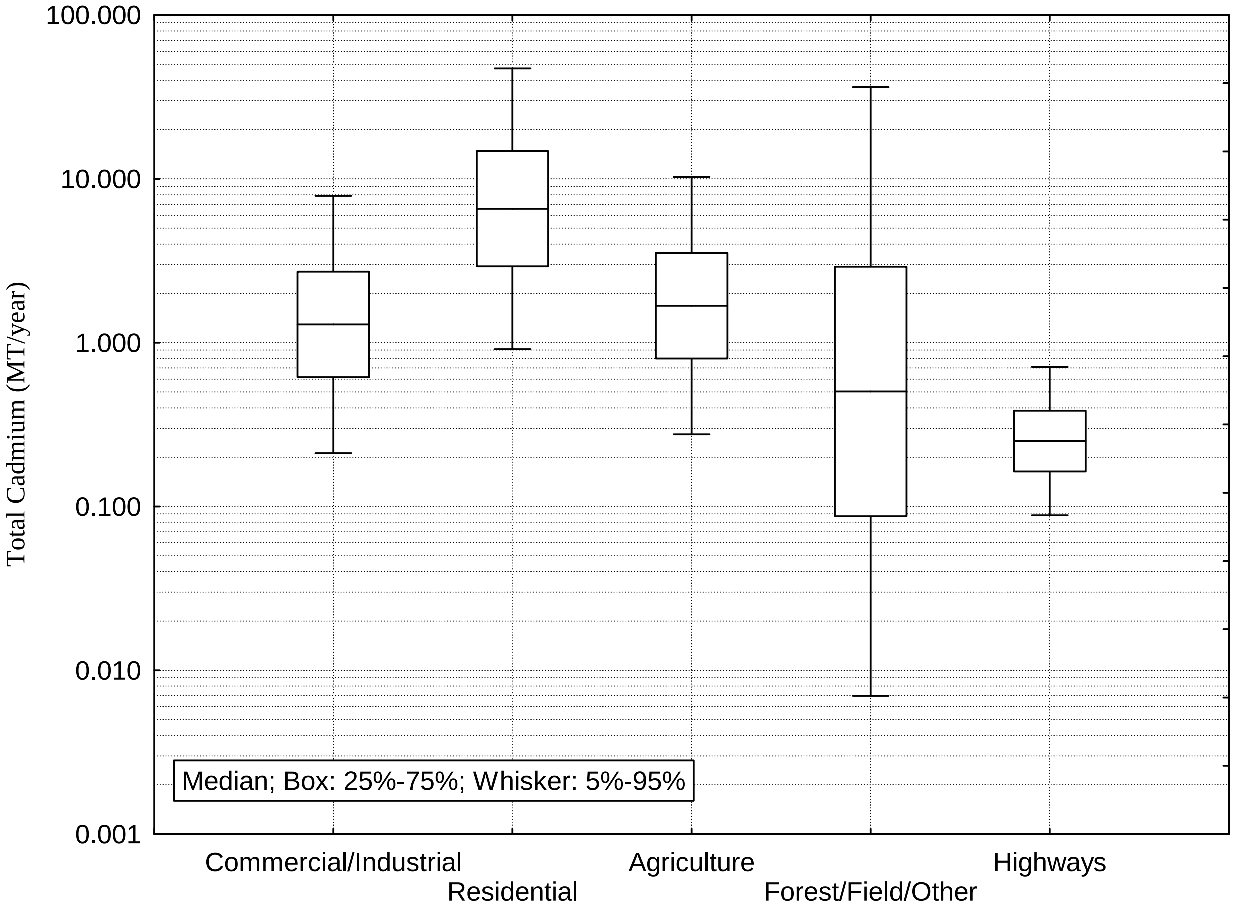

Figure F-2. **Total Cadmium Loading Rates by Land Use Category in the Puget Sound Basin.**

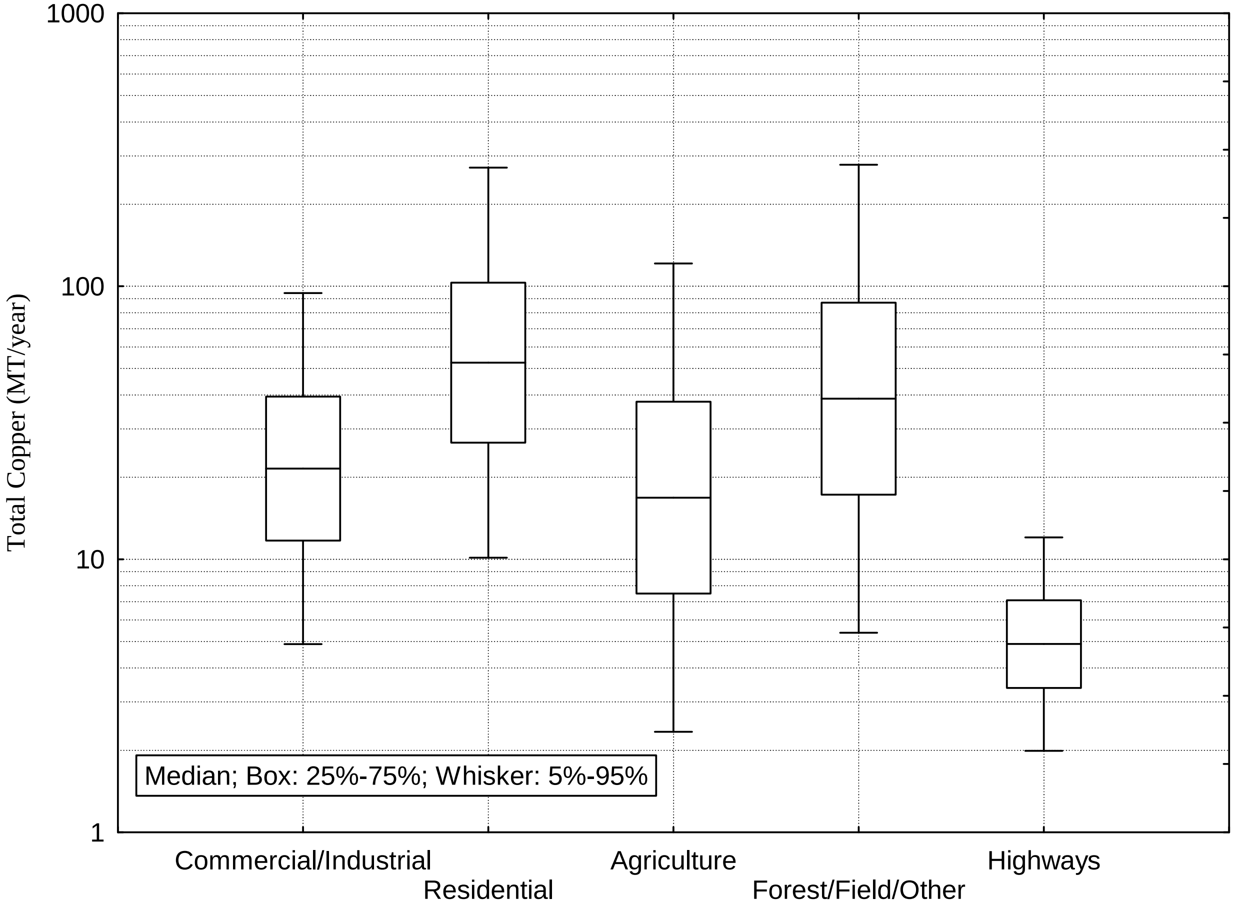

Figure F-3. Total Copper Loading Rates by Land Use Category in the Puget Sound Basin.

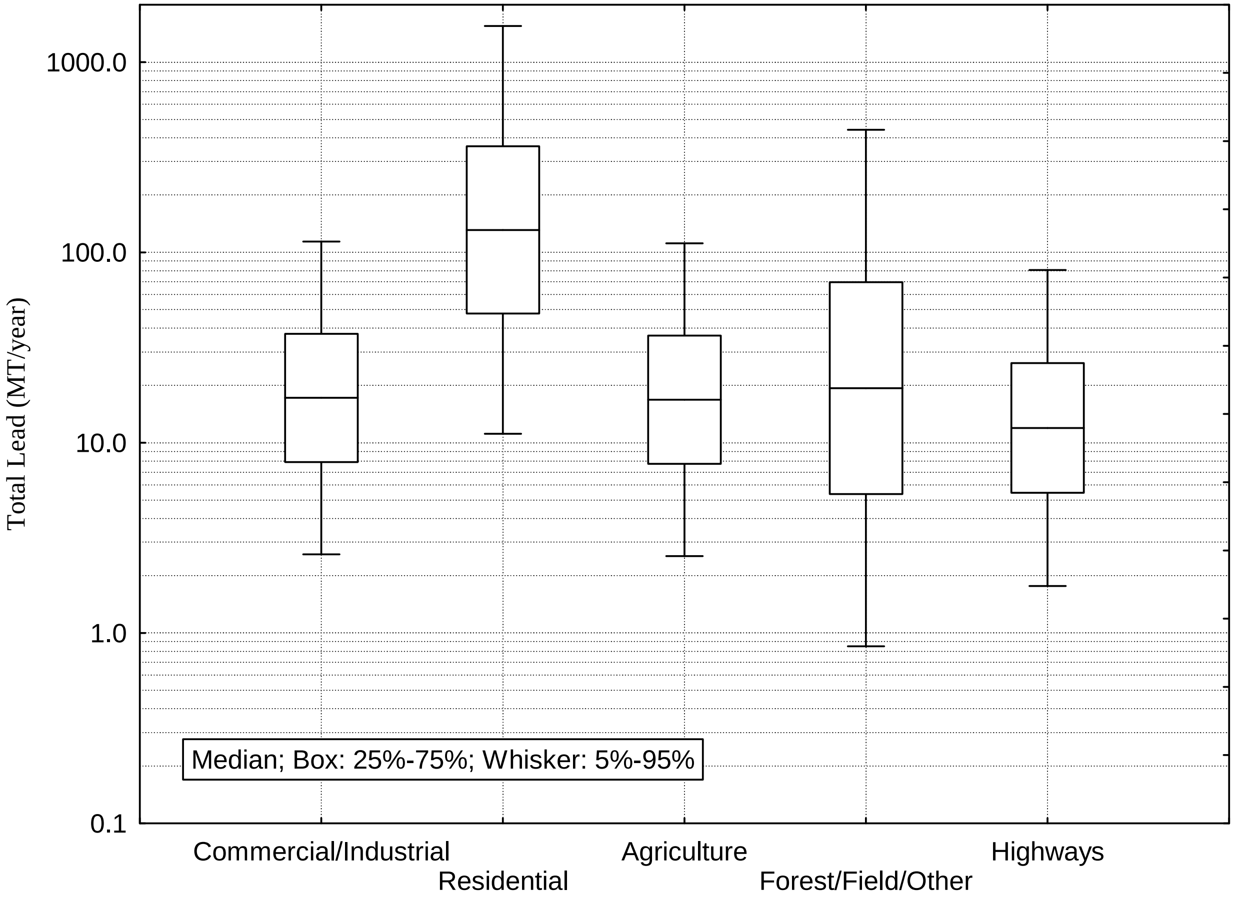

Figure F-4. Total Lead Loading Rates by Land Use Category in the Puget Sound Basin.

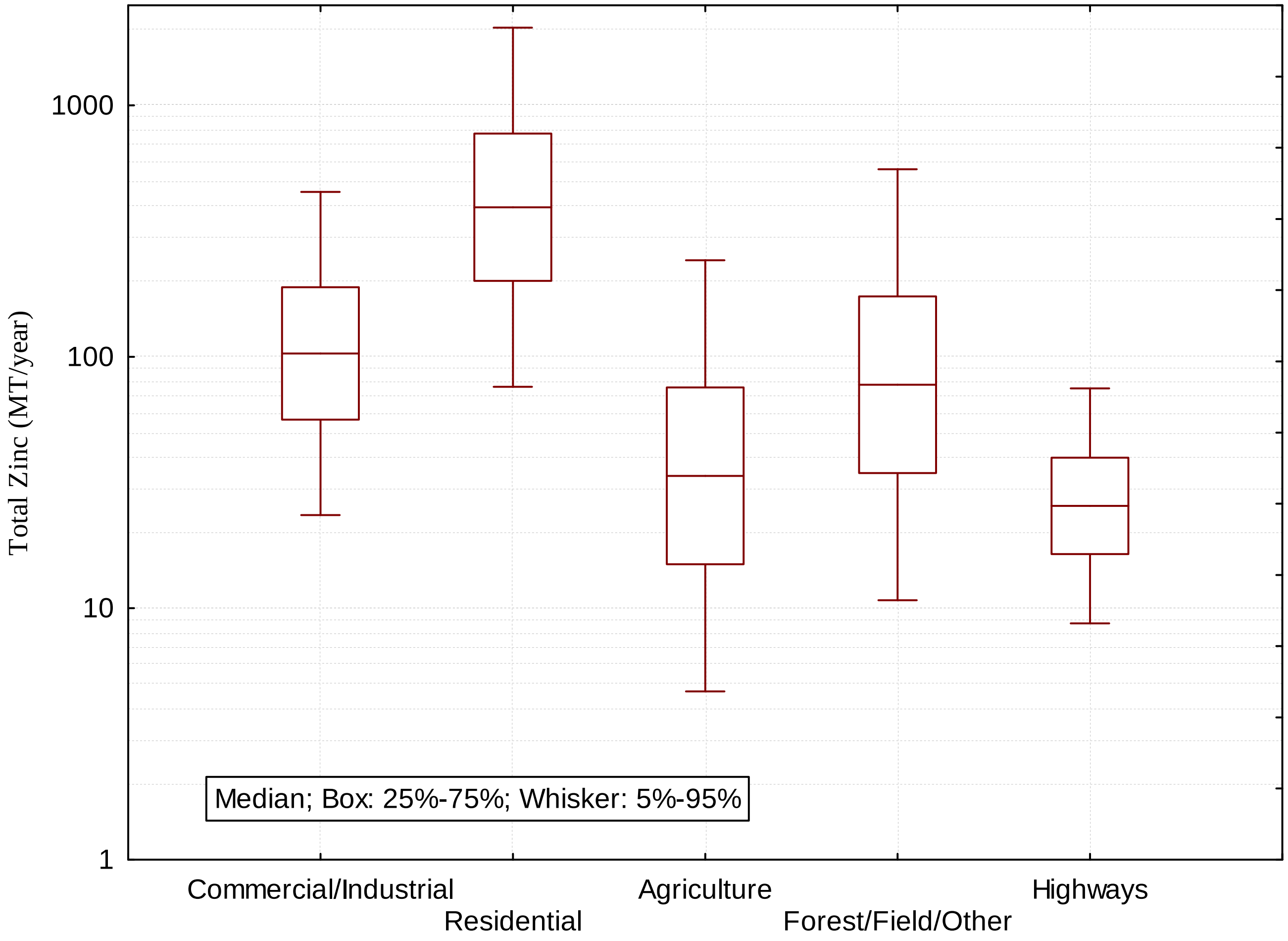

Figure F-5. Total Zinc Loading Rates by Land Use Category in the Puget Sound Basin.

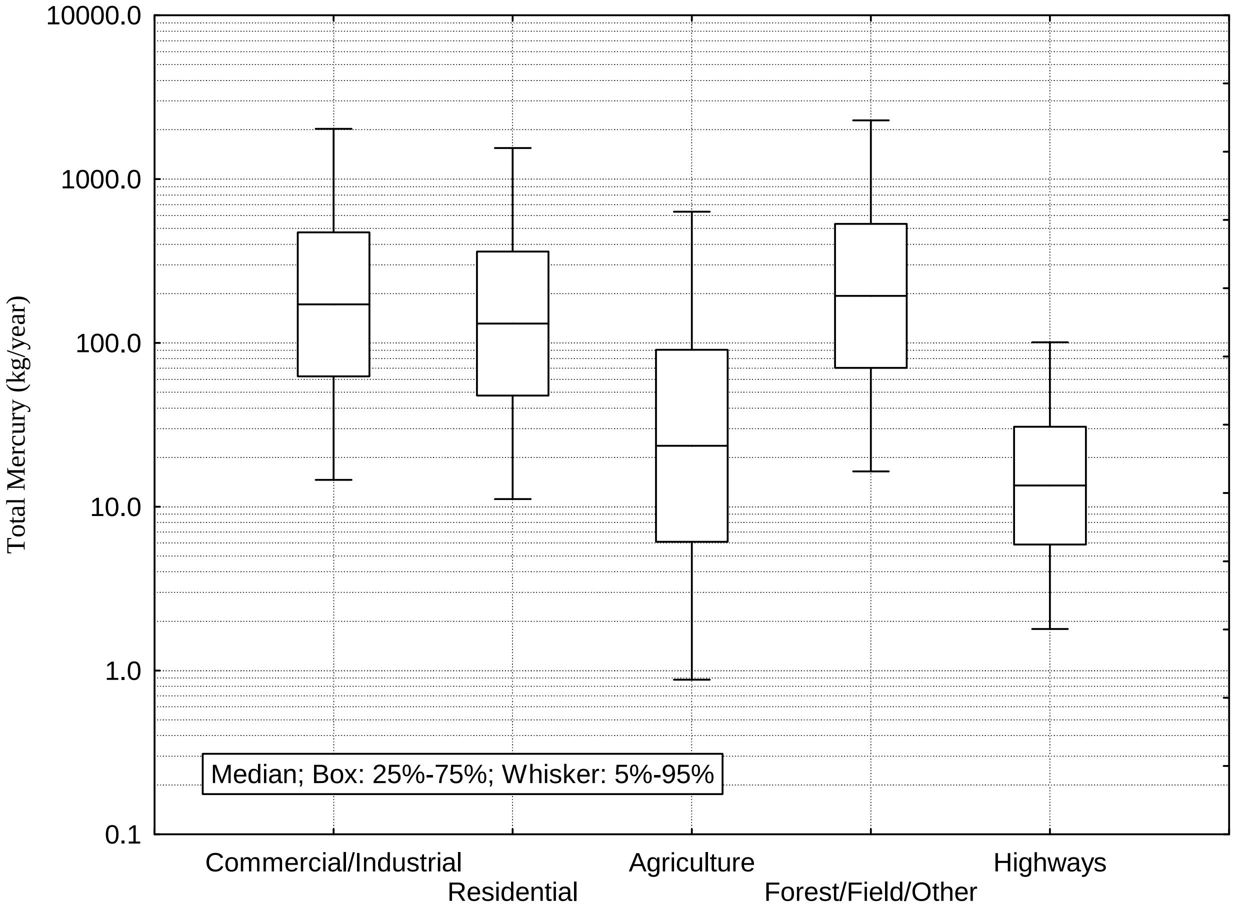

Figure F-6. Total Mercury Loading Rates by Land Use Category in the Puget Sound Basin.

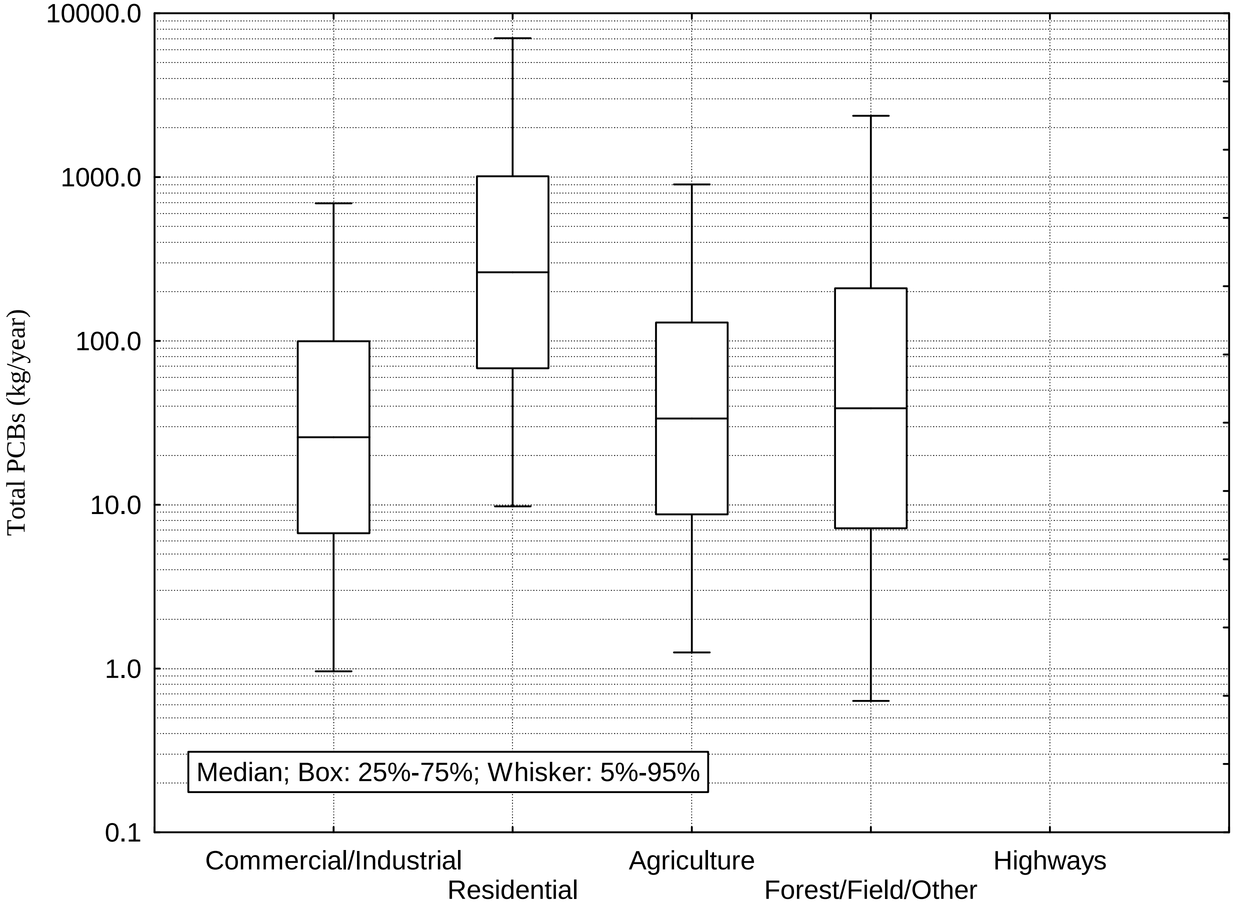

Figure F-7. Total Polychlorinated Biphenyls (PCBs) Loading Rates by Land Use Category in the Puget Sound Basin.

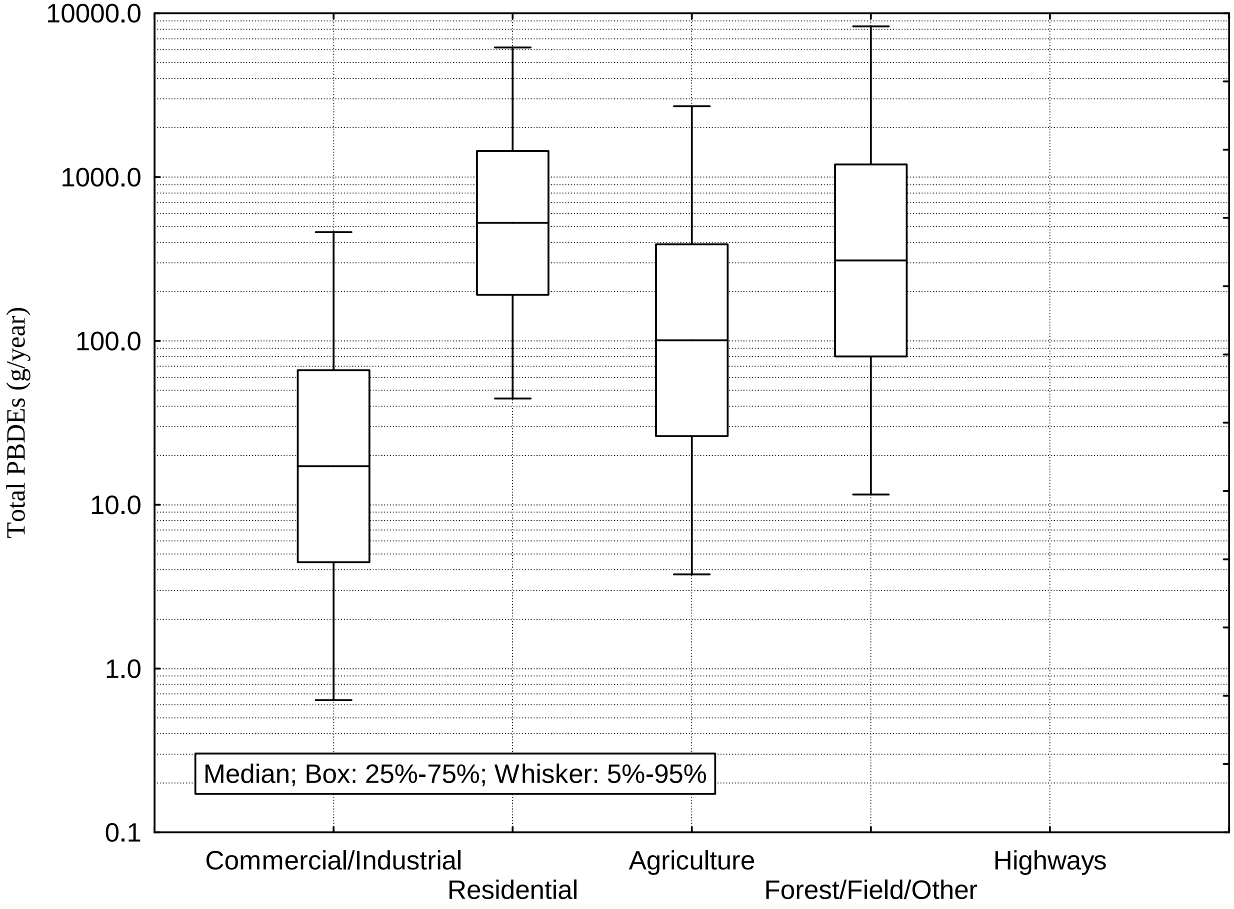

Figure F-8. Total Polybrominated Diphenyl Ethers (PBDEs) Loading Rates by Land Use Category in the Puget Sound Basin.

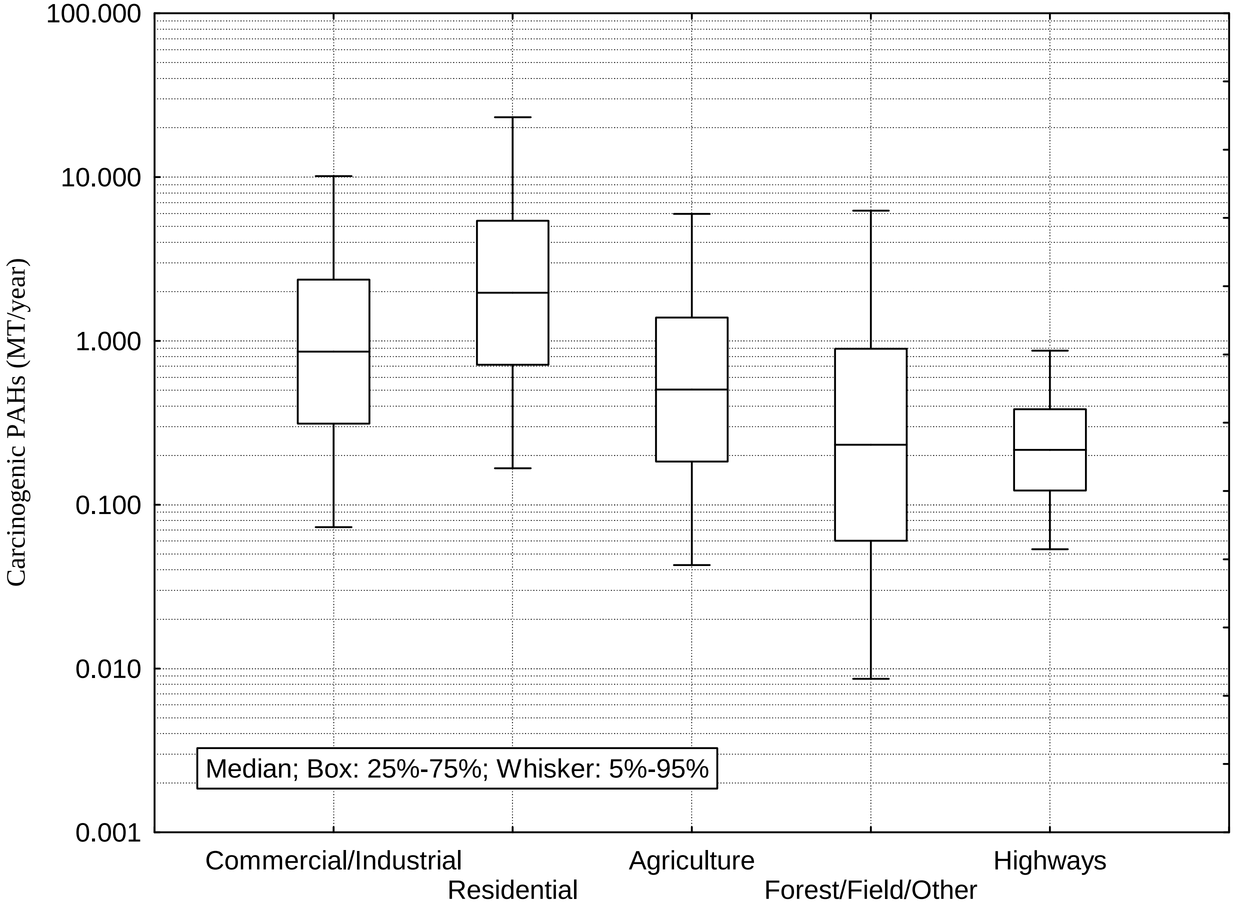

Figure F-9. **Carcinogenic Polyaromatic Hydrocarbons (PAHs) Loading Rates by Land Use Category in the Puget Sound Basin.**

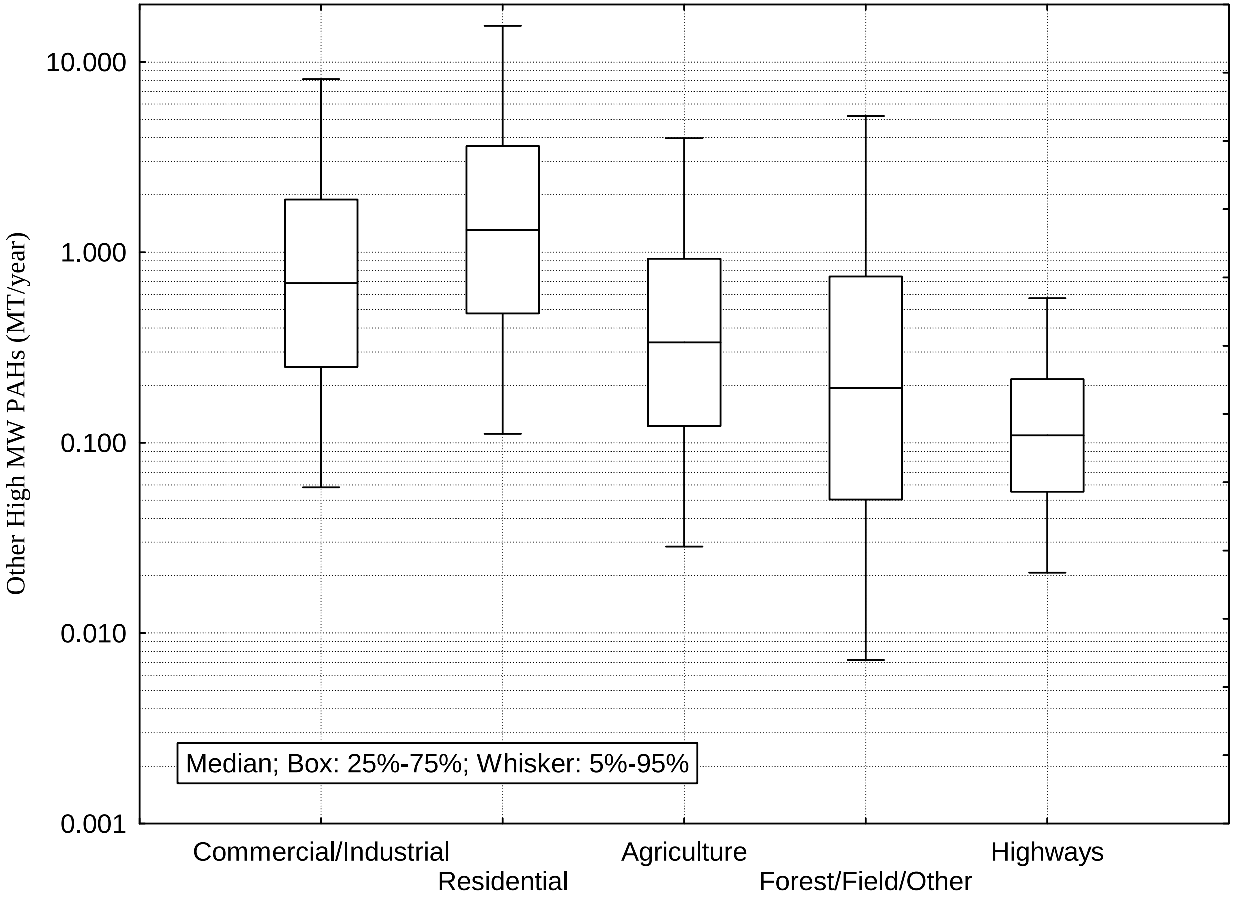

Figure F-10. **Other High Molecular Weight Polyaromatic Hydrocarbons (PAHs) Loading Rates by Land Use Category in the Puget Sound Basin.**

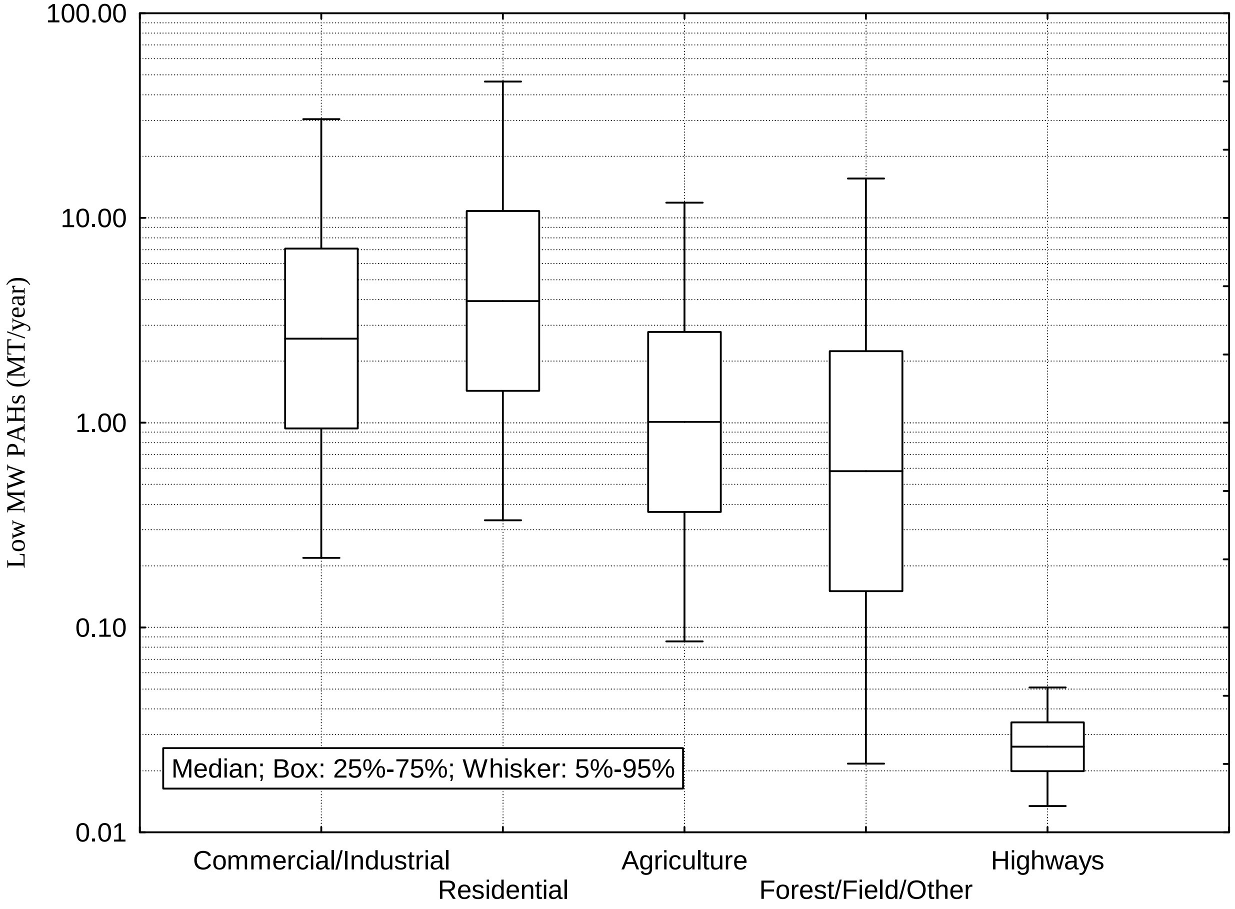

Figure F-11. Low Molecular Weight Polyaromatic Hydrocarbons (PAHs) Loading Rates by Land Use Category in the Puget Sound Basin.

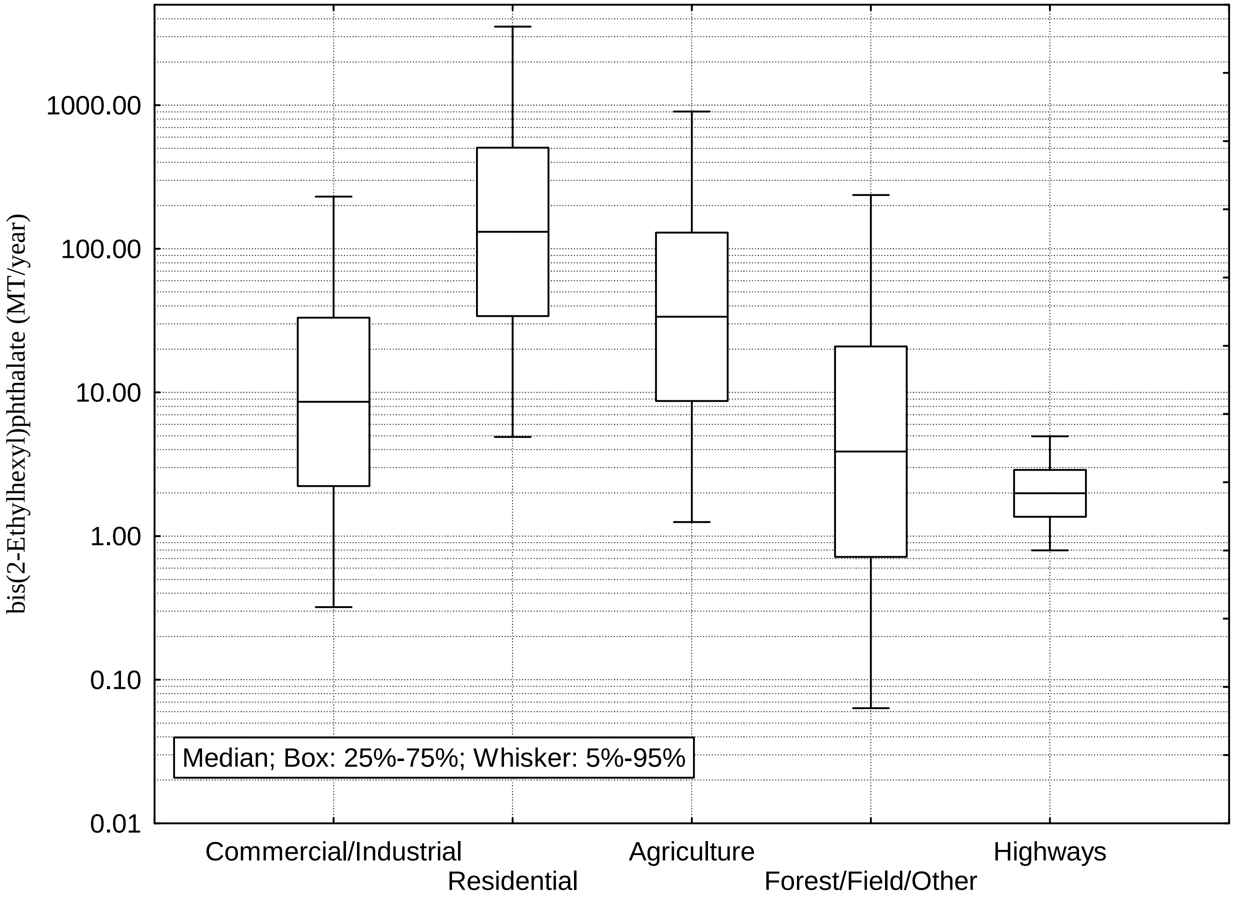

Figure F-12. bis(2-Ethylhexyl)phthalate Loading Rates by Land Use Category in the Puget Sound Basin.

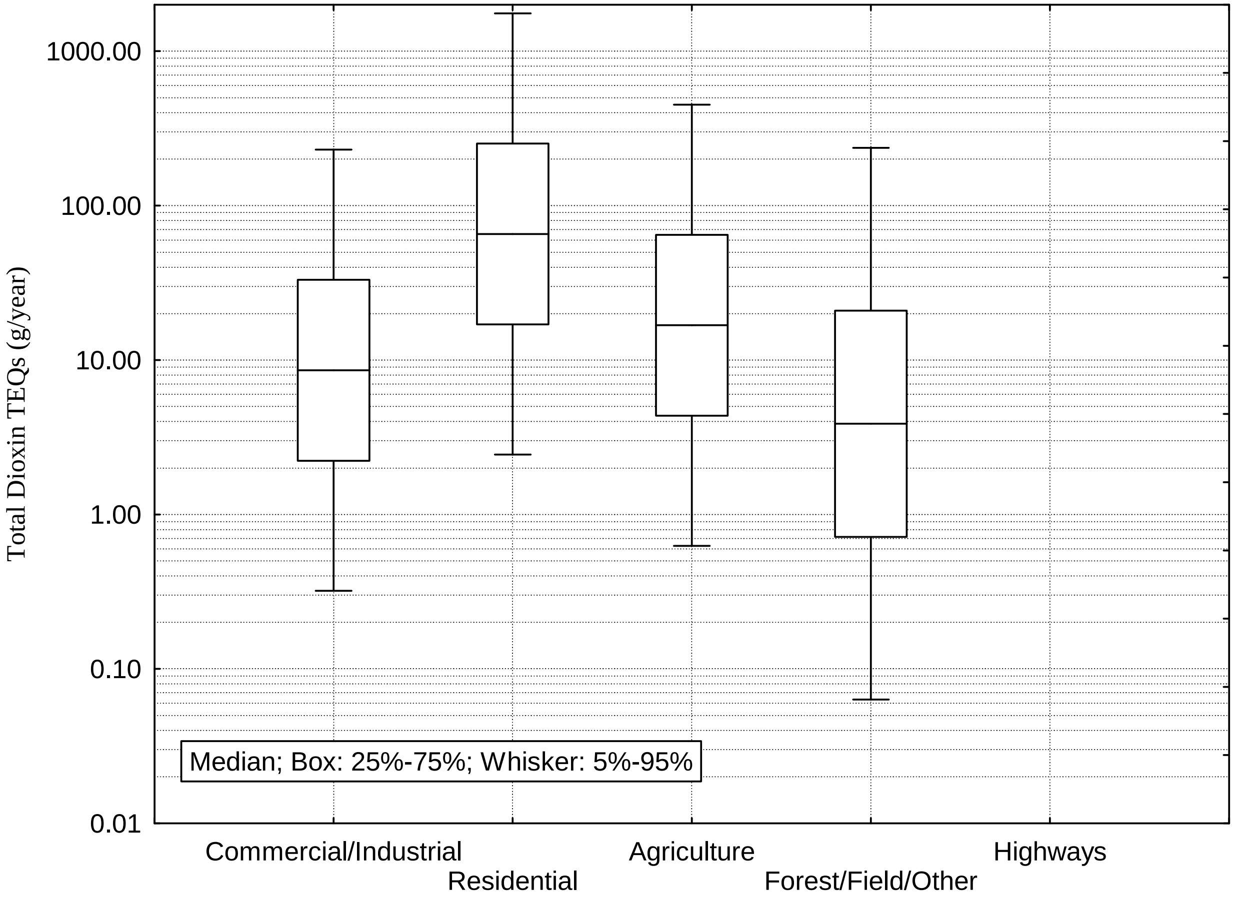

Figure F-13. Total Dioxin Toxicity Equivalents Loading Rates by Land Use Category in the Puget Sound Basin.

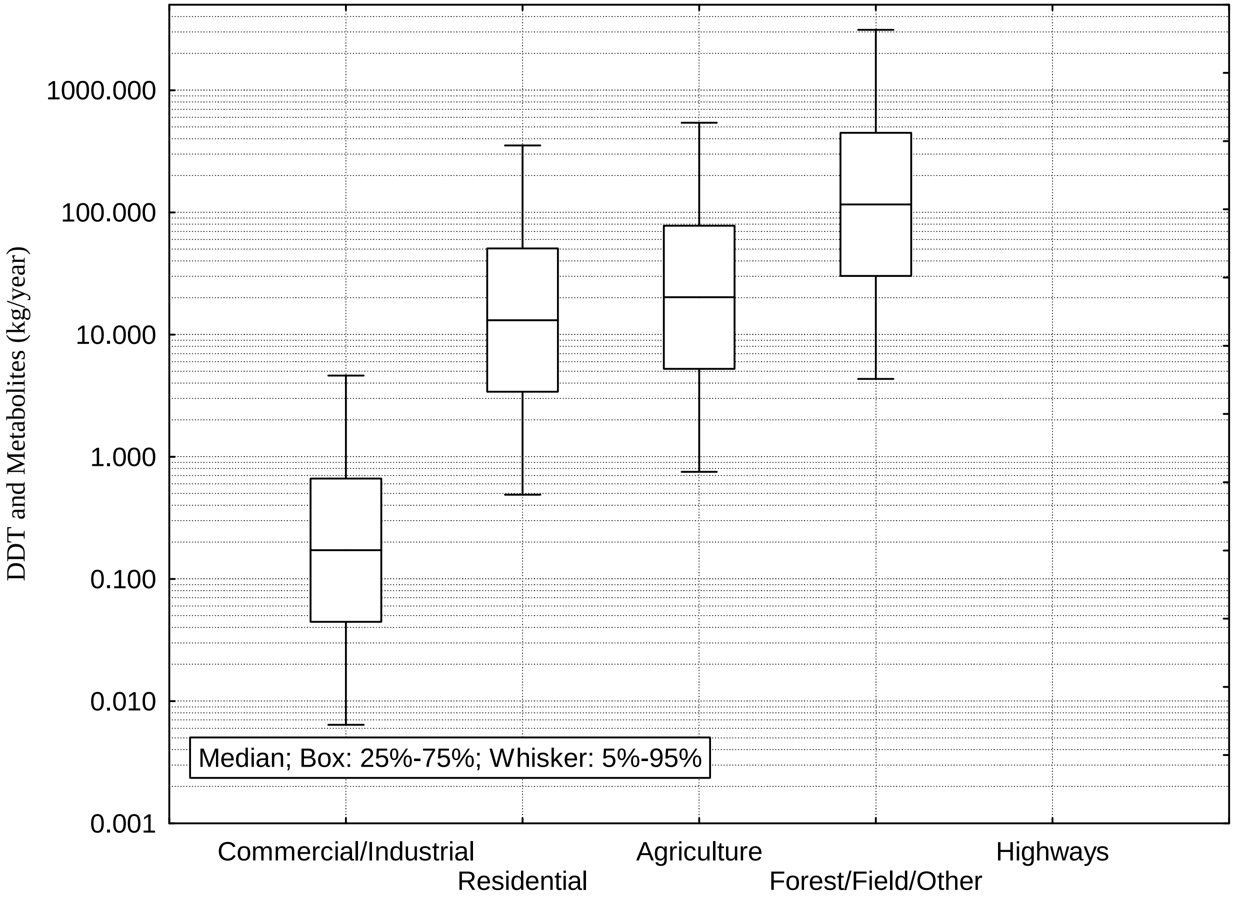

Figure F-14. Dichlorodiphenyltrichloroethane (DDT) and Metabolites Loading Rates by Land Use Category in the Puget Sound Basin.

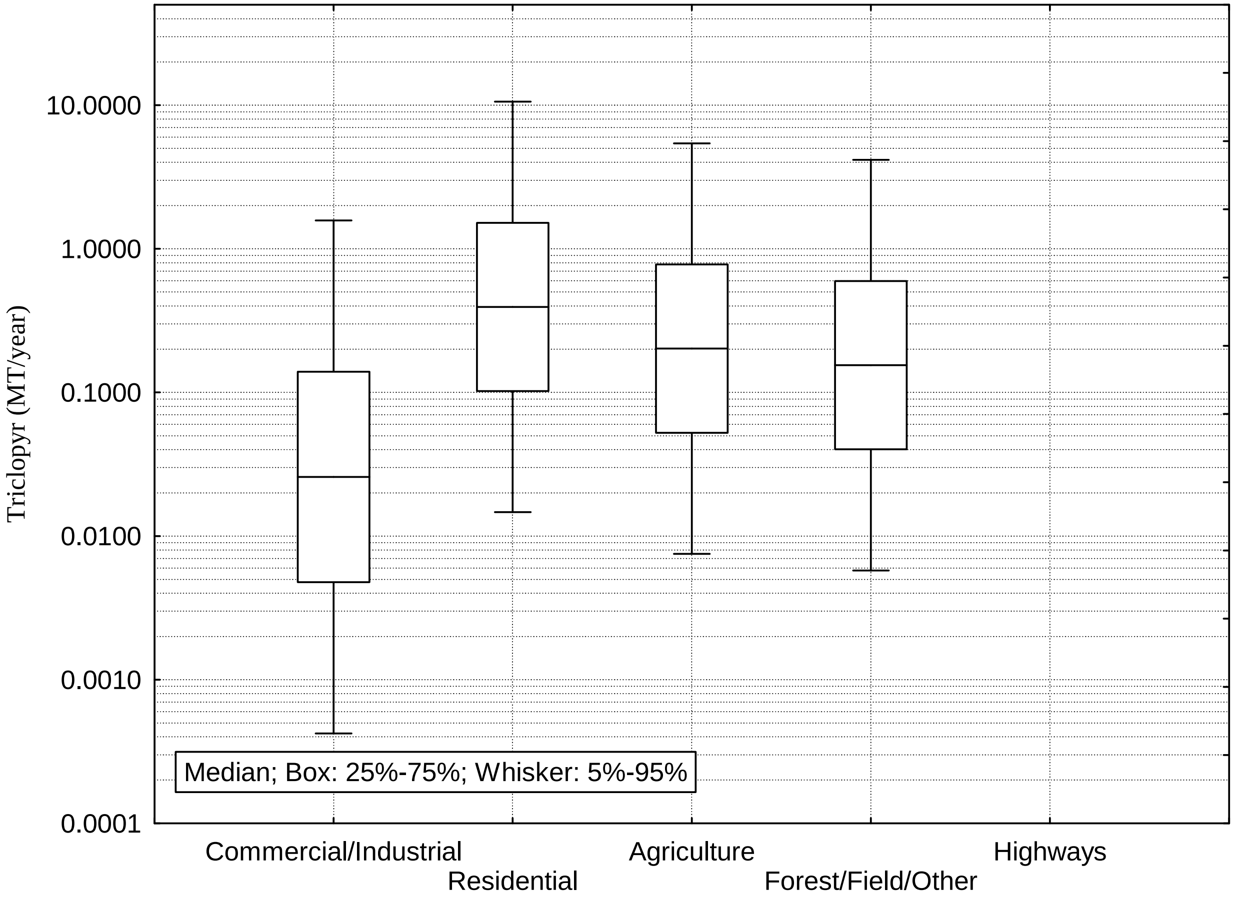

Figure F-15. Triclopyr Loading Rates by Land Use Category in the Puget Sound Basin.

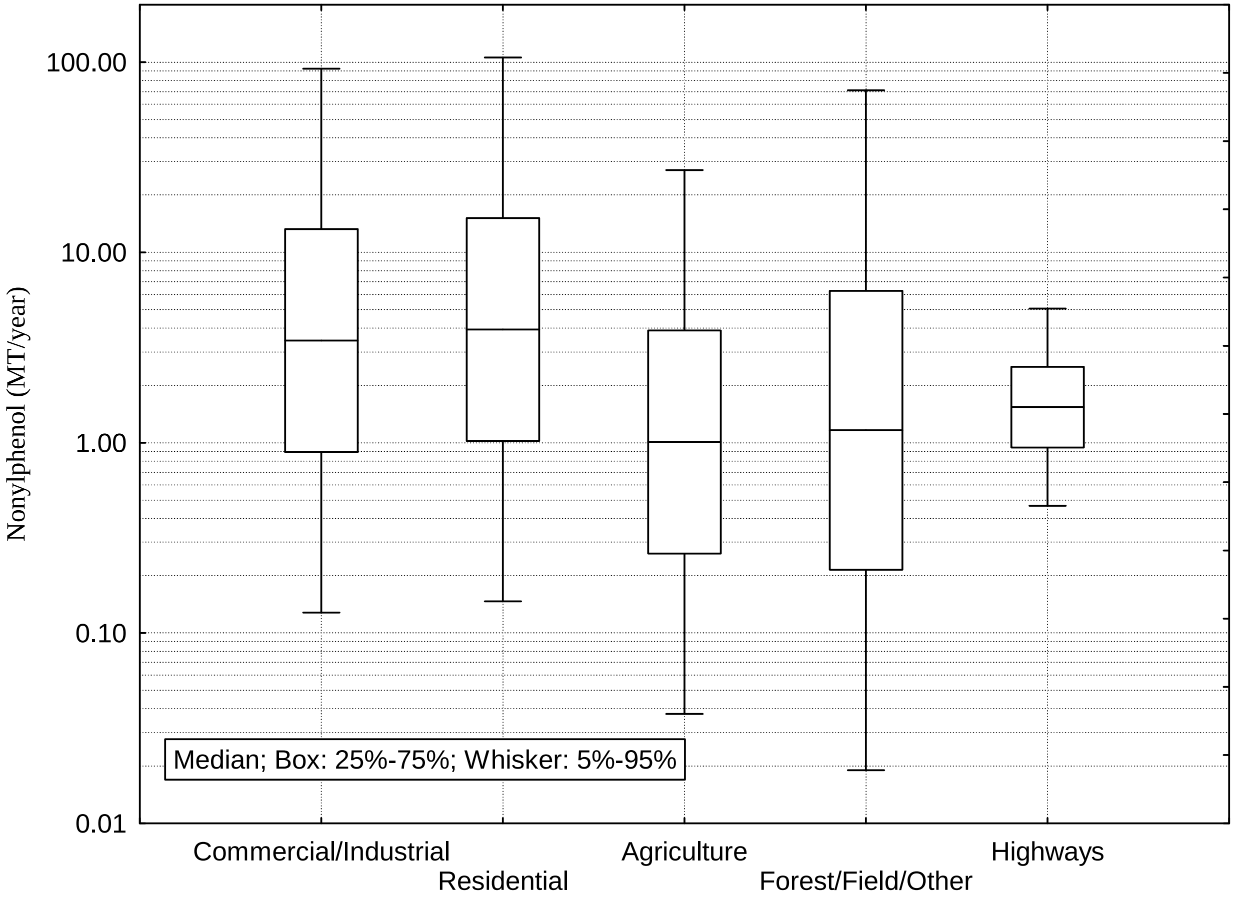

Figure F-16. Nonylphenol Loading Rates by Land Use Category in the Puget Sound Basin.

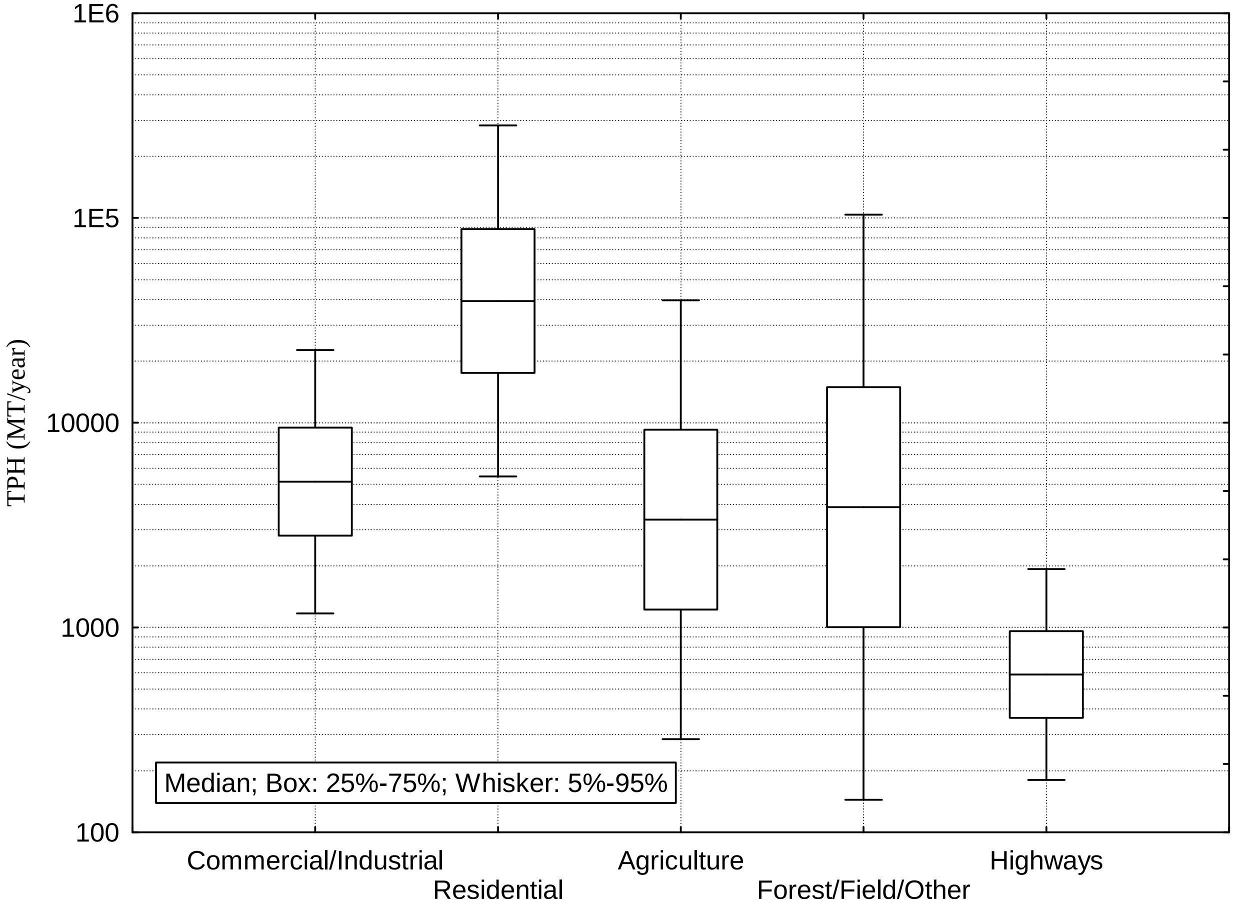

Figure F-17. Total Petroleum Hydrocarbon (TPH) Loading Rates by Land Use Category in the Puget Sound Basin.

Appendix G

Graphical Summaries Comparing Absolute Toxic Chemical Loading Estimates across the 14 Study Areas in Ecology's Puget Sound Box Model

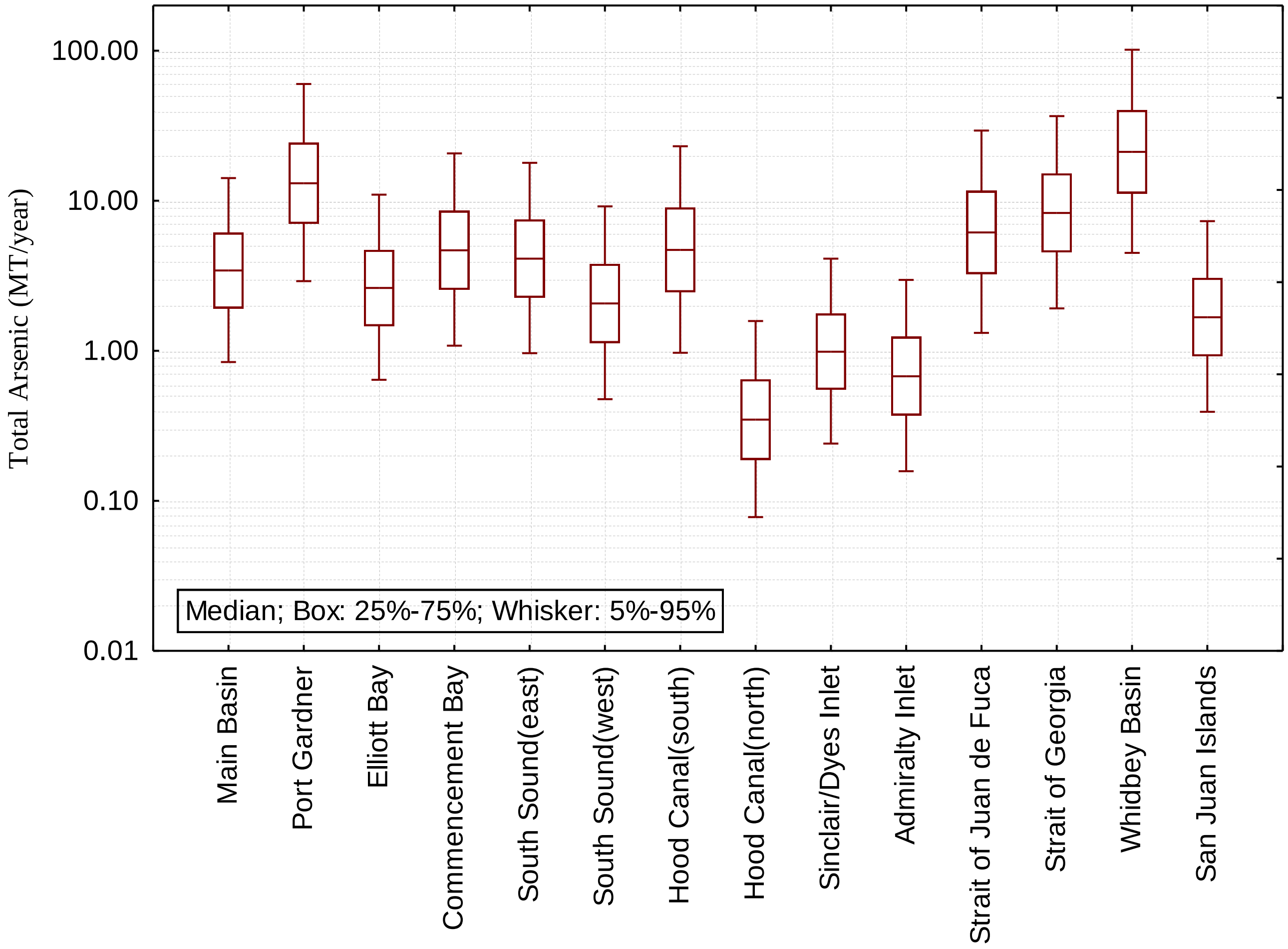

Figure G-1. Total Arsenic Loading Rates by Study Area.

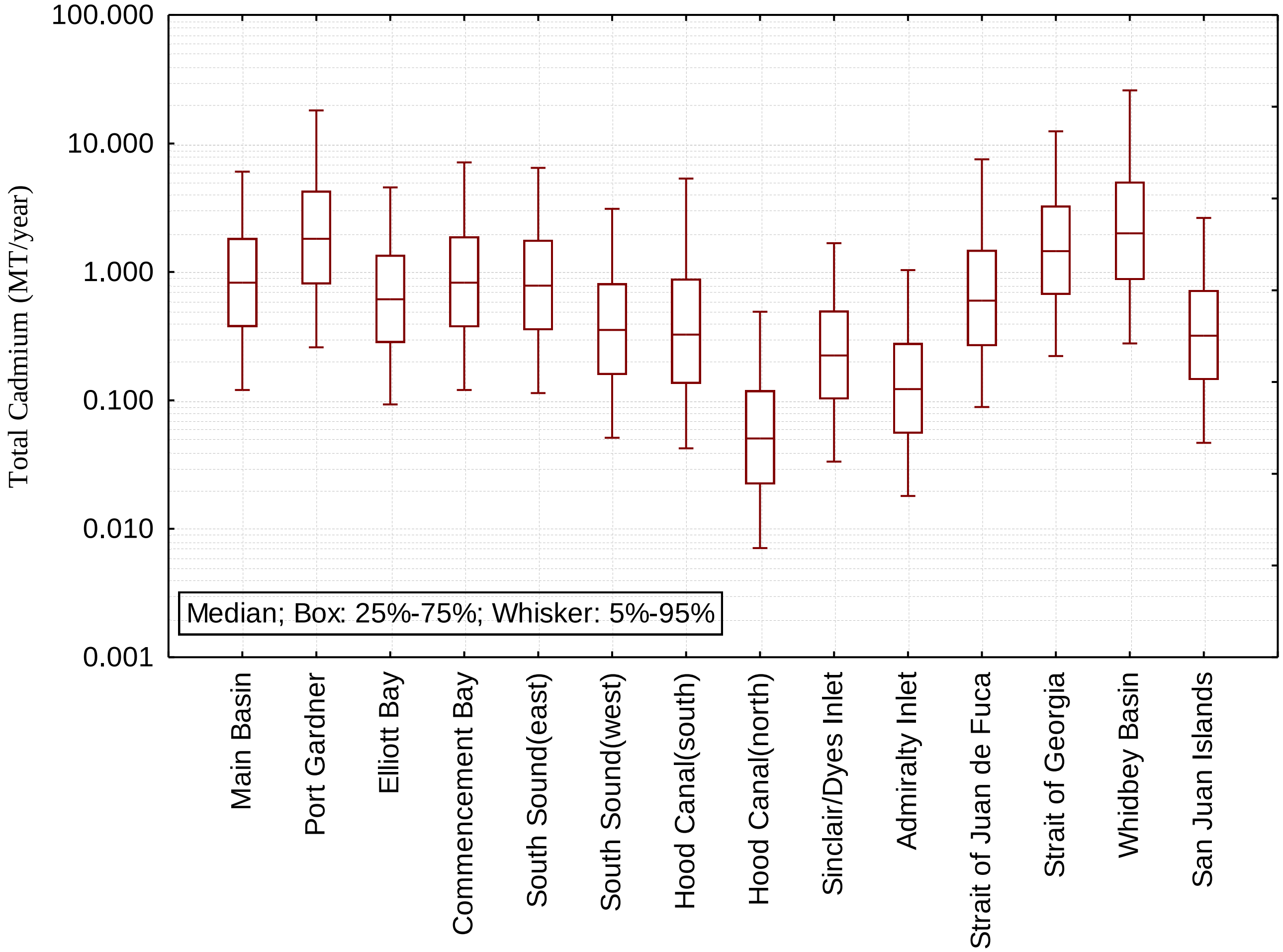

Figure G-2. Total Cadmium Loading Rates by Study Area.

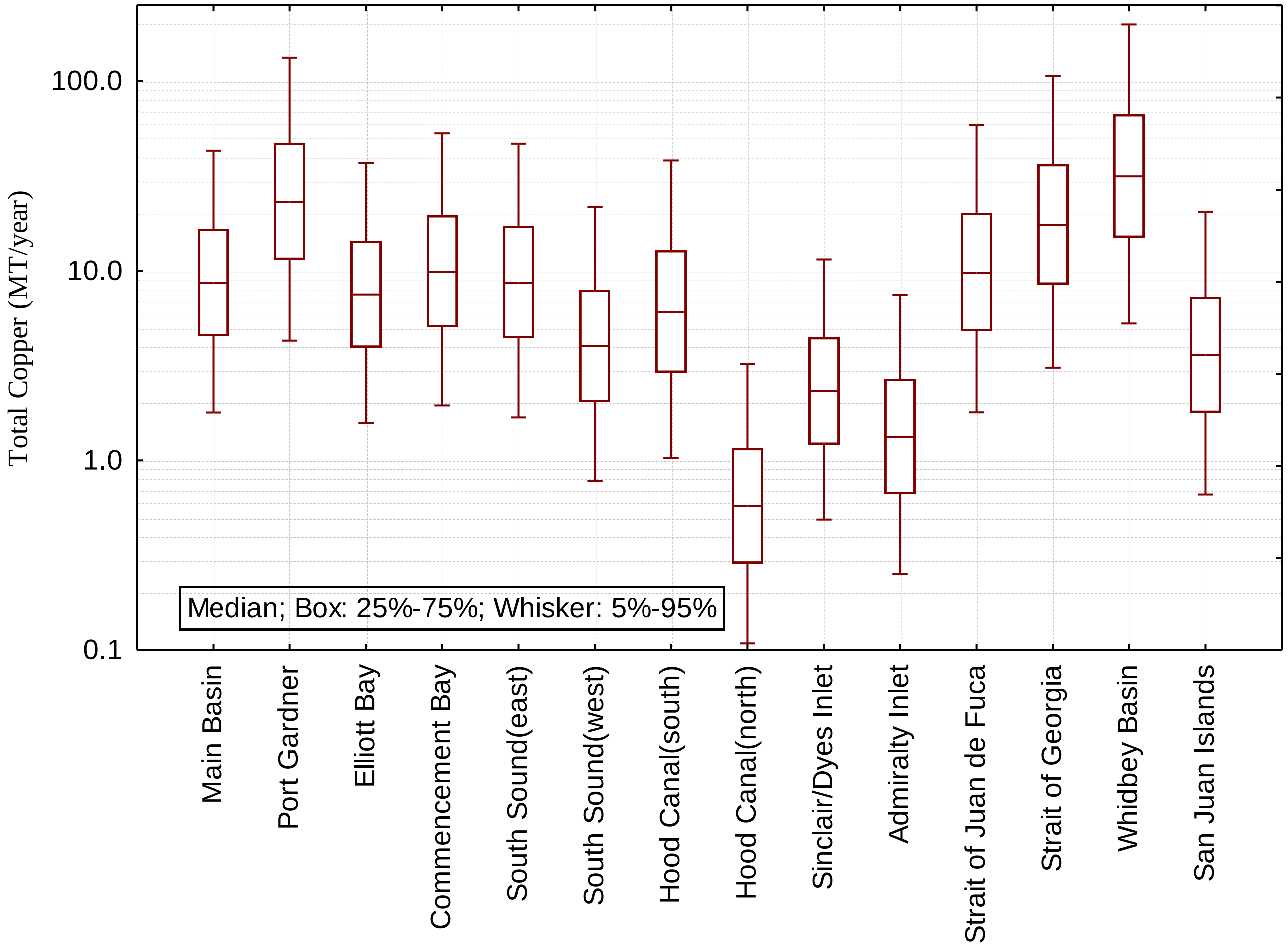

Figure G-3. Total Copper Loading Rates by Study Area.

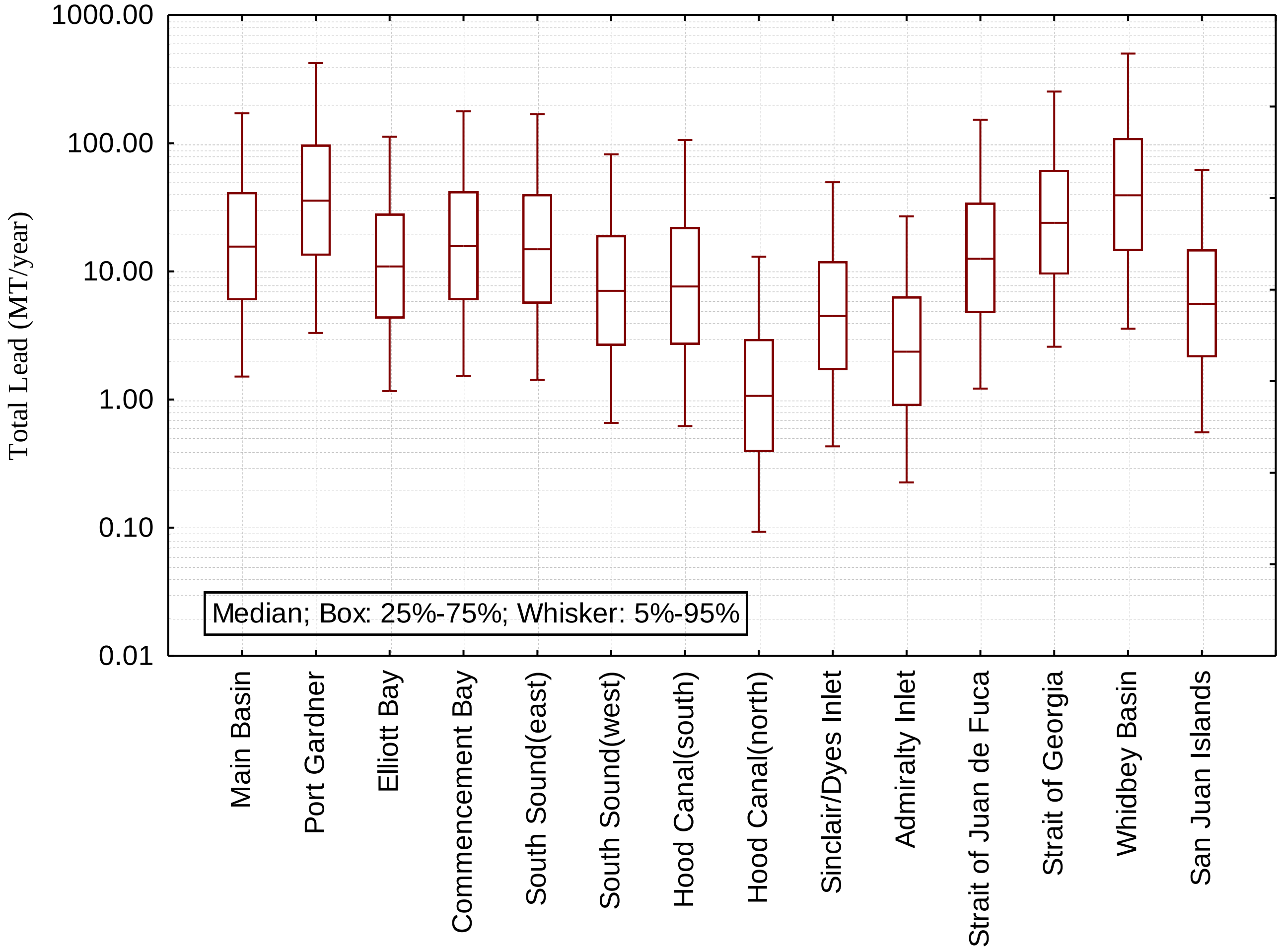

Figure G-4. Total Lead Loading Rates by Study Area.

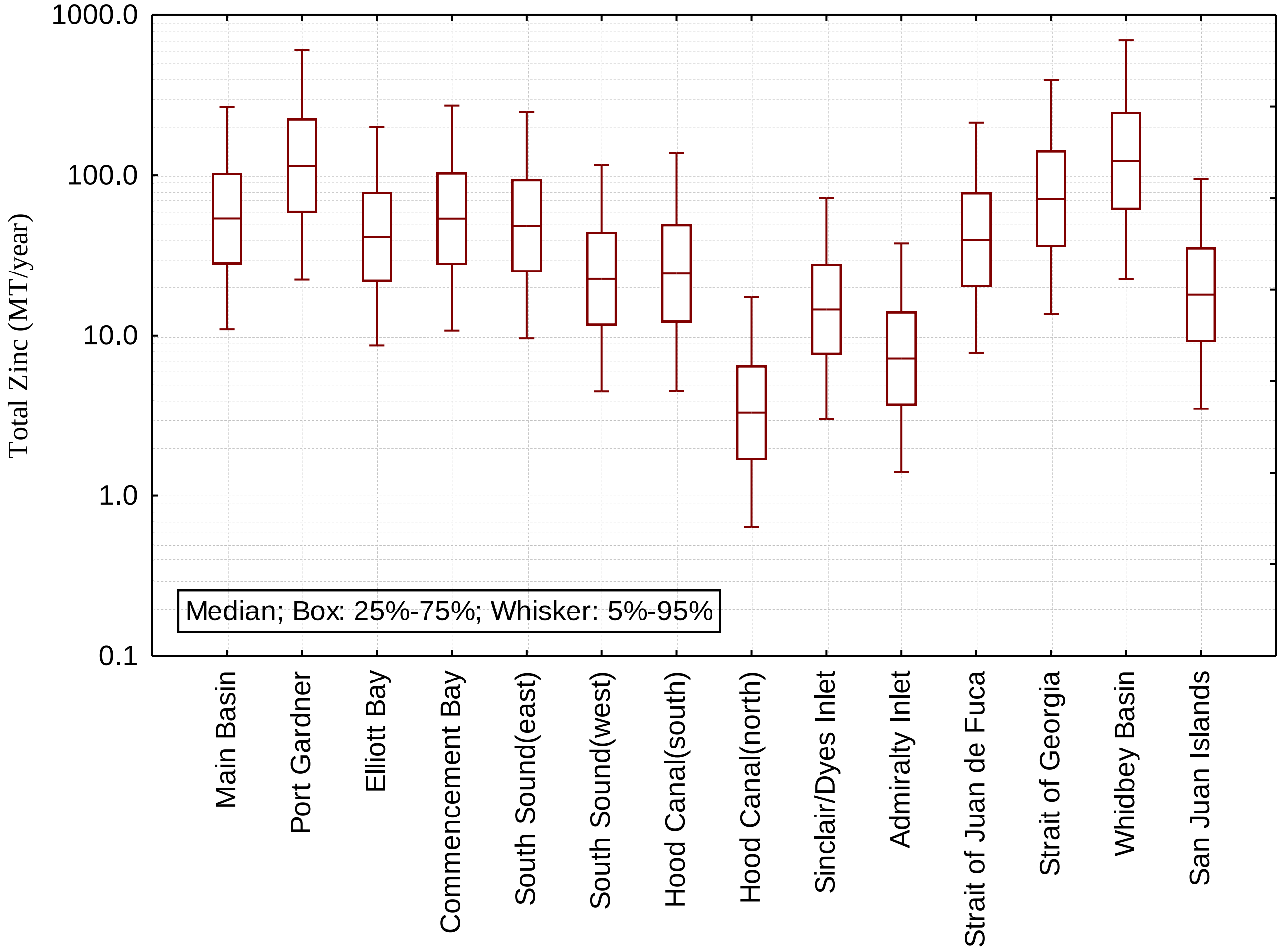

Figure G-5. Total Zinc Loading Rates by Study Area.

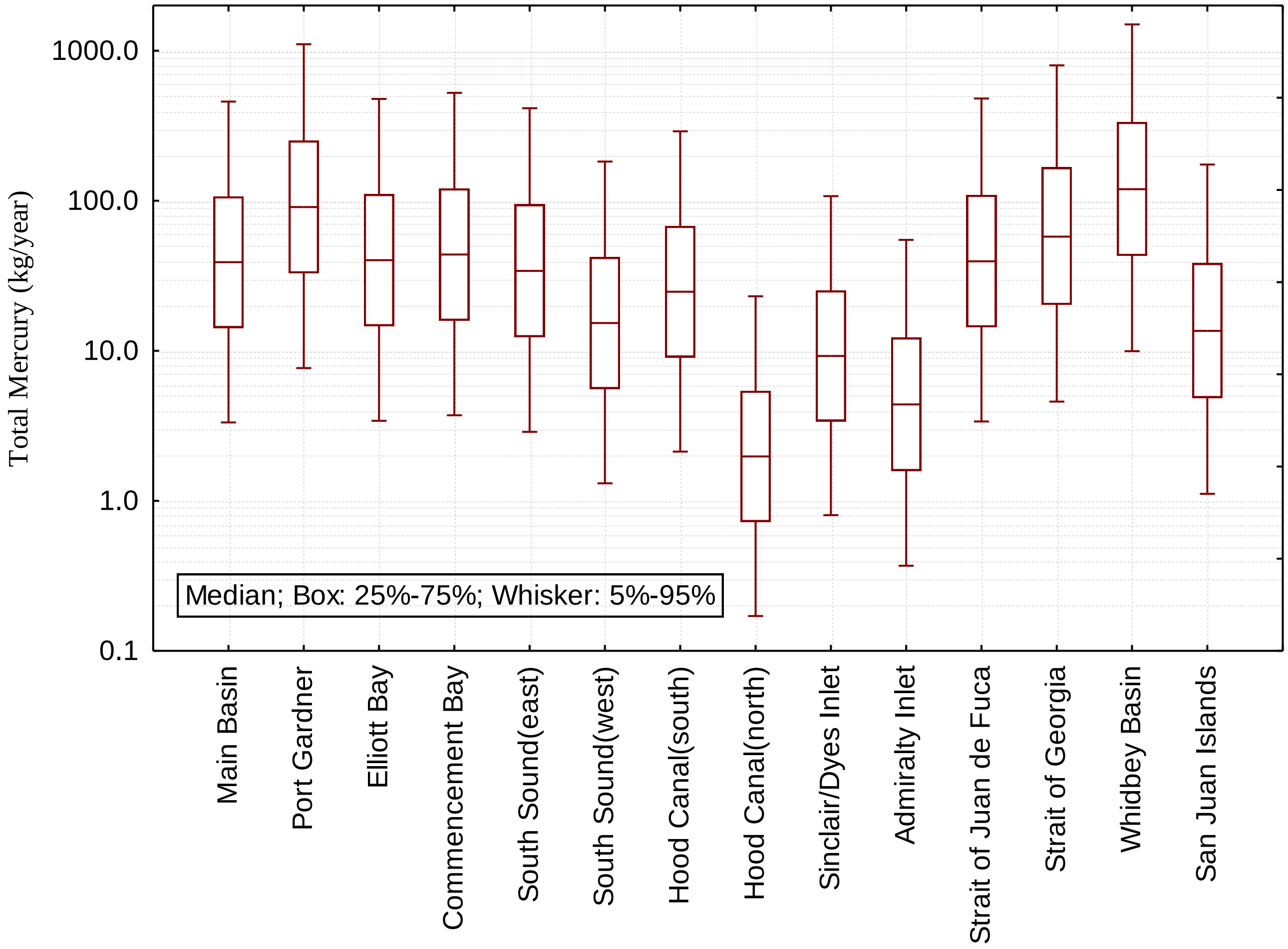

Figure G-6. Total Mercury Loading Rates by Study Area.

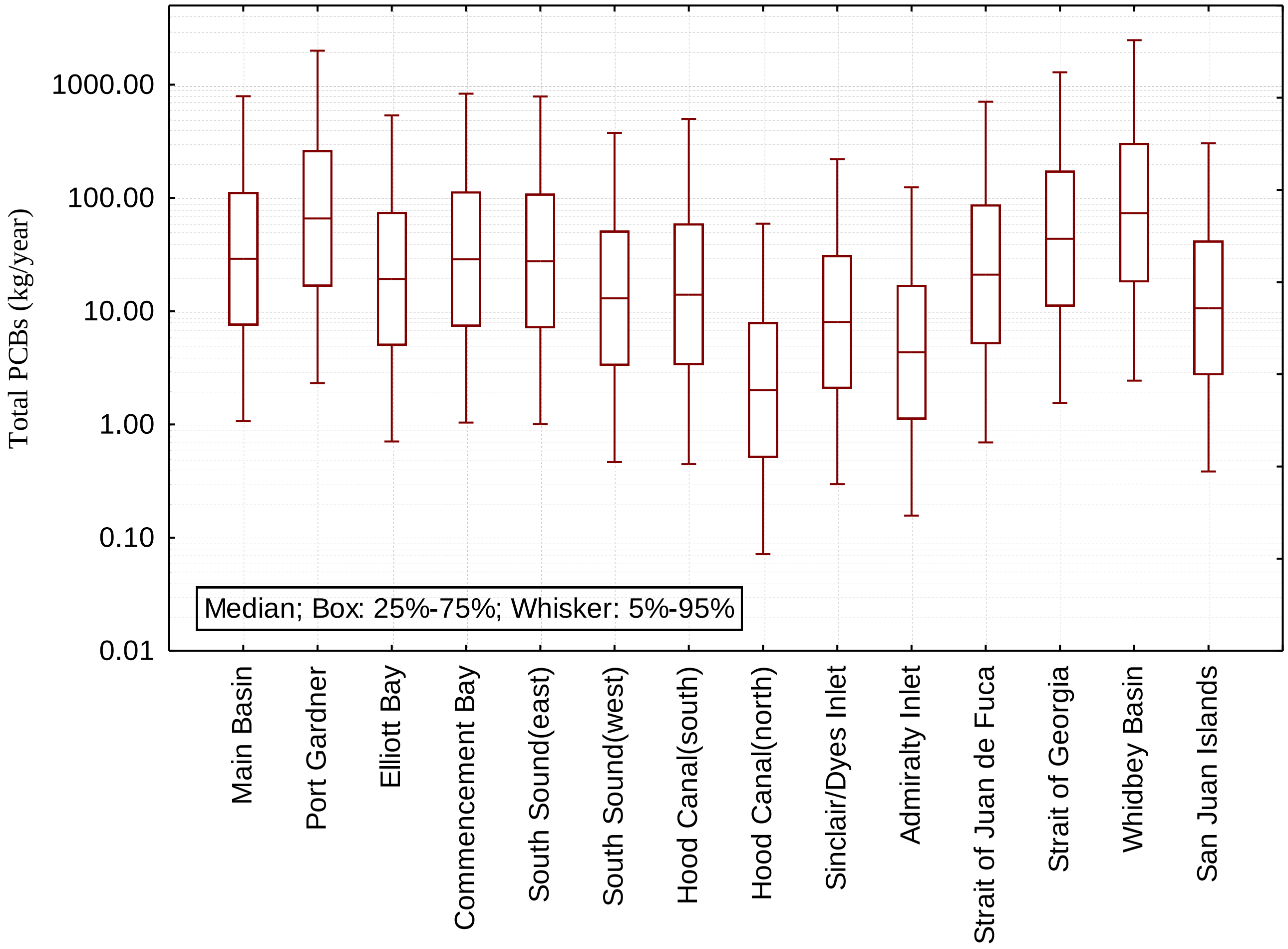

Figure G-7. Total Polychlorinated Biphenyls (PCBs) Loading Rates by Study Area.

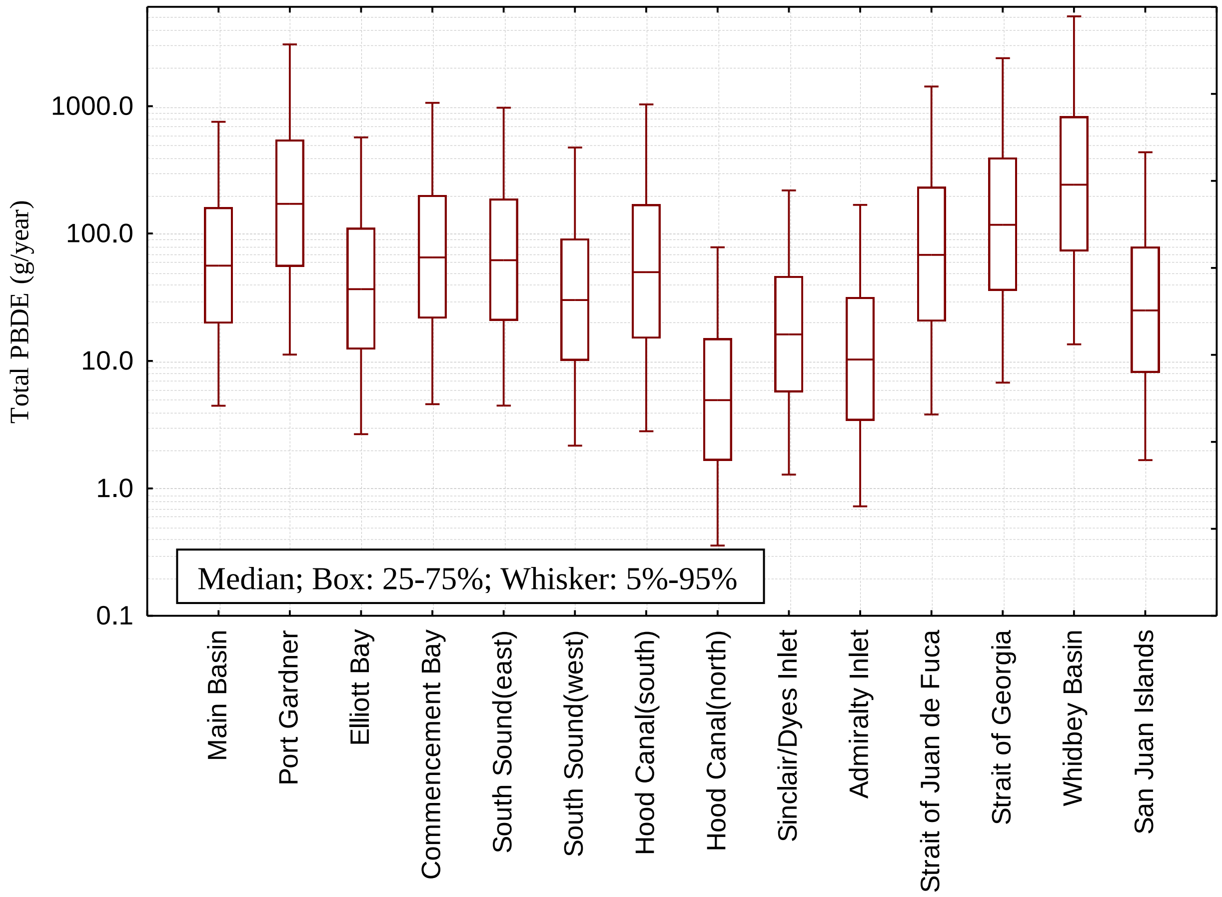

Figure G-8. Total Polybrominated Diphenyl Ethers (PBDEs) Loading Rates by Study Area.

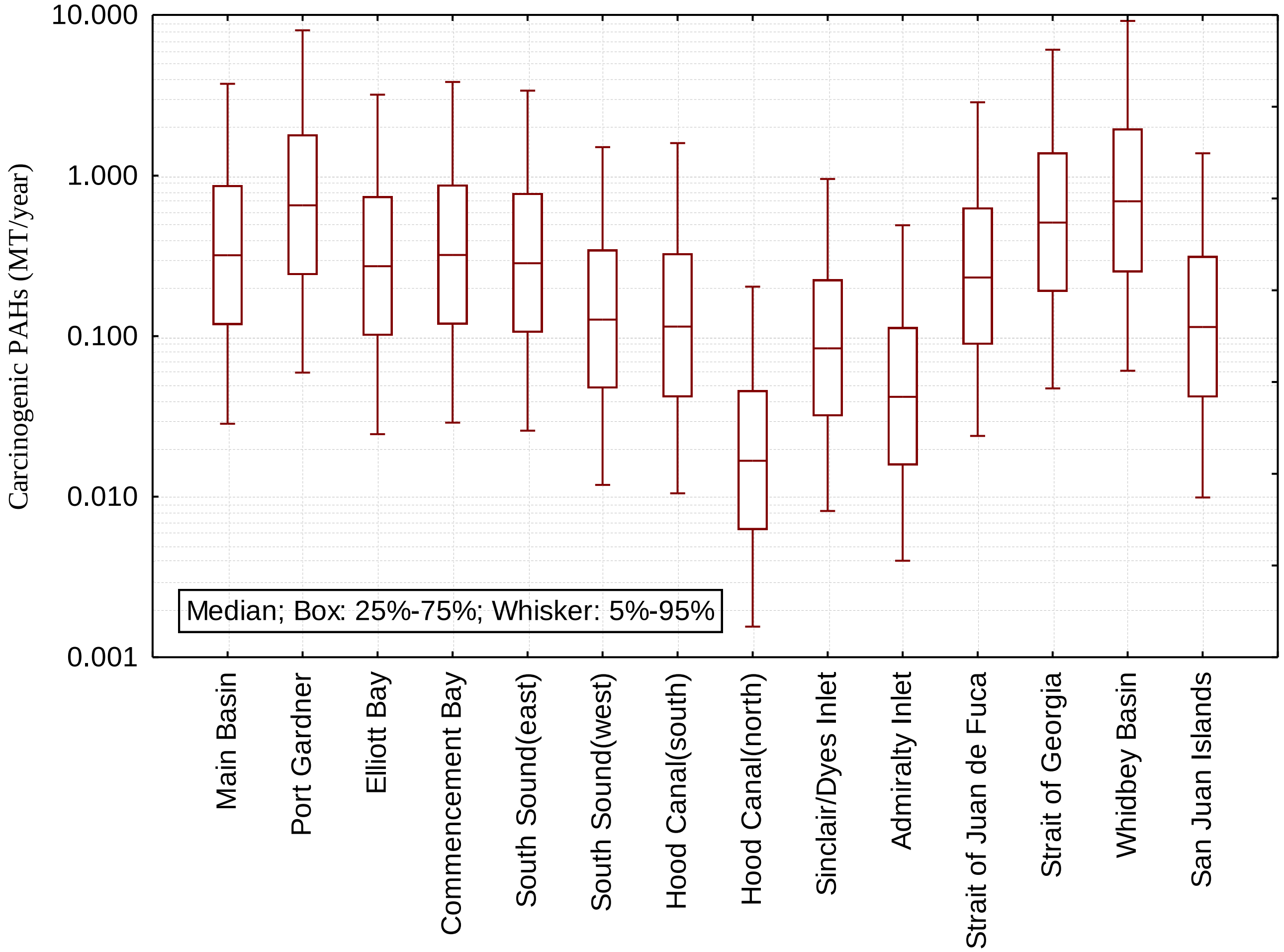

Figure G-9. Carcinogenic Polyaromatic Hydrocarbons (PAHs) Loading Rates by Study Area.

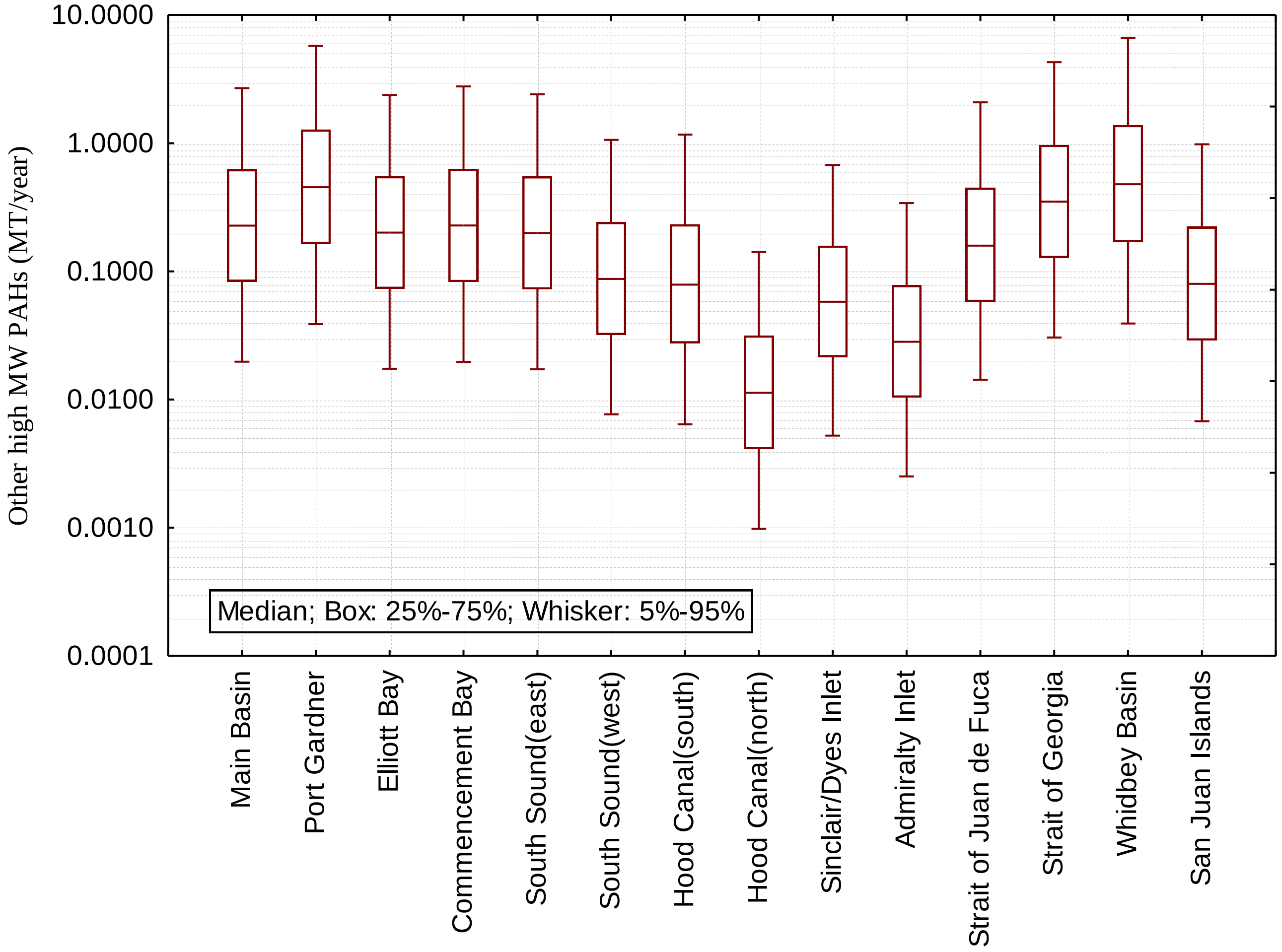

Figure G-10. Other High Molecular Weight Polyaromatic Hydrocarbons (PAHs) Loading Rates by Study Area.

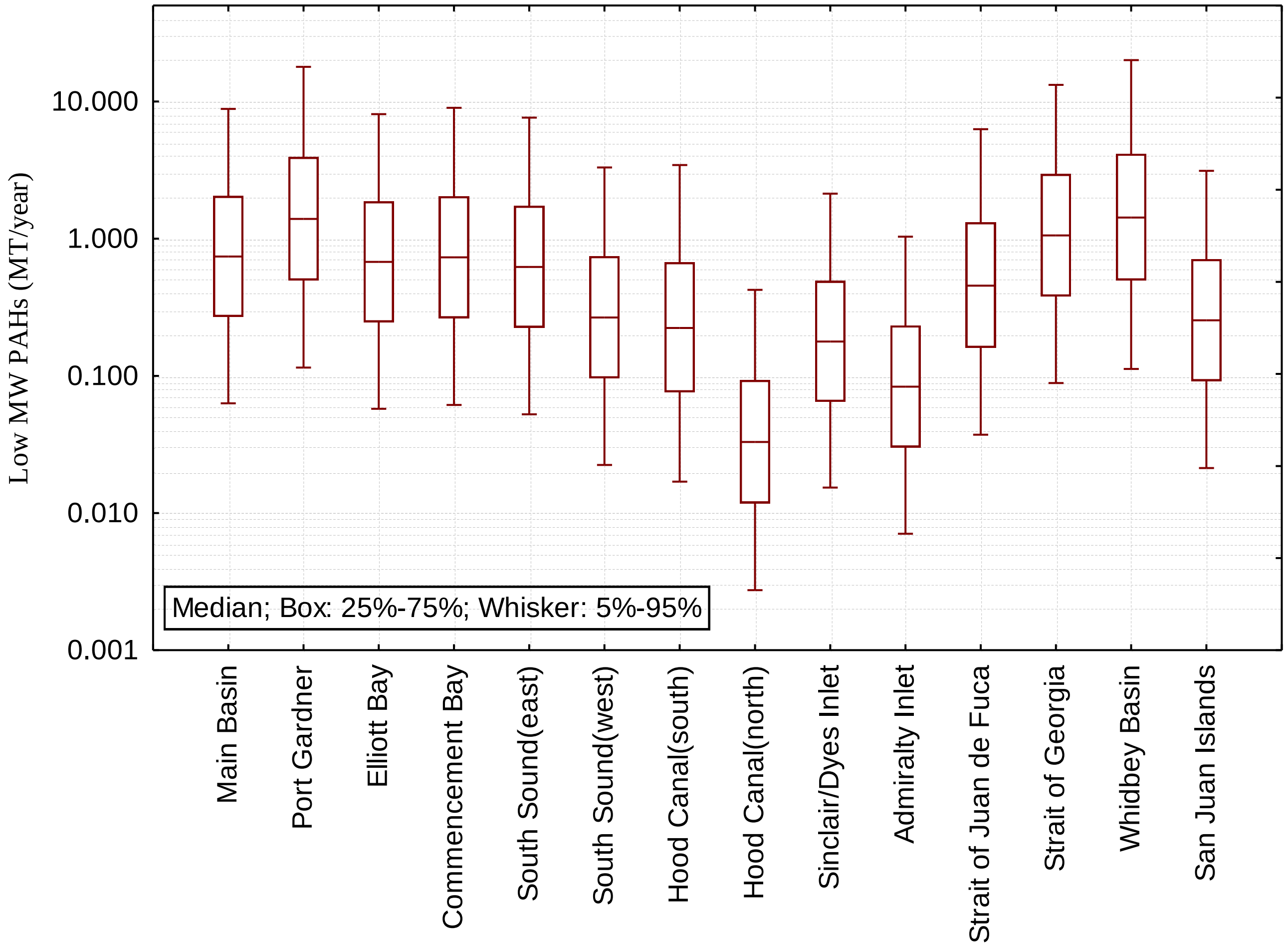

Figure G-11. Low Molecular Weight Polyaromatic Hydrocarbons (PAHs) Loading Rates by Study Area.

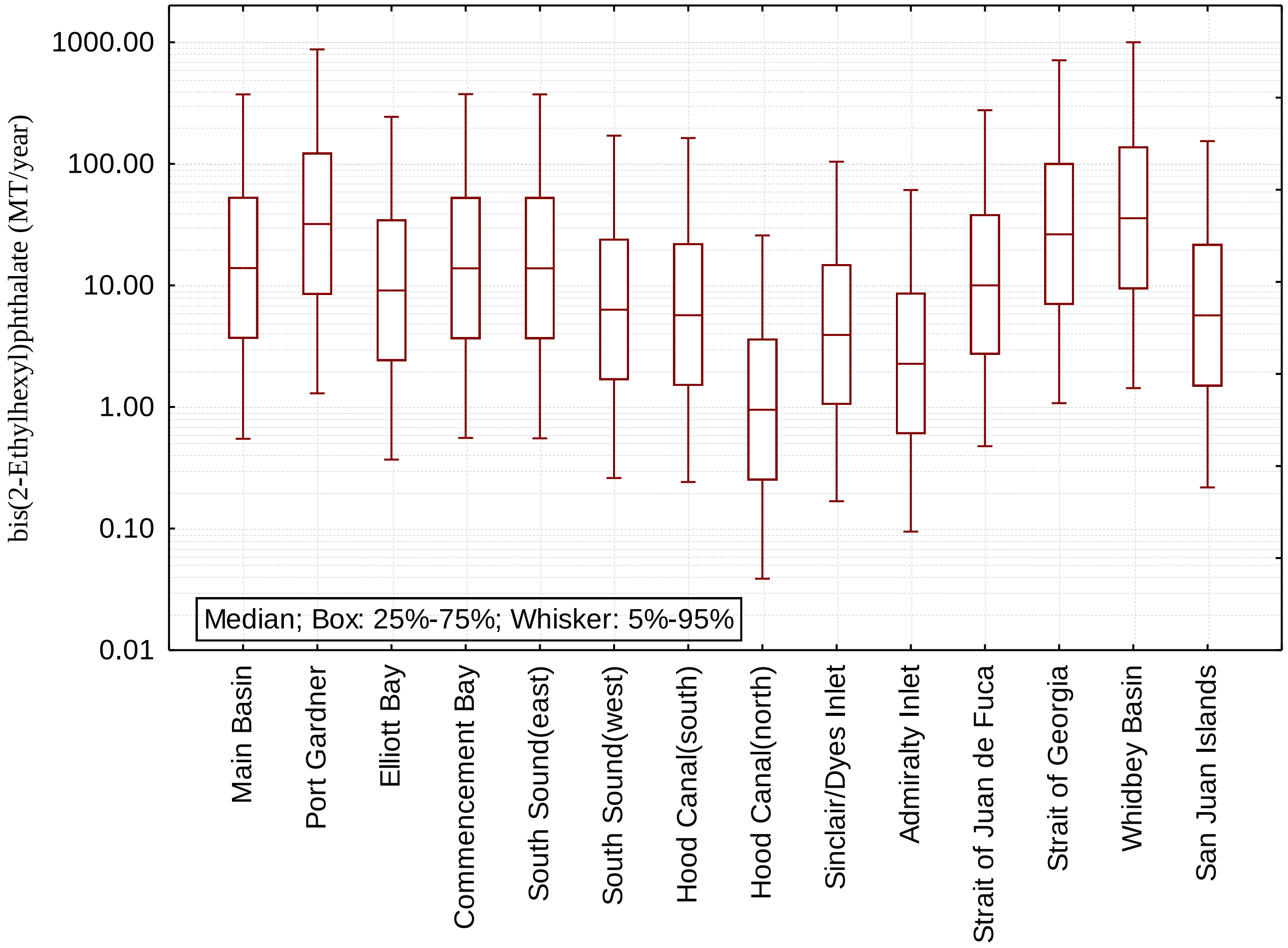

Figure G-12. bis(2-Ethylhexyl)phthalate Loading Rates by Study Area.

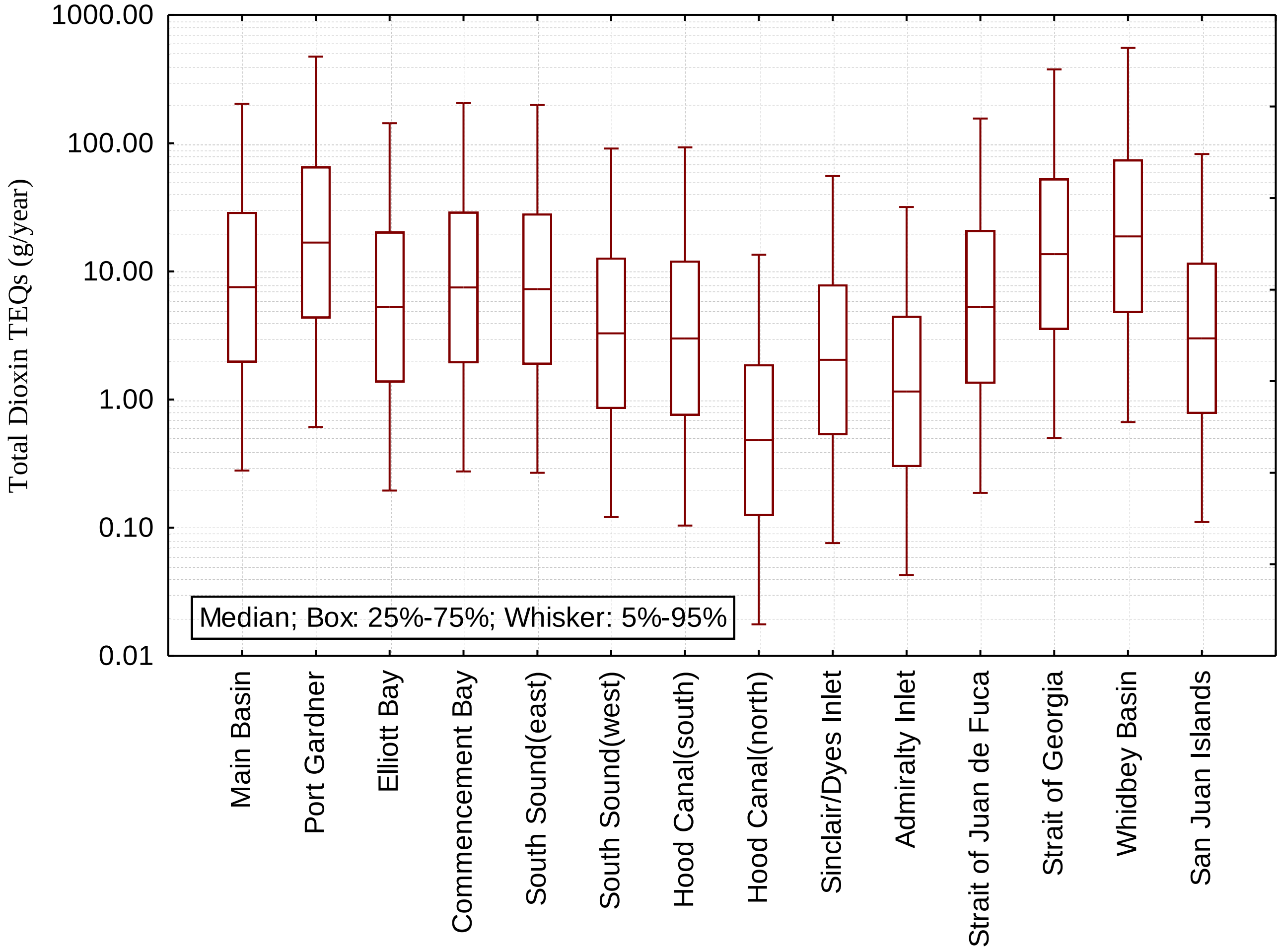

Figure G-13. Total Dioxin Toxicity Equivalents (TEQs) Loading Rates by Study Area.

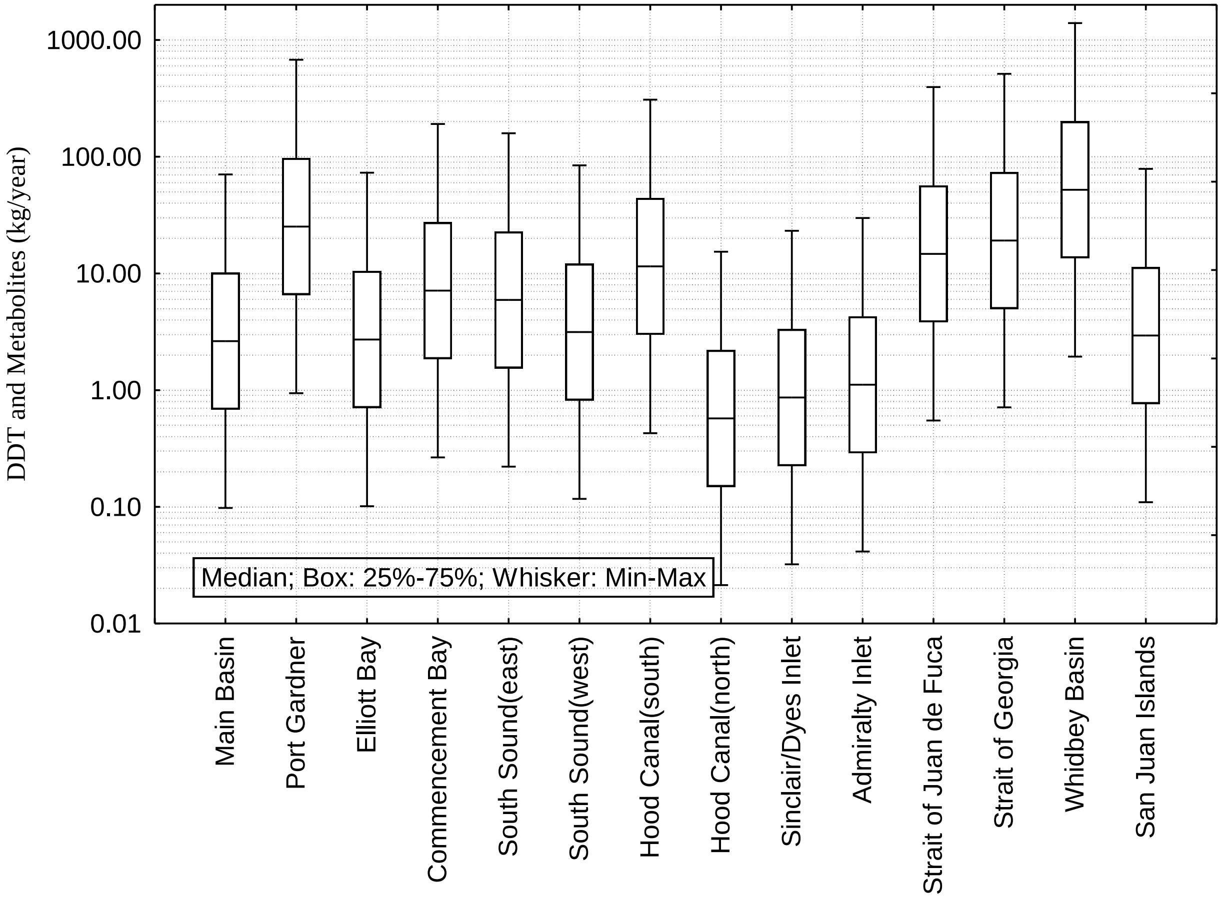

Figure G-14. Dichlorodiphenyltrichloroethane (DDT) and Metabolites Loading Rates by Study Area.

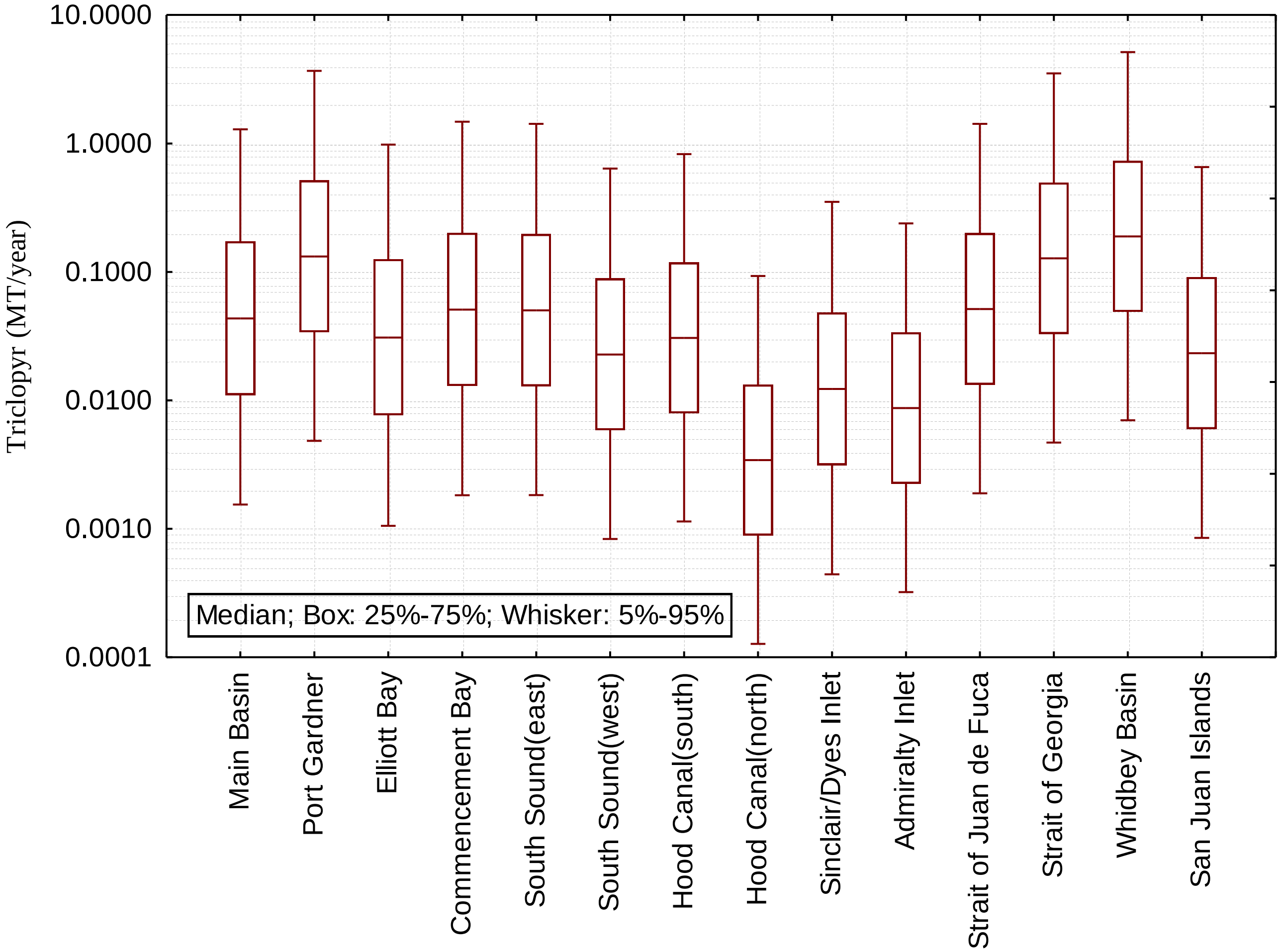

Figure G-15. Triclopyr Loading Rates by Study Area.

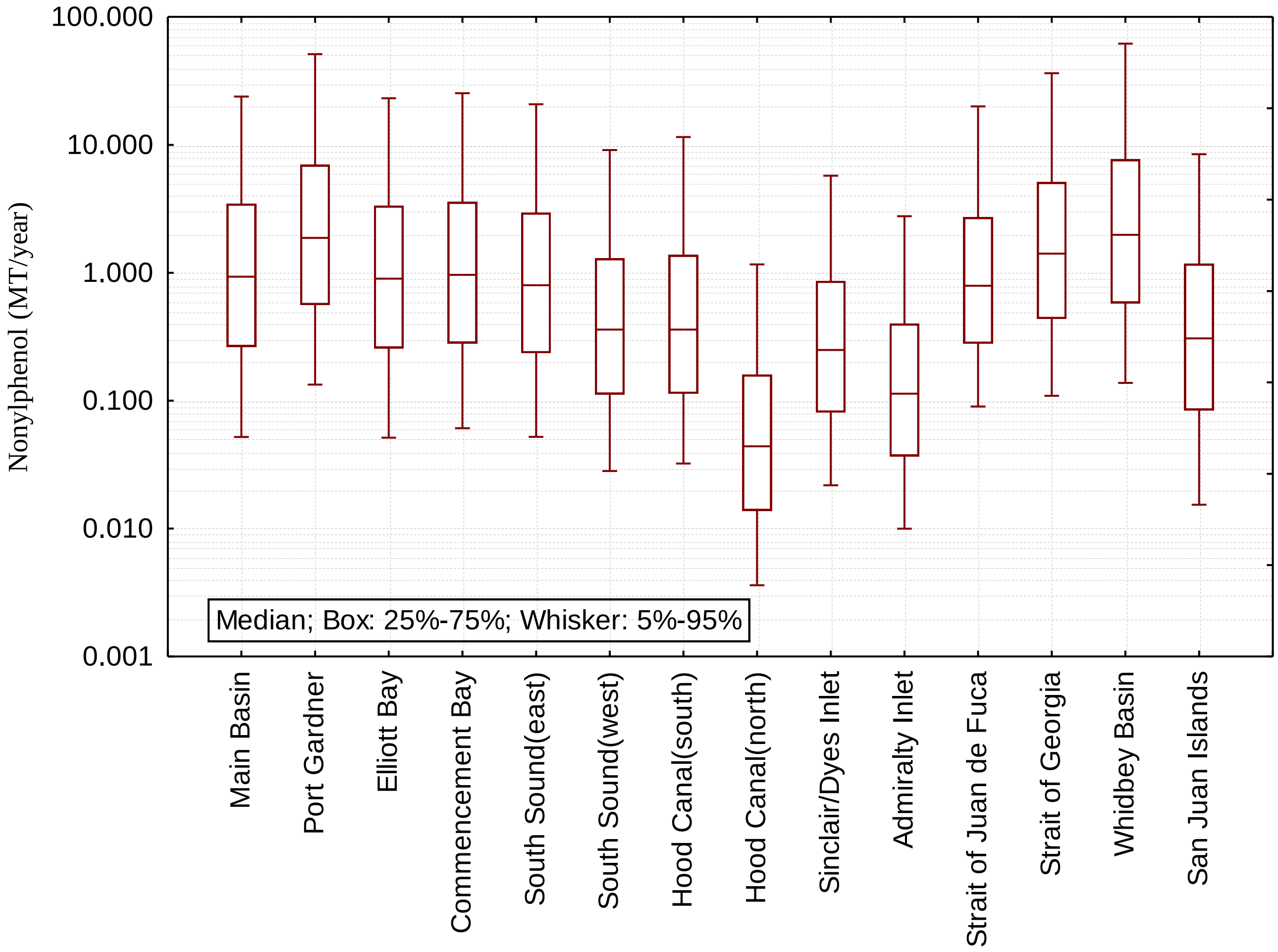

Figure G-16. Nonylphenol Loading Rates by Study Area.

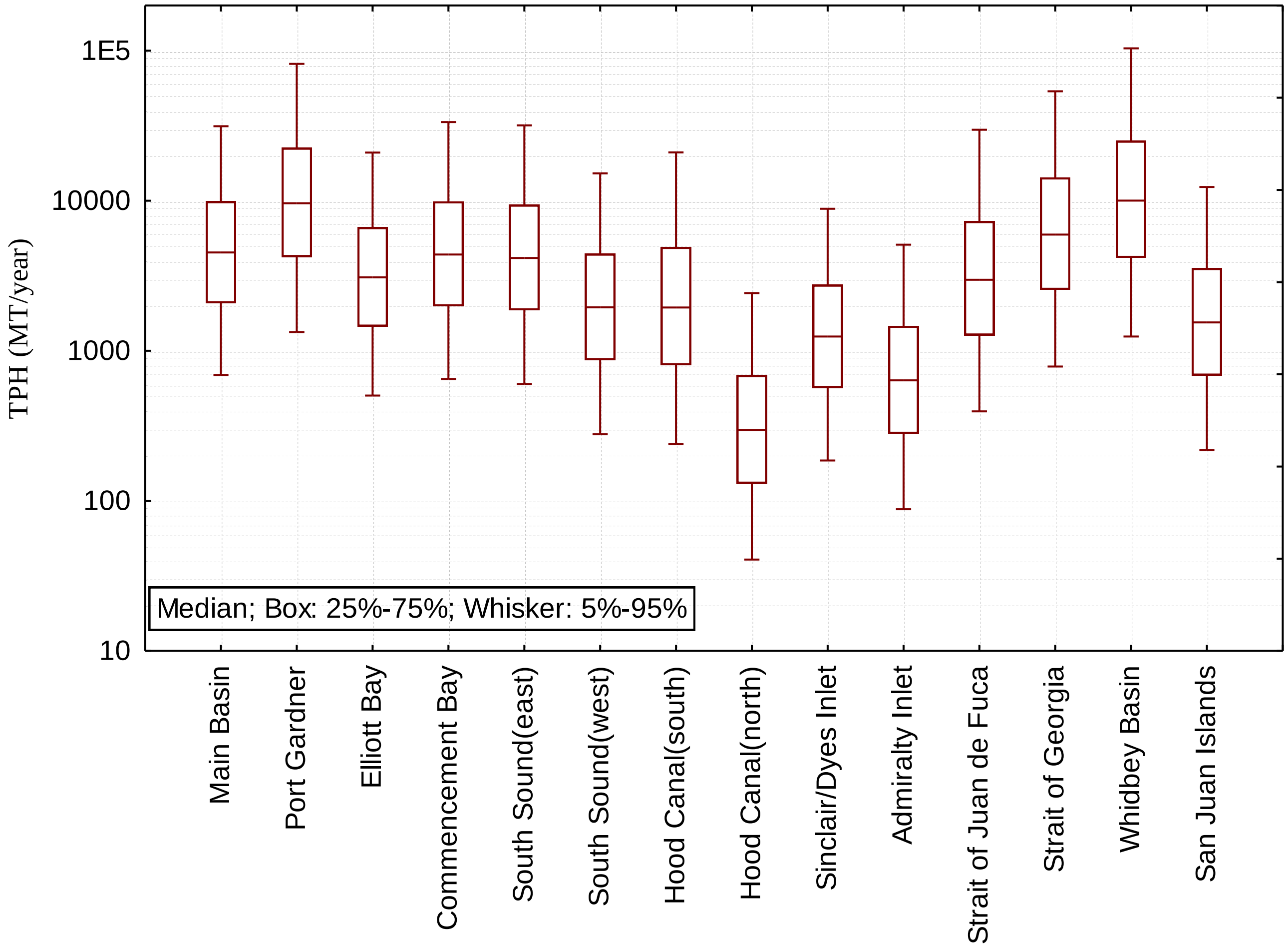

Figure G-17. Total Petroleum Hydrocarbon (TPH) Loading Rates by Study Area.